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A collection of tools for land restoration

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Introduction and background

Forests and trees have a major role to play to address major global challenges such as: climate change, deforestation, forest degradation, biodiversity erosion, poverty and food insecurity. Over the last ten years, forest and landscape restoration (FLR) has gained increased traction on the political agenda (**Box 1**). The Bonn Challenge (2011),[1] completed by the New York Declaration on Forests (2014),[2] have set a global target of 350 million ha of degraded forests and landscapes restored by 2030.

Box 1. Defining some common terms

Degradation: Loss of functionality of e.g. land or forests, usually from a specific human perspective, based on change in land cover with consequences for ecosystem services.

Degraded lands: Lands that have lost functionality beyond what can be recovered by natural processes and existing land-use practices in a defined, policy-relevant time frame.

Restoration: Efforts to halt ongoing and reverse past degradation, by aiming for increased functionality (not necessarily recovering past system states).

Source: Joint workshop on land restoration (FTA/PIM/WLE, 2018)[a]

a FTA/PIM/WLE. 2018. Joint CRP *(FTA-WLE-PIM) workshop on Land restoration*, held on 31st August and 1st September, 2018 at ICRAF Headquarters in Nairobi. Full proceedings. https://www.cifor.org/publications/pdf_files/FTA/ProgramRecords/FTA-Record-1.pdf

In March 2019, the UN General Assembly declared 2021-2030 the UN Decade on Ecosystem Restoration (A/RES/73/284).[3] By fostering the achievement of global FLR targets, this UN Decade will contribute not only to achieve SDG15 ("Life on land") but also to address simultaneously most of the other sustainable development goals (SDGs), including: poverty reduction (SDG1), food security (SDG2), provision of clean water (SDG6) and clean energy (SDG7), job creation and economic growth (SDG8), responsible consumption and production (SDG12), and climate action (SDG13). The UN Environment Programme (UNEP) considers that restoring 350 million hectares (ha) of degraded land by 2030, as committed in the New York Declaration on Forests, could generate USD 9 trillion in various ecosystem services and remove about 13–26 gigatons of greenhouse gases (GHG) from the atmosphere.[4]

Regional initiatives have also emerged, such as the Great Green Wall Initiative,[5] the African Forest Landscape Restoration (AFR100) Initiative,[6] the Asia-Pacific Regional Strategy and Action Plan on Forest and Landscape Restoration to 2030 (APFLR),[7] or the initiative 20x20 in Latin America and the Caribbean.[8] At national level, FLR is increasingly identified

1 See: http://www.bonnchallenge.org

2 See: http://forestdeclaration.org

3 See: https://undocs.org/en/A/RES/73/284

4 See: https://www.unenvironment.org/news-and-stories/press-release/new-un-decade-ecosystem-restoration-offers-unparalleled-opportunity

5 See: https://www.unccd.int/actions/great-green-wall-initiative

6 See: http://afr100.org

7 See: http://www.fao.org/3/i8382en/I8382EN.pdf

8 See: https://initiative20x20.org/

as an efficient way to advance national commitments under global UN conventions. FLR can also be a major contribution to the implementation and achievement of Nationally Determined Contributions (NDCs, under the UN Framework Convention on Climate Change - UNFCCC) and National Biodiversity Strategies and Action Plans (NBSAPs, under the UN Convention on Biological Diversity – CBD), as a way to combat climate change and biodiversity loss as well as to contribute to climate change adaptation.

Successful and sustainable land restoration requires a broad, diverse and transdisciplinary knowledge, as well as a deep knowledge of local socio-ecological contexts. Research and development (R&D) institutions are pivotal as they generate the knowledge, conceptual approaches, field results and practical tools to inform and support the relevant stakeholders (e.g.: international organizations, national governments and local administrations, private companies, civil society organizations, smallholders and local communities). R&D institutions can help the relevant stakeholders: achieve their FLR targets at different scales; make sure that FLR effectively contributes to the SDGs; and feedback properly the lessons learned into FLR planning processes. A range of tools have been developed to support countries and stakeholders in the preparation, design, implementation and assessment of FLR.

The present document is a compilation of existing restoration tools developed by CGIAR research programmes (CRPs), CGIAR centers and partner organizations. Its objective is to inform the different stakeholders involved in FLR at different scales (policy makers, forest managers and restoration practitioners, land owners, project managers, conservation organizations, students and researchers) and help them navigate through the huge diversity of existing restoration tools that can be used to support the design, implementation and assessment of restoration projects as well as on the range of topics and issues for them to consider. This compilation gathers a collection of short information sheets on existing FLR tools, developed following a common template. It is organized as follows. **Section 1** explains the conceptual framework and the methodology followed. **Section 2** provides a synthetic overview of the different restoration tools presented here, that can be used in different contexts for different purposes. **Section 3** presents in more details the 123 restoration tools included in this compilation.

1 Methodology

1.1 Definition and scope

A "tool" generally designates "any physical item that can be used to achieve a goal, especially if the item is not consumed in the process" (Van Noordwijk *et al.,* 2013[9]). However, for the purpose of this compilation, as in previous reviews (Van Noordwijk *et al.*, 2013; Gitz *et al.,* 2020[10]), the term "tool" is used in a wider sense, to denote not only physical items (such as databases, maps or models), but also methods and guidelines, or negotiation supporting processes.

This compilation focuses primarily on "mature tools", already tested and effectively used on the ground, with positive evidence of impact (101 tools out of 123). However, it includes also some promising tools at earlier stages of development (21 tools) and even one terminated tool, no longer used nor maintained, but that could inspire future research or future restoration projects. It contains mainly tools developed over the past decade but some of them are older.

This compilation is not limited to tools explicitly focused on FLR but covers also tools that can be used to explore the links between restoration activities and other related issues such as: sustainable landscape management, land use and land use changes; biodiversity, vegetation, genetic diversity and seeds; climate change, GHG emissions and carbon storage; natural resources management (water, soil, air); livelihoods and gender, resilience and equity, profitability and markets; rights, governance, institutions and capacity development.

1.2 Process

This compilation of restoration tools builds upon previous FTA reviews of restoration tools (van Noordwijk et al., 2013; Gitz et al., 2020).

Van Noordwijk *et al.* (2013) presented a collection of about 50 tools that allow rapid landscape appraisals, help build a shared understanding of the landscape dynamics in a specific context, and support negotiation between local stakeholders around specific issues such as: livelihoods, gender inequalities, conflicts over land tenure, resilience to climate change and market fluctuations, landscapes and the ecosystem services they provide (e.g. water provision, biodiversity, air quality and carbon storage).

In 2018, FTA organized with PIM and WLE [11] a joint workshop on land restoration to explore and define future collaboration on land restoration, bringing together the

9 Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D. (eds). 2013. Negotiation-support toolkit for learning landscapes. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. https://apps.worldagroforestry.org/region/sea/publications/download?dl=/BK0170-13.pdf-1.pdf&pubID=3007&li=7522; and, https://apps.worldagroforestry.org/region/sea/publications/download?dl=/BK0170-13-2.pdf&pubID=3007&li=7523

10 Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

11 i.e., the CGIAR research programmes on: Forests, Trees and Agroforestry (FTA); Policies, Institutions and Markets (PIM); and, Water, Land and Ecosystems (WLE).

streams working on soil, water and forest and land restoration (FTA/PIM/WLE, 2018). As a first product of this collaboration, Gitz *et al.* (2020) reviewed CGIAR activities on forest and landscape restoration. They analyzed 76 projects, grouped in three main categories: (i) 39 case studies and projects (CSP); (ii) 22 tools for development (T4D); and (iii) 12 analyses and conceptual frameworks (ACF). They distinguished two categories of tools, namely: (i) decision-making supporting tools; and (ii) models and maps.

This 2018 joint workshop also recommended to develop a compilation of existing tools that can be of use to inform and support the design, implementation and assessment of restoration projects. Following this recommendation, the realization of this compilation of restoration tools was inscribed in 2019 as a key activity under FTA's research priority on FLR. A preliminary work was coordinated in 2019 and 2020 by our late colleague, Muhammad Mehmood Ul Hassan, in collaboration with Nargiza Nizamedinkhodjayeva (IWMI) and Cristina Maria Katto (Alliance of Bioversity International and CIAT). A survey conducted between March and December 2019 within FTA partner centers led to the inclusion of 37 additional restoration tools in this compilation.

A draft compilation was sent in November 2021 to all contributors, acknowledged in **Annex**, for a last round of comments. Seven additional information sheets were collected during this phase. In total, this compilation gathers information sheets on 123 different tools (**Section 3**).

The present compilation does not pretend to be exhaustive. It gathers the tools developed or used by the researchers that participated in the successive surveys. As such it gives an initial picture of the field. Further efforts will be needed to extend and regularly update this exercise. Further communication, outreach and capacity-building efforts would also be needed to share broadly the wealth of information already included in this compilation and use it to enhance FLR.

1.3 Method

The information sheets contain the information available at the time of completion, relying mainly on what was provided during the survey. The level of details provided thus varies across information sheets. All information sheets were developed following a common template to ease data treatment and analysis. This common templat**e** (**Box 2**), is organized as follows.

A short text describes the tool, its scope and main objective. Then, a range of variables are informed, using the closed lists of possible answers reproduced in **Box 2**, to facilitate classification, clustering and comparison across tools for different purposes:

- **Category of tool:** two broad categories are distinguished: (i) decision-making supporting tools; and (ii) data-analysis supporting tools. Sub-categories are indicated in **Box 2**.
- **Main theme:** as mentioned above, the restoration tools included in this compilation do not all focus exclusively on FLR but cover a wide diversity of topics listed in **Box 2.**
- **Main focus:** the tools can focus either on biophysical and ecological aspects of restoration, on socio-economic aspects, or on governance and institutional aspects.
- **Scale:** the tools cover different scales, from the individual tree or plot to the regional and global scales. Some tools can be applied at multiple scales.
- **Stage of development:** although this compilation focuses mainly on mature tools, it includes also some tools either under development or terminated.
- Examples of impact and effective use of the tool on the ground, useful references and further readings.

Box 2. Information sheet: a common template

Title:

Contact:
Name – Surname
CRP/Institution:
Website:

Short description of the tool:

Category of tool:

- Data-analysis supporting tool:
  - Data collection and database
  - Modelling and mapping
- Decision-making supporting tool:
  - Method or process facilitating discussions between actors
  - Manual or guidelines

Main theme:

- Agriculture
- Agroforestry
- Biodiversity, natural resources and ecosystem services
- Climate change and carbon stocks
- Forest landscape restoration
- Food security and nutrition
- Gender
- Governance, institutions and capacity development
- Land use, land use changes
- Livelihoods and resilience
- Seeds, genetic diversity and tree-site matching
- Sustainable forest management
- Sustainable landscape management
- Soil
- Water
- Other topics

Main focus:

- Biophysical and ecological aspects
- Socio-economic aspects
- Governance aspects

Scale:

- Individual tree
- Plot/Field
- Farm
- Landscape
- National
- Regional
- Global

Stage of development:

- Under development or pilot-test at the time of writing
- Effective use on the ground (mature tool)

Example(s) of effective use:

References and further readings:

2 Overview: analysis of existing tools

Table 1. Restoration tools: scale of application

Scale	Nb. of tools	Information sheet #
Landscape	63	#1, #2, #3, #4, #5, #6, #8, #10, #12, #13, #14, #19, #20, #21, #22, #23, #24, #25, #26, #27, #29, #32, #33, #34, #37, #38, #39, #40, #41, #42, #43, #44, #45, #46, #47, #48, #49, #50, #51, #53, #55, #56, #59, #61, #62, #64, #68, #70, #71, #72, #87, #92, #94, #96, #97, #98, #99, #100, #101, #105, #106, #108, #120
From landscape to global level	38	#54, #57, #60, #69, #73, #74, #75, #76, #77, #78, #79, #80, #81, #82, #83, #85, #86, #88, #89, #90, #93, #95, #102, #103, #104, #107, #109, #110, #113, #114, #115, #116, #117, #118, #119, #121, #122, #123
From individual tree to landscape	17	#15, #16, #17, #18, #28, #30, #31, #35, #36, #58, #63, #65, #66, #67, #84, #111, #112
Scale neutral or applicable at all scale	5	#7, #9, #11, #52, #91

This section draws a broad overview of the tools included in this compilation. It aims at helping the different stakeholders navigate through the diversity of restoration tools and find the tools that can match their priorities, objectives and needs in a specific context. Existing tools can also serve as a source of inspiration, a basis to develop new tools, filling a gap, more accurate, or better adapted to a specific context. This section aims to answer the following questions:

- At which scale can the restoration tool be implemented?
- Which aspects of restoration are addressed by the tool? Which topics, issues and challenges are covered, in relation with FLR?
- What kind of tool can be implemented? How can it contribute to the decision-making process?

2.1 Scope and scale of tools

Most of the tools presented here have been designed for use in a developing countries context. Some tools have been designed for and developed within specific contexts, either local (e.g. #63[12]), national (e.g. #79, #84, #88, #89, #118) or regional (e.g. #54, #60, #61, #71, #73, #74, #80, #113). Others are global in scope (e.g. #75, #76, #77, #119) or easy to adapt and implement in various contexts around the globe (e.g. #70, #92). For instance, since 2005, the Land Degradation Surveillance Framework (LDSF, #70) has been applied in over 250 landscapes (100 km^2 sites), in more than 30 countries across the global tropics, by governments, NGOs, CGIAR centers, CRPs, donors, to assess land and soil health, prioritize, monitor and track interventions (Gitz et al., 2020).

This compilation covers a variety of scales, with tools applicable either at individual tree, plot, field, farm, landscape, national, regional or global level. It includes also some multi-level tools, applicable at different scales. About

12 Numbers between brackets refer to numbers of the information sheets in Section 3. Examples given between brackets in this overview are illustrative, and by no way an exhaustive list of what exists.

half of the tools included in this compilation (63 out of 123) are implemented at farm and/or landscape level. This highlights the importance of integrated landscape approaches for effective restoration interventions. The landscape perspective is wide enough to allow synergies among different socio-ecological system components and functions and fine enough to build upon a deep knowledge of, and a fine adaptation to, local conditions (Gitz et al., 2020). 38 tools embrace the landscape level and/or wider scales, while 17 tools focus on smaller scales, from individual tree to landscape, and five tools are either scale-neutral or applicable at all scales (**Table 1**).

2.2 Issues and challenges addressed

The tools presented here address different aspects of restoration, including: (i) biophysical and ecological aspects (99 tools); (ii) socio-economic aspects (53 tools); and (iii) governance and institutional aspects (33 tools). These three dimensions are not mutually exclusive. A small number of tools (15) address all the three dimensions of restoration, and more than one third (47) address at least two dimensions.

These restoration tools cover 16 main themes closely linked to FLR and sustainable forest management (SFM) (see **Box 2**). These topics can be further grouped into seven categories, as illustrated in **Table 2**: (i) biodiversity, genetic diversity and seeds; (ii) climate change, GHG and carbon stocks, (iii) FLR and SFM; (iv) governance, institutions and capacity development; (v) land use and landscapes; (vi) livelihoods and gender; (vii) natural resources management (water, soil, air).

In **Table 2**, for each tool, only one main theme has been selected among the 16 possible answers. Obviously, this classification is just one of the possible ways to organize this collection of tools. It facilitates the identification of existing tools that can be used to address a given concern but presents some limitations. In particular, this classification does not reflect correctly the fact that these 16 topics are intertwined and that some tools may address simultaneously several issues.

To address this limit, the short description of each tool was reviewed to flag the various areas of concern, the direct and indirect drivers of land degradation, they claim to address. This rapid review flagged the following issues (not an exhaustive list) :

- deforestation, forest conversion, overlogging, overgrazing, forest degradation and habitat fragmentation (e.g. #38, #39, #42, #44, #49, #55, #62, #64, #69, #70, #71, #79, #80, #81, ##83-86, #92, #100, #104, #105, #109, #113, #119, #122);
- climate change, fire, GHG emissions and carbon stocks (e.g. #13, #14, #27, #28, #30, #36, #37, #42, #44, #47, #54, #57, #66, #70, #75, #83, ##85-92, #109, #112, #115, #116, #121, #123);
- changes in rainfall, water flows and watershed functions (e.g. #1, #14, #24, ##31-37, #115)[13];
- soil productivity and fertility, soil infiltration capacity, soil erosion or slope stability (e.g. #1, #23, #35, #36, #61, #63, #70, #96, #112);
- loss of biodiversity or agrobiodiversity (e.g. #1, #25, #26, #37, #38, #70, #95, #112, #115);
- lack of quality germplasm material, weak seed supply chain and lack of knowledge about tree-site matching (i.e. which tree to grow where and how, e.g. #4, #9, #11, #12, #41, #60, ##72-78, #92, #109, #110, #114, #120, #121);
- provision of ecosystem services, trade-offs among ecosystem services, and trade-offs between production and protection, livelihoods and ecosystem services (e.g. #3, #21, #36, #37, #45, #46, #55, #106, #115);
- conflicts and competition for land and natural resources (e.g. #17, #18, #40);
- livelihoods and resilience - profitability, employment, price fluctuations, poverty, and food insecurity - (e.g. #2, #6, #14, #17, #37, #46, #47, #53, #101, #103, #112, #116, #120);
- gender inequalities (e.g. #8, #10, #97);
- power asymmetries in access to natural resources and along the value chains (e.g. #7, #98);
- lack of capacity, skills and information (e.g. #41, #47, #101, #113, #118, #119, #120);
- lack of financial resources (e.g. #108);
- inadequate legal framework, insecure land tenure, weak governance and institutions (e.g. #41, #43, #116);

13 That can, in extreme cases, lead either to droughts or floods.

Table 2. Main themes covered by the restoration tools included in the compilation

Main theme	Nb. of tools	Information sheet #
Land use and landscapes	36	
Land use and land use changes	14	#3, #19, #20, #21, #35, #36, #37, #49, #55, #62, #69, #70, #115, #118
Agroforestry	10	#4, #17, #18, #41, #77, #84, #101, #111, #112, #113
Sustainable landscape management	9	#1, #56, #57, #59, #64, #93, #96, #100, #108
Agriculture	2	#5, #68
Bamboo	1	#82
Biodiversity, genetic diversity and seeds	21	
Seeds, genetic diversity and tree-site matching	13	#9, #11, #12, #60, #72, #73, #74, #75, #76, #78, #107, #114, #121
Biodiversity, natural resources and ecosystem services	8	#25, #26, #38, #50, #51, #95, #106, #110
Climate change, GHG and carbon stocks	20	#13, #15, #27, #28, #30, #39, #42, #44, #46, #54, #66, #83, #85, #86, #87, #88, #89, #90, #91, #116
FLR and SFM	15	
Forest landscape restoration	11	#53, #58, #80, #81, #92, #102, #105, #109, #119, #122, #123
Sustainable forest management	4	#16, #71, #79, #104
Natural resources management (water, soil, air)	14	
Water	8	#22, #24, #31, #32, #33, #34, #98, #99
Soil	5	#23, #61, #63, #65, #67
Air quality	1	#29
Livelihoods and gender	11	
Livelihoods and resilience	7	#2, #6, #7, #14, #45, #47, #120
Gender	3	#8, #10, #97
Food security and nutrition	1	#103
Governance, institutions and capacity development	6	#40, #43, #48, #52, #94, #117
Total	124	

2.3 Categories of tools

This compilation contains: (i) tools that directly support the decision-making process (57 tools); and (ii) tools that facilitate the data-analysis process (66 tools).

The first category of tools comprises: (i) methods or processes facilitating discussions between actors (37 tools); and (ii) manuals or guidelines (20 tools). The compilation includes a set of methods building upon the rich experience of participatory rural appraisals that emerged and became popular in the 1980s and 1990s (e.g. #1, #3, #4, #22, #23, #25, #27). Some methods highlight the different roles and responsibilities, as well as the interactions and power relations across actors and genders, as well as the need for inclusive and participatory governance and multi-stakeholder partnerships (e.g. #2, #8, #24, #40, #43, #81, #94, #117). Manuals and guidelines included in this compilation cover a diversity of topics and address a broad range of issues. Some manuals help restoration practitioners chose the right tree,

for the right place and the right purpose to match specific objectives and local conditions (e.g. #78, #84, #92, #101). Others provide guidance to assess, monitor, restore, and/or sustainably manage landscapes and forest ecosystems (e.g. #53, #70, #71, #79, #80, #102, #122, #123). Some manuals or methods aim at training targeted stakeholder groups or help them conduct negotiations or role-playing games (e.g. #49, #97-99).

The second category of tools aims to facilitate data analysis and generate the knowledge and evidence needed to inform decision-making (Gitz *et al.,* 2020). This category comprises: (i) databases and data collection tools (18 tools); (ii) models and maps (48 tools). Out of the 18 databases included in this compilation, 10 are either global or covering large scales, wider than the landscape level, while only 6 operate at local scales, i.e. at landscape or smaller scales. Some databases help restoration practitioners to find the tree species, management practice or production system matching specific needs, objectives and conditions at different scales (e.g. #9, #11, #76, #77, #93, #112, #114). Other databases or models provide information on the context and baseline, the costs and benefits of restoration or REDD+ projects (e.g. #83, #85, #86, #119). Such information can be used for cross-project comparisons, as well as reference when designing and calibrating new restoration projects.

Out of the 48 models and maps included in this compilation, 14 operate at small scales, 17 at farm or landscape level, while 17 embrace wider scales. Level of detail and spatial resolution are highly variable across models and maps, with tools covering smaller scales tending to be more precise. Models and maps address very diverse topics, including: modelling carbon stocks, GHG emissions and mitigation potentials (e.g. #15, #39, #54, #66, #87, #88); rainfall and water flow (e.g. ##31-34); different aspects of tree growth and competition for natural resources[14] (e.g. ##16-18, #101, #111, #112); biodiversity, species distribution and population dynamics (e.g. #38, #73, #95, #110); simulating the impacts of alternative land-uses and land-use changes (e.g. #6, #20, #30, #36, #37); mapping vegetation and soil characteristics (e.g. ##60-63, #65, #67; #104).

2.4 Discussion and conclusion

The number of tools that can be used to inform and support decision-making in restoration activities is impressive and continuously growing. This reflects the interest of the researchers to develop interfaces that can help users mobilize scientific knowledge and use it to inform evidence-based decision processes. The collection of tools presented here is, of course, far from being exhaustive. It shows however the broad range of issues, approaches and perspectives that relate to restoration and need to be considered in restoration projects. We hope that it will be of use to decision-makers and practitioners on the ground. We also expect that it can be of use to all those that want to develop new tools and incentivize them to first look at what already exists. Tools can be costly to develop but also to maintain and update regularly. The involvement of users during the conception, development and utilization phases of a tool is generally a critical factor of success. The present collection could pave the way to the construction of a database of tools relevant to FLR that could inform and support actors in their efforts towards the achievement of the objectives of the UN decade on ecosystem restoration. This database could be shared online and regularly updated.

14 Including: tree-to-tree interactions and competition for space, water, nutrient, shade and light.

3 Tools analyzed

3.1 List of restoration tools included in this compilation

Table 3. List of restoration tools included in this compilation

#	Title
1	Participatory landscape appraisal (PaLA)
2	Participatory analysis of poverty, livelihoods and environment dynamics (PAPoLD)
3	Rapid appraisal of drivers of land-use change (DriLUC)
4	Rapid appraisal of agroforestry practices, systems and technology (RAFT)
5	Local ecological knowledge: agroecological knowledge toolkit (AKT5)
6	Land-use profitability analysis (LUPA)
7	Rapid market appraisal (RMA)
8	Gender roles in land use and value chains (GRoLUV)
9	Tree diversity and tree–site matching (WhichTreeWhere?)
10	Gender perspectives in selecting tree species (G-TreeFarm)
11	The Tree functional attributes and ecological database (Tree FUNATIC)
12	Access to trees of choice (NotJustAnyTree)
13	Climate-change opportunities offered by local trees (CooLTree)
14	Tree and farming system resilience to climate change and market fluctuations (Treesilience)
15	Functional branch analysis (FBA): tree architecture and allometric scaling
16	Simple light interception model (SLIM)
17	Water, nutrient and light capture in agroforestry systems (WaNuLCAS): at the plot level
18	Spatially explicit individual-based forest simulator (SExI-FS): for management of agroforests
19	Adopt and learn: modelling decision making and information flow
20	Analysis of land-use and -cover trajectory (ALUCT)
21	Trade-off matrix between private and public benefits of land-use systems (ASB Matrix)
22	Rapid hydrological appraisal (RHA): watershed functions and management options
23	Rapid landslide mitigation appraisal (RaLMA): managing trees for improved slope stability
24	Participatory water monitoring (PaWaMo)
25	Rapid agro-biodiversity appraisal (RABA)
26	Quick biodiversity survey (QBSur)
27	Rapid carbon stock appraisal (RaCSA)
28	Reducing emissions from peatlands (REPEAT)
29	Re-assessing oxygen supply and air quality (ROSAQ)

#	Title
30	Biofuel emission reduction estimator scheme (BERES): land-use history, production systems and technical emission factors
31	Generic river flow at landscape level (GenRiver)
32	Flow persistence (FlowPer)
33	Rainfall Simulator (RainyDay)
34	Spatial Rainfall (SpatRain)
35	Land-use-change impact assessment (LUCIA)
36	Polyscape
37	Forest, agroforest, low-value landscape or wasteland (FALLOW)
38	Ecological corridors (ECor): a distributed population model with gender specificity
39	REDD Abacus SP
40	Rapid land tenure assessment (RaTA): understanding land tenure conflicts
41	Why No Tree? (WNoTree) analysis of agroforestry constraints
42	Fair and efficient REDD value chains allocation (FERVA)
43	Rapid assessment of institutional strengths, networks and actors (RISNA)
44	REDD/REALU site-level feasibility appraisal (RESFA)
45	Trade-off analysis for land-use scenarios (TALaS)
46	Scenario tools: land-use planning for low-emissions development strategies (LUWES)
47	Capacity-strengthening approach to vulnerability assessment (CaSAVA)
48	Assessing and adopting social safeguards in all planned programs (AASSAPP)
49	RUPES role-play game (RPG)
50	Conservation auction and environmental services' enhancement (Con$erv)
51	Multi-scale payments-for-environmental services' paradigms (MuScaPES)
52	Integration
53	Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale.
54	Mitigation potentials in Latin American landscapes through two carbon-intense restoration options: forest expansion and peat restoration
55	Methods and tools to analyze tradeoffs between ecosystem services in restoration
56	Enhancing the value of ecosystem services in pastoral systems (EVESPS) project
57	G-Range global rangelands model
58	Catalogue of restoration and conservation initiatives in the tropical dry forests of northern Peru
59	The FORLAND project
60	Vegetation map for Africa including species selection tools
61	Africa Soil Information Service (AfSIS)
62	Methodology on bush encroachment mapping
63	Digital soil maps for Mukuyu and Shikomoli -web applications and map books.
64	Landscape Doctor
65	Package 'mapsRinteractive'
66	The CIAT SOC App
67	R package: 'SurfaceTortoise'
68	Decision Analysis

#	Title
69	Global Economic Assessment of Land Degradation and Improvement
70	Land Degradation Surveillance Framework (LDSF)
71	Manual for the ecological and productive monitoring of secondary forests of Mesoamerica (FOREST-MONITOR)
72	Package for Community Ecology and Suitability Analysis (BiodiversityR)
73	Africa Tree Finder (AfricaTreeFinder)
74	Useful Tree Species for Africa (UsefulTree)
75	Ecoregions2017
76	Agroforestry Species Switchboard (AgroforestrySwtichboard)
77	Agroforestree Database
78	Tree seeds for farmers (TreeSeed)
79	Standard for the management of secondary forests in Costa Rica (SFMStandard)
80	Active restoration of secondary forests in Central America (ARSF)
81	Stakeholder Approach to Risk Informed and Evidence Based Decision Making (SHARED Decision Hub)
82	On-farm Bamboo inventory mobile application (OnfarmBamboo)
83	International Database on REDD+ projects and programs (ID-RECCO)
84	Guidebook on agroforestry-based restoration in Brazil (AFSGuide)
85	REDD+ Benefit Sharing Knowledge Tree Toolbox
86	REDD+ Cost Model
87	CarboScen
88	The Indonesian National Carbon Accounting System (INCAS)
89	The Indonesian Peatland Network (IPN) Toolbox
90	The Sustainable Wetlands for Mitigation and Adaptation Program (SWAMP) Toolbox
91	The Forests Climate Change Toolbox
92	Diversity for Restoration (D4R)
93	Global Geoinformatics Options by Context (GeOC)
94	STAMP4 Irrigation: Stakehold Task Alignment Matrix for Public-Private-Producer Partnerships in Irrigation
95	Agrobiodiversity Index
96	LAndscape Planning and MAnagement Tool (LAPMAT)
97	Participatory Gender Training for Community Groups

#	Title
98	Watershed Game for Practitioners
99	Groundwater Game for Practitioners
100	Evaluating Land Management Options (ELMO)
101	The shade canopy of cocoa (SCC)
102	A diagnostic for collaborative monitoring in forest landscape restoration (Diagnostic)
103	Food Tree and Crop Portfolios (FTCP)
104	Digital maps of secondary forests in four Central American countries, by classes of aptitude for sustainable management
105	Generation of knowledge for decision making in secondary natural succession
106	Mapping Ecosystem Services to Human Well-being (MESH)
107	Mapforgen
108	Landscape Assessment of Financial Flows (LAFF)
109	Trait-based tree species vulnerability mapping to guide conservation and restoration efforts
110	High resolution species distribution modelling across Africa: Atlases and decision-support tools to select suitable species and their seed sources for 150+ priority tree species
111	Shademotion
112	Shade Tree Advice
113	Regreening Africa App
114	The Tree Diversity Database
115	Land-Use Planning for Multiple Environmental Services (LUMENS)
116	FAO framework methodology for climate change vulnerability assessment of forests and forest-dependent people
117	The role of multi-stakeholder forums in subnational jurisdictions: Methods training manual and tools for in-depth field research
118	One Map Initiative to support land-use and development planning in Papua and South Sumatra, Indonesia
119	The Economics of Ecosystem Restoration (TEER) initiative
120	Farmer Demonstration Trials (FDTs)
121	CacaoDiversity
122	Guideline on mangrove restoration: lessons learned
123	Manual for the Measurement, Monitoring and Reporting of Carbon and Greenhouse Gases in Mangroves in Restoration

3.2 Presentation of each tool

This section gathers the information sheets compiled for the 123 restoration tools included in this compendium.

1. Participatory landscape appraisal (PaLA)

Contact:

Hoang Minh Ha, Laxman Joshi and Meine van Noordwijk

CRP/Institution: ICRAF

Short description of the tool:

Participatory Landscape Appraisal (PaLA) can be used as an early diagnostic tool of the issues in a landscape. It can help document a process of participatory appraisals of issues of local concern, such as changes in water flows, soil erosion, slope stability or agrobiodiversity. It combines Rapid Rural Appraisal and Participatory Rural Appraisal (RRA/PRA) tools and methods with agroecological analysis to capture local knowledge at relevant temporal and spatial scales. PaLA can be used in scoping studies that can inform more detailed, subsequent analysis of specific functions and issues (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:

Method or process facilitating discussions between actors

Main theme:

Sustainable landscape management

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

PaLA case study: Dong Cao catchment, Hoa Binh province, Viet Nam (Van Noordwijk et al., 2013).

References and further readings:

Hoang Fagerström MH, van Noordwijk M & Nyberg Y (eds). 2005. Development of sustainable land-use practices in the uplands for food security: an array of field methods developed in Viet Nam. Hanoi: Science and Techniques Publishing House.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

2. Participatory analysis of poverty, livelihoods and environment dynamics (PAPoLD)

Contact:

Hoang Minh Ha and Pham Thu Thuy
CRP/Institution: ICRAF

Short description of the tool:

The Participatory Analysis of Poverty, Livelihoods and Environment Dynamics method (PAPoLD), developed by ICRAF in 2007 based on the Stages of Progress method developed by Dr Krishna of Duke University in the USA, provides insights in the local ranking and classification of wealth versus poverty, the indicators that can be used as proxies and the challenges at the bottom of the local pyramid to move out of poverty" (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Livelihoods and resilience

Main focus:

Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

PAPoLD case study: land-use strategies and the impacts of market and resource access on poor tea growers in Hoang Nong, Viet Nam (Van Noordwijk et al., 2013).

References and further readings:

Hoang MH, Pham TT, Swallow B, Nguyen TLH, Thai PT, Nguyen VH & Dao NN. 2007a. Understanding the voice of the poor: participatory poverty analysis with environment focus. Hanoi: United Nations Development Programme; Ministry of Natural Resources and Environment of Viet Nam.

Hoang MH, Nguyen LH, Pham TT, Mai HY & Be QN. 2007b. Comparative analysis of market and resource access of the poor in upland zones of the Greater Mekong Region (MMSEA project). Viet Nam case study. Hanoi: World Agroforestry Centre Viet Nam.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/sea/Publications/files/leaflet/LE0094-08.pdf

3. Rapid appraisal of drivers of land-use change (DriLUC)

Contact:

Meine van Noordwijk
CRP/Institution: ICRAF

Short description of the tool:

"Rapid Appraisal of Drivers of Land-use Change (DriLUC) provides an initial overview of the dynamics of land-use change in the local context and the way this is related to processes acting at larger scales. The method combines desk study of available documents and maps with interviews with key informants and focus-group discussions. A specific topic is the trade-off between economic development and environmental quality, as locally perceived" (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Land use and land use changes

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Example of trade-off analysis in Jambi province, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Thomas DE, Ekasingh B, Ekasingh M, Lebel L, Hoang MH, Ediger L, Thongmanivong S, Xu JC, Sangchyoswat C & Nyberg Y. 2008. Comparative assessment of resource and market access of the poor in upland zones of the Greater Mekong Region. Chiang Mai: World Agroforestry Centre Thailand.

Tomich TP, van Noordwijk M, Budidarseno S, Gillison A, Kusumanto T, Murdiyarso D, Stolle F & Fagi AM. 1998. Alternatives to slash-and-burn in Indonesia: summary report and synthesis of Phase II. Bogor, Indonesia: International Centre for Research in Agroforestry.

Van Noordwijk M, Williams SE & Verbist B, eds. 2001. Towards integrated natural resource management in forest margins of the humid tropics: local action and global concerns. ASB Lecture Notes 1–12. Bogor, Indonesia: International Centre for Research in Agroforestry.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/downloads/Publications/PDFS/LE08323.pdf

4. Rapid appraisal of agroforestry practices, systems and technology (RAFT)

Contact:

Laxman Joshi, Meine van Noordwijk, Endri Martini and Janudianto
CRP/Institution: ICRAF

Short description of the tool:

Agroforestry practices, systems and technology exist in many forms but are often 'invisible' in official documents and statistics that see agriculture, commodities and forestry as separate sectors. The Rapid Appraisal of Agroforestry Practices, Systems and Technology (RAFT) tool helps assess what exists in the landscape as seen through the eyes of farmers and land managers and to relate that to emerging classifications of land use to become more inclusive. The RAFT framework provides guidelines for the description and analysis of the different ways trees are used to improve rural livelihoods, on farms and in landscapes (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Agroforestry

Main focus:

Biophysical and ecological aspects
Governance aspects

Scale:

Farm
Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Case study: RAFT applied in Sulawesi, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Joshi L, Wibawa G, Beukema HJ, Williams SE & van Noordwijk M. 2003. Technological change and biodiversity in the rubber agroecosystem. In: JH Vandermeer, ed. Tropical agroecosystems: new directions for research. Boca Raton, FL: CRC Press. p. 133–157.

Sinclair FL. 1999. A general classification of agroforestry practice. Journal of Agroforestry Systems 46:161–180. https://doi.org/10.1023/A:1006278928088

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

5. Local ecological knowledge: agroecological knowledge toolkit (AKT5)

Contact:

Laxman Joshi, Fergus Sinclair and Elok Mulyoutami

CRP/Institution: ICRAF

Website: http://akt.bangor.ac.uk/
http://apps.worldagroforestry.org/sea/Products/AFModels/akt5/akt5.htm

Short description of the tool:

Local ecological knowledge (LEK) refers to what people know about their natural environment, based primarily on their own experience and observation. The Agroecological Knowledge Toolkit (AKT5 software) provides a systematic framework for documenting and subsequently analyzing local agroecological knowledge. Within the frame of a relational database, local knowledge is teased apart into unitary statements that can subsequently be viewed with all their interconnections". Perceptions and knowledge systems of different actors (local actors, scientists or policy makers) can be analyzed and compared which facilitate negotiations. (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:

Data collection and database

Main theme:

Agriculture

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The AKT methodology has been used successfully in a number of projects in Asia, Africa and Latin America and has been adopted globally by the World Agroforestry Centre. A Spanish language version is used in Latin America by the Tropical Agricultural Research and Higher Education Centre and a Thai version has been developed in conjunction with the Department of National Parks, Wildlife and Plant Conservation in Thailand (Van Noordwijk et al., 2013).

References and further readings:

Dixon HJ, Doores JW, Joshi L & Sinclair FL. 2001. Agroecological knowledge toolkit for Windows: methodological guidelines, computer software and manual for AKT5. Bangor, UK: School of Agricultural and Forest Sciences, University of Wales. http://akt.bangor.ac.uk/documents/AKT5manual.pdf.

Joshi L, Suyanto S, Catacutan DC & van Noordwijk M. 2001. Recognising local knowledge and giving farmers a voice in the policy development debate. In: M van Noordwijk, S Williams, B Verbist, eds. Towards integrated natural resource management in forest margins of the humid tropics: local action and global concerns. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Joshi L, Shrestha P, Moss C & Sinclair FL. 2004. Locally derived knowledge of soil fertility and its emerging role in integrated natural resource management. In: M van Noordwijk, G Cadisch, CK Ong, eds. Belowground interactions in tropical agroecosystems: concepts and models with multiple plant components. Wallingford, UK: CABI.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

6. Land-use profitability analysis (LUPA)

Contact:

Arif Rahmanulloh, Muhammad Sofiyuddin, Suyanto and Suseno Budidarsono

CRP/Institution: ICRAF

Short description of the tool:

The most important source of livelihoods for most people living surrounding forests comes from land use. Understanding the characteristics of existing land-use systems is important to develop interventions to improve people's livelihoods. Land-Use Profitability Assessment (LUPA) is an analysis framework for economic assessment of land-use systems, conducted at landscape level. LUPA estimates monetary surplus (profitability) for each land area as result of investment allocated by the operator, both smallholders or large-scale (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Livelihoods and resilience

Main focus:

Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The tool was used in Tanjung Jabung Barat district, Jambi province, Indonesia (Van Noordwijk et al., 2013). References to other recent case studies include Ekadinata et al. (2010), Rahmanulloh et al. (2012) and Sofiyuddin et al. (2012).

References and further readings:

Ekadinata A, Rahmanulloh A, Pambudhi F, Ibrahim I, van Noordwijk M, Sofiyuddin M, Sardjono MA, Rahayu S, Dewi S, Budidarsono S & Said Z. 2010. Carbon emissions from land use, land use change and forestry (LULUCF) in Berau District, East Kalimantan, Indonesia. Project Report. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Monke E & Pearson SR.1989. The Policy Analysis Matrix for agricultural development. Ithaca, NY: Cornell University Press.

Rahmanulloh A, Sofiyudin M & Suyanto. 2012. Agroforestry and Forestry in Sulawesi series: Profitability and land-use systems in South and Southeast Sulawesi. Working paper 157. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. https://doi.org/10.5716/WP12056.PDF

Sofiyuddin M, Rahmanulloh A & Suyanto S. 2012. Assessment of profitability of land use systems in Tanjung Jabung Barat District, Jambi Province, Indonesia. Open Journal of Forestry 2(4):252–256. https://doi.org/10.4236/ojf.2012.24031

Tomich T, Noordwijk M, Budidarsono S, Gillison A, Trikurniati K, Murdyaso D & Fagi A. 1998. Alternatives to slash-and-burn in Indonesia: summary report and synthesis of phase II. Bogor, Indonesia: ASB Partnership for the Tropical Forest Margins; Central Research Institute for Food Crops.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

7. Rapid market appraisal (RMA)

Contact:

Aulia Perdana, Suseno Budidarsono, Iwan Kurniawan and James M. Roshetko

CRP/Institution: ICRAF

Website: https://www.worldagroforestry.org/publication/rapid-market-appraisal-rma

Short description of the tool:

A Rapid Market Appraisal (RMA) is an iterative process and interactive research methodology, which is used to better understand complex market systems in a short time and to discover and capture market opportunities. The RMA method, developed by the International Labour Organization (ILO, 2000), was adapted to analyze value chains from farmgate to consumers, the role of various people involved in adding value, and their bargaining power used to capture part of the end-user value.

This information can subsequently be used to 1) raise awareness with farmers about the importance of market information; and 2) guide interventions aimed at improving the efficiency of marketing systems and generating benefits for participants (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:

Method or process facilitating discussions between actors

Main theme:

Livelihoods and resilience

Main focus:

Socio-economic aspects

Scale:

N/A

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Tukan et al. (2006) used the RMA methodology to identify opportunities to improve the market chain of bananas grown in farm gardens by linking farmers to markets in West Java, Indonesia.

References and further readings:

ILO (International Labour Organization). 2000. Rapid market appraisal: a manual for entrepreneurs. FIT Manual Series. Geneva: International Labour Organization.

Nang'ole EM, Mithöfer D & Franzel S. 2011. Review of guidelines and manuals for value chain analysis for agricultural and forest products. ICRAF Occasional Paper No. 17. Nairobi: World Agroforestry Centre

Roshetko JM, Nugraha E, Tukan JCM, Manurung G, Fay C, & van Noordwijk M. 2007. Agroforestry for Livelihood Enhancement and Enterprise Development. 137-148 p. In: S. Djoeroemana, B. Myers, J. Russell-Smith, M. Blyth, & I.E.T. Salean (eds). Integrated Rural Development in East Nusa Tenggara, Indonesia. Proceedings of a workshop to Identify Sustainable Rural Livelihoods, held in Kupang, Indonesia, 5–7 April 2006. ACIAR Proceedings No.126, 197p. http://aciar.gov.au/files/node/3367/pr126_pdf_78826.pdf#page=137

Tukan JC, Budidarsono S, Manurung GS & Roshetko JM. 2006. Market Chain Improvement: Linking Farmers to Markets in Nanggung, West Java, Indonesia. Acta Horticulturae (ISHS) 699: 429–438. https://doi.org/10.17660/ActaHortic.2006.699.51

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/sea/Publications/files/leaflet/LE0091-08.pdf

8. Gender roles in land use and value chains (GRoLUV)

Contact:

Elok Mulyoutami, Delia Catacutan, Endri Martini, Noviana Khususiyah, Janudianto, Grace B. Villamor and Meine van Noordwijk

CRP/Institution: ICRAF

Short description of the tool:

Gender specificity of land use (decisions, labor, remuneration) and participation in value chains needs to be understood: intra-household relations and the position of female-headed households deserve specific attention. Analysis and reliable data can be used by local 'agents of change' to create the conditions for greater gender equity. The Gender Roles in Land Use and Value Chains (GRoLUV) tool can be used to further elicit gender-specific information and understand the conditions underpinning differences. (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:

Method or process facilitating discussions between actors

Main theme:

Gender

Main focus:

Socio-economic aspects

Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Case study: GRoLUV in Sulawesi, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Quisumbing AR & Pandolfelli L. 2010. Promising approaches to address the needs of poor female farmers: resources, constraints and intervention. World Development 38(4):581–592. https://doi.org/10.1016/j.worlddev.2009.10.006

Mulyoutami E, Martini E, Khususiyah N, Isnurdiansyah & Suyanto. 2012. Agroforestry and Forestry in Sulawesi series: Gender, livelihoods and land in South and Southeast Sulawesi. Working paper 158. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. https://doi.org/10.5716/WP12057.PDF

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

9. Tree diversity and tree–site matching (WhichTreeWhere?)

Contact:

Degi Harja, Roeland Kindt, Jenny C. Ordonez, Hesti Lestari Tata, Subekti Rahayu, Avniar N. Karlan and Meine van Noordwijk

CRP/Institution: ICRAF

Short description of the tool:

To operationalize the slogan, 'The right tree in the right place for the right purpose', we need to know: 1) which trees currently grow where; 2) how well they grow at the locations where they grow; 3) what direct and indirect functions they have associated with their properties; and 4) how important tree diversity is at multiple scales of management. The data collection method described here contributes to answer to these questions at different scales (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:

Data collection and database

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

All scales, from plot to global.

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

References and further readings:

Kindt R & Coe R. 2005. Tree diversity analysis. A manual and software for common statistical methods for ecological and biodiversity studies. Nairobi: World Agroforestry Centre (ICRAF). http://apps.worldagroforestry.org/downloads/Publications/PDFS/b13695.pdf

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

10. Gender perspectives in selecting tree species (G-TreeFarm)

Contact:

Sonya Dewi, Janudianto and Endri Martini
CRP/Institution: ICRAF

Short description of the tool:

Analytic hierarchy process (AHP) is a decision-making framework used for large-scale, multiparty, multi-criteria decision analysis developed by Thomas L. Saaty in the 1970s. The G-TreeFarm tool uses this process to elucidate the gender differences in selecting tree species and farming systems in Sulawesi, Indonesia. The objective of G-TreeFarm is to first clarify, for different stakeholder groups, the primary functions needed and then focus on which trees, crops and farming systems can fulfil these functions. Subsequent analysis can clarify gender and social differentiation in criteria and knowledge of options to provide the desired functions. (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Gender

Main focus:

Socio-economic aspects

Scale:

Farm

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The method has been applied in 40 villages in Sulawesi, across gender groups, and showed some interesting findings regarding the perceptions of male and female groups on an existing farming system, variations of preferences in tree species and farming system, and criteria perceived as most important in selecting tree species and farming system.
(Van Noordwijk et al., 2013).

References and further readings:

Ho W. 2008. Integrated analytic hierarchy process and its applications: a literature review. European Journal of Operational Research 186:211–228. https://doi.org/10.1016/j.ejor.2007.01.004

Saaty TL. 2008. Decision making with the analytic hierarchy process. International Journal of Services Sciences 1(1):83–98. https://doi.org/10.1504/IJSSCI.2008.017590

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

11. The Tree functional attributes and ecological database (Tree FUNATIC)

Contact:

Degi Harja, Subekti Rahayu and Sidiq Pambudi
CRP/Institution: ICRAF
Website: http://db.worldagroforestry.org/

Short description of the tool:

The 'Tree functional attributes and ecological database' (Tree FUNATIC) is an open access, web-based database, developed by ICRAF, that provides information about the ecological requirements, geographical distribution, functional attributes and traits of a variety of tree species. The database also stores tree entity information from observations, such as stem diameter, height and crown dimensions, as well as habitat information, including geographic information on soils and climate (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Data collection and database

Main theme:

Seeds, genetic diversity, and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

N/A

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

12. Access to trees of choice (NotJustAnyTree)

Contact:

James M. Roshetko, Pratiknyo Purnomosidhi and Endri Martini

CRP/Institution: ICRAF

Short description of the tool:

Unfortunately, tree-planting programs are mostly evaluated by the numbers of trees planted rather than by the number of trees that actually survive and grow and even less in the quality of products and services that they provide. A major shift is needed from supplying what is easily available to what is prioritized. The aim of the 'NotJustAnyTree' tool is to assess the supply and demand of quality tree germplasm, the capacity of local nurseries, and the effectiveness of support to local nursery development (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:

Method or process facilitating discussions between actors

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Case study: 'Developing nurseries of excellence (NOEL)' project in Aceh, Indonesia (Roshetko et al., 2013). In just 18 months, 178 capacity-building events were conducted, training 3582 people. Across all NOEL activities, the involvement of women exceeded 30%. Fifty 'nurseries of excellence' were established, 32 by program partners and 18 'susulan' (spontaneous) nurseries by neighbouring farmers who were inspired by the success of NOEL. Over 400,000 seedlings were produced (Van Noordwijk et al., 2013).

References and further readings:

Del Castillo R & Roshetko JM. 1998. Agroforestry seed technology and nursery management: a training manual. Bogor, Indonesia: Institute of Agroforestry; International Centre for Research in Agroforestry Southeast Asia Regional Program; Winrock International; Rockefeller Brothers Fund.

Roshetko JM, Idris N, Purnomosidhi P, Zulfadhli T & Tarigan J. 2013. Farmer extension approach to rehabilitate smallholder fruit agroforestry systems: the Nurseries of Excellence (NOEL) program in Aceh, Indonesia. Acta Horticulturae (ISHS) 975:649–656. https://doi.org/10.17660/ActaHortic.2013.975.81

Roshetko JM, Purnomosidhi P & Martini E. 2013. Access to trees of choice (NotJustAnyTree). pp 75-79. In: van Noordwijk M, Lusiana B, Leimona B, Dewi S, Wulandari D (eds) Negotiation-support toolkit for learning landscapes. World Agroforestry Centre (ICRAF) Southeast Asia Regional Program, Bogor, Indonesia. p 285. ISBN: 978-979-3198-74-3

Roshetko JM & Purnomosidhi P. 2013. Smallholder agroforestry fruit production in Lampung, Indonesia: horticultural strategies for smallholder livelihood enhancement. Acta Horticulturae (ISHS), 975: 671–679. https://doi.org/10.17660/ACTAHORTIC.2013.975.84

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

13. Climate-change opportunities offered by local trees (CooLTree)

Contact:

Meine van Noordwijk, Jules Bayala and Kurniatun Hairiah
CRP/Institution: ICRAF

Short description of the tool:

Trees have a substantial influence on climate at local and larger scales. Yet, trees have mostly been discussed in the climate-change debate in terms of their carbon storage and the contributions they make to the global carbon balance. Their more direct effects on micro- and meso-climate are largely absent from the debates. The CooLTree method contrasts the local, public/policy and science-based knowledge about the role of trees in designing 'climate-smart' landscapes (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Case studies:
Kali Konto landscape in East Java, Indonesia (Van Noordwijk et al., 2013).
Parkland agroforestry systems of West Africa (Bayala et al., 2013).

References and further readings:

Bayala J, Sanou J, Bazié P & van Noordwijk M. 2013. Empirical data collection of tree effects on temperature and humidity at crop level. Nairobi: World Agroforestry Centre.

Van Noordwijk M, Bayala J, Hairiah K, Lusiana B, Muthuri C, Khasanah N & Mulia R. 2014. Agroforestry solutions for buffering climate variability and adapting to change. In: J Fuhrer, PJ Gregory, eds. Climate change impact and adaptation in agricultural systems. Wallingford, UK: CABI.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

14. Tree and farming system resilience to climate change and market fluctuations (Treesilience)

Contact:

Sonya Dewi, Endri Martini and Janudianto
CRP/Institution: ICRAF

Short description of the tool:

Two of the biggest external sources of uncertainties in farmers' livelihoods are (i) impacts of changes in the mean and fluctuations of annual rainfall and shifts in seasons; and (ii) market fluctuations of agricultural products. The 'Tree and Farming System Resilience to Climate Change and Market Fluctuations' (Treesilience) method uses focus-group discussions to encourage farmers to 1) identify the fluctuations that cause shocks to their livelihoods in a guided process thinking though the shocks-exposure-responses-capacity chain; 2) reveal the impacts of the shocks to their farming systems; 3) characterize the impacts of the shocks on dominant tree species; and 4) semi-quantitatively assess the price fluctuations of dominant tree products (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Livelihoods and resilience

Main focus:

biophysical and ecological aspects
socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The whole Treesilience method has been successfully applied in 10 clusters of 40 villages in South and Southeast Sulawesi provinces, Indonesia. The method has been partly applied in Viet Nam (Van Noordwijk et al., 2013).

References and further readings:

Hoang MH, Namirembe S, van Noordwijk M, Catacutan D, Öborn I, Perez-Teran AS, Nguyen HQ & Dumas-Johansen MK. 2014. Farmer portfolios, strategic diversity management and climate change adaptation: implications for policy in Viet Nam and Kenya. Climate and Development. https://doi.org/10.1080/17565529.2013.857588

Nguyen Q, Hoang MH, Öborn I & van Noordwijk M. 2013. Multipurpose agroforestry as a climate change adaptation option for farmers: an example of local adaptation in Vietnam. Climatic Change 117:241–257. https://doi.org/10.1007/s10584-012-0550-1

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

15. Functional branch analysis (FBA): tree architecture and allometric scaling

Contact:

Meine van Noordwijk, Rachmat Mulia and Degi Harja
CRP/Institution: ICRAF

Short description of the tool:

Functional Branch Analysis (FBA) is a tool to generate tree architecture and allometric scaling. It can be used as a non-destructive approach to develop allometric equations that are often used to estimate plot-level carbon stocks (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects

Scale:

Individual tree

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

A comparison between the FBA model estimation and real observation of tree biomass aboveground and its components was carried out for four tropical tree species in the Philippines: *Shorea contorta, Vitex parviflora, Pterocarpus indicus and Artocarpus heterphyllus*. Total aboveground tree biomass, as calculated with the allometric equations from the FBA model, fits well with the biomass measurements obtained from destructive methods. Slight differences were found for the tree components (wood and leaf biomass) for all four tree species. (Van Noordwijk et al., 2013).

References and further readings:

Smiley G & Kroschel J. 2008. Temporal change in carbon stocks of cocoa–gliricidia agroforests in Central Sulawesi, Indonesia. Agroforestry Systems 73:219–231. https://doi.org/10.1007/s10457-008-9144-3

Van Noordwijk M & Mulia R. 2002. Functional branch analysis as tool for fractal scaling above- and belowground trees for their additive and non-additive properties. Ecological Modelling 149:41–51. https://doi.org/10.1016/S0304-3800(01)00513-0

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/sea/projects/tulsea/sites/default/files/inrm_model/19_TULSEA_FBA.pdf

16. Simple light interception model (SLIM)

Contact:

Degi Harja and Gregoire Vincent
CRP/Institution: ICRAF

Short description of the tool:

The purpose of the Simple Light Interception Model (SLIM) is to compute canopy closure at any height above the ground within a forest canopy. The forest canopy in SLIM is a 3D geometrical object modelled from measured tree properties. SLIM can be used for stand profile visualization (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Sustainable forest management

Main focus:

Biophysical and ecological aspects

Scale:

Individual tree
Plot/Field

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

SLIM was tested for instance in damar agroforest in Sumatra, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Vincent G & Harja D. 2002. SLIM software: a simple light interception model for multi-species, multistrata forests. Bois et Forets des Tropiques 272(2):97–100. http://bft.cirad.fr/cd/BFT_272_97-100.pdf

Vincent G & Harja D. 2007. Exploring ecological significance of tree crown plasticity through three-dimensional modelling. Annals of Botany 101(8):1221–1231. https://doi.org/10.1093/aob/mcm189

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

17. Water, nutrient and light capture in agroforestry systems (WaNuLCAS): at the plot level

Contact:

Ni'matul Khasanah, Betha Lusiana, Rachmat Mulia and Meine van Noordwijk

CRP/Institution: ICRAF

Website: http://apps.worldagroforestry.org/sea/Products/AFModels/wanulcas/isi.htm

Short description of the tool:

Water, Nutrient and Light Capture in Agroforestry Systems (WaNuLCAS) is a tree–crop–soil interactions model at plot level with daily time steps. The model simulates interactions between crops and trees in sharing and competing for aboveground resource, that is, light, and belowground resources, that is, nitrogen, phosphorous and water. The model can be used to assess the performance (production and profitability) of agroforestry systems under different management regimes with different spatial and temporal configurations (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Agroforestry

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Researchers carried out ex-ante analysis with WaNuLCAS to explore the effect of different management practices on growth and production of intercropped teak and maize in Indonesia (Van Noordwijk et al., 2013).

References and further readings:

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Khasanah N, Perdana A, Rahmanullah A, Manurung G, Roshetko J, van Noordwijk M & Lusiana B. 2013. Trade-off analysis and economic valuation of intercropping teak (Tectona grandis)–maize under different silvicultural options in Gunung Kidul, West Java. Paper presented at the Tropentag Conference 2013, 17–19 September 2013, Stuttgart-Hohenheim, Germany.

Van Noordwijk M & Lusiana B. 1999. WaNulCAS: a model of water, nutrient and light capture in agroforestry systems. Agroforestry Systems 43:217–242. https://doi.org/10.1023/A:1026417120254

Van Noordwijk M, Lusiana B, Khasanah N & Mulia R. 2011. WaNuLCAS version 4.0: Background on a model of water nutrient and light capture in agroforestry systems. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

18. Spatially explicit individual-based forest simulator (SExI-FS): for management of agroforests

Contact:

Degi Harja and Gregoire Vincent

CRP/Institution: ICRAF

Website: http://apps.worldagroforestry.org/sea/Products/AFModels/SExI/index.htm

Short description of the tool:

The Spatially Explicit Individual-based Forest Simulator (SExI-FS) simulates tree-to-tree interactions in multispecies agroforests. The model uses an object-oriented approach whereby each tree is individually modelled. Individual trees interact by modifying their neighbours' environment and competing for two major aboveground resources: space and light. An optimum scale for 3D representation of the agroforest plot is 1 hectare (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Agroforestry

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

SExI-FS has been used to explore the performance of various agroforestry scenarios (Harja et al 2005) and the potential role of trees in reducing the risk of landslides in the district of Bogor, West Java province, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Harja D, Vincent G, Purnomosidhi P, Rahayu S & Joshi L. 2005. Impact of rubber tree planting patterns on Imperata cylindrica dynamics: exploring weed control through shading using SExI-FS, a forest stand simulator. Proceedings of the International Workshop on Smallholder Agroforestry Options on Degraded Soils. Batu, East Java, Indonesia, 18–21 August 2005.

Harja D & Vincent G. 2008. Spatially Explicit Individual-based Forest Simulator: user guide and software. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program; Marseille, France: Institut de Recherche pour le Développement.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

19. Adopt and learn: modelling decision making and information flow

Contact:

Meine van Noordwijk, Betha Lusiana and Desi A. Suyamto
CRP/Institution: ICRAF

Short description of the tool:

'Adopt and Learn' is a simple model of an 'adoption' process. It provides an analytical framework for understanding factors influencing the success or failure of a technology dissemination project, including the role of extension agents. The model works at community scale with a diversity of agents and their multiple learning styles. 'Adopt and Learn' was developed in the STELLA programming language and can be incorporated as a module in more comprehensive models, such as dynamic models of land-use change (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Land use and land use changes

Main focus:

Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The 'Adopt and learn' concept was used to explore gender differentiation of land-use decisions (Villamor et al 2014; Van Noordwijk et al., 2013).

References and further readings:

Villamor GB, van Noordwijk M, Djanibekov U, Chiong-Javier E & Catacutan D. 2014. Gender differences in land-use decisions: shaping multifunctional landscapes? *Current Opinion in Environmental Sustainability,* vol. 6, pp128-133. https://doi.org/10.1016/j.cosust.2013.11.015

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

20. Analysis of land-use and -cover trajectory (ALUCT)

Contact:

Sonya Dewi and Andree Ekadinata
CRP/Institution: ICRAF

Short description of the tool:

Analysis of land-use and -cover trajectory (ALUCT) provides basic spatial information to support other tools in appraising watershed functions, agrobiodiversity conservation and carbon stocks, and building land-use and land-use-change scenarios (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Land use and land use changes

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

ALUCT was used in a study of oil-palm plantations in Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Dewi S, Khasanah N, Rahayu S, Ekadinata A & van Noordwijk M. 2009. Carbon footprint of Indonesian palm oil production: a pilot study. Bogor, Indonesia:World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Dewi S & Ekadinata A. 2010. ALUCT: Analysis of Land Use and Cover Trajectory, (1), 1–2. http://www.worldagroforestri.org/sea/Publications/files/leaflet/LE0172-10.pdf

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Hairiah K, Dewi S, Agus F, Velarde SJ, Ekadinata A, Rahayu S & van Noordwijk M. 2011. Measuring carbon stocks across land use systems: a manual. Bogor, Indonesia:World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Useful websites

http://www.google.com/earth/index.html

http://rst.gsfc.nasa.gov/Front/overview.html (online remote-sensing tutorials)

Poster:

http://apps.worldagroforestry.org/sea/Publications/files/poster/PO0263-10.pdf

21. Trade-off matrix between private and public benefits of land-use systems (ASB Matrix)

Contact:

Thomas P. Tomich and Meine van Noordwijk
CRP/Institution: ICRAF

Short description of the tool:

The Trade-off Matrix between Private and Public Benefits of Land-use systems (ASB Matrix) provides in one table an overview of key characteristics of land-use systems that coexist in a landscape and form alternatives to each other. The rows form the land-use systems and the columns hold key characteristics that are of local, national and/or global concern, such as employment, profitability, sustainability, biodiversity and carbon stock (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Land use and land use changes

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The ASB Matrix was first used in Indonesia to seek best alternatives to slash-and-burn (Tomich et al., 1998). The ASB Matrix was also used in humid lowlands of Sumatra Clark et al (2011)

References and further readings:

Clark WC, Tomich TP, van Noordwijk M, Guston D, Catacutan D, Dickson NM & McNie E. 2011. Boundary work for sustainable development: natural resource management at the Consultative Group on International Agricultural Research (CGIAR). Proceedings of the National Academy of Sciences of the United States of America. https://doi.org/10.1073/pnas.0900231108

Tomich TP & Lewis J, eds. 2003. Balancing rainforest conservation and poverty reduction. Policybrief 5. Reprinted July 2004. Nairobi: Alternatives to Slash and Burn. http://www.asb.cgiar.org//PDFwebdocs/Policybrief5.pdf

Tomich TP, van Noordwijk M, Vosti S & Whitcover J. 1998. Agricultural development with rainforest conservation: methods for seeking best bet alternatives to slash-and-burn, with applications to Brazil and Indonesia. Agricultural Economics 19:159–174. https://doi.org/10.1111/j.1574-0862.1998.tb00523.x

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

22. Rapid hydrological appraisal (RHA): watershed functions and management options

Contact:

Meine van Noordwijk, Betha Lusiana and Beria Leimona
CRP/Institution: ICRAF

Short description of the tool:

Rapid hydrological appraisal (RHA) diagnoses the hydrological situation of a landscape and perceptions and ecological knowledge of its important stakeholders: local, general public and scientific domains. These perceptions and knowledge include information concerning trade-offs between local decisions on land-use practices that influence watershed functions, types of local institutions that can increase effective management of the watershed, and social relationships among stakeholders. The RHA enables an appraisal of the opportunities for negotiating land-use agreements that include rewards for protecting and rehabilitating watershed functions (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Water

Main focus:

Biophysical and ecological aspects
Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The first RHA was conducted at Lake Singkarak in West Sumatra, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Jeanes K, van Noordwijk M, Joshi L, Widayati A, Farida & Leimona B. 2006. Rapid hydrological appraisal in the context of environmental service rewards. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Lusiana B, Widodo R, Mulyoutami E, Adi DK & van Noordwijk M. 2008. Assessing the hydrological situation of Talau Watershed, Belu Regency, East Nusa Tenggara. Working Paper 57. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

23. Rapid landslide mitigation appraisal (RaLMA): managing trees for improved slope stability

Contact:
Meine van Noordwijk, Kurniatun Hairiah and Degi Harja
CRP/Institution: ICRAF

Short description of the tool:
Trees can protect slopes from landslides, but can also be a risk factor. Rapid Landslide Mitigation Appraisal (RaLMA) explores local knowledge and the science of landslides and their relationship to trees. The result is an analysis of which trees have complementary functions in protecting slopes. However, not building houses in the likely pathway of landslides remains the primary way to avoid human loss of lives (Van Noordwijk et al., 2013).

Category of tool:
Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:
Soil

Main focus:
Biophysical and ecological aspects

Scale:
Landscape

Stage of development:
Effective use on the ground (mature tool)

Example(s) of effective use:
Research was carried out between January and May 2008 in the Bukit Sentul area of the Bogor district in West Java (Van Noordwijk et al., 2013).

References and further readings:
Hairiah K, Widianto, Prayogo C, Kurniawan S, Harja D, Khasanah N & van Noordwijk M. 2008. The role of trees outside forest in anchoring soil and reducing landslide risk during high rainfall episodes. TroFCCA project on the role of tropical forests in climate change adaptation.
Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

24. Participatory water monitoring (PaWaMo)

Contact:

Subekti Rahayu, Rudy H. Widodo, Meine van Noordwijk and Bruno Verbist
CRP/Institution: ICRAF

Short description of the tool:

Participatory Water Monitoring (PaWaMo) involves local community members in measuring and monitoring water flow using several simple quantitative indicators. These indicators can be used as an index for assessing and comparing the patterns of relationship between river flow and rain as a basis for monitoring changes of hydrological functions at sub-watershed level (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Water

Main focus:

Biophysical and ecological aspects
Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Case study: water quality biomonitoring in Way Petai, Sumberjaya, Lampung province, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Rahayu S, Widodo RH, van Noordwijk M, Suryadi I &Verbist B. 2013. Water monitoring in watersheds. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

25. Rapid agro-biodiversity appraisal (RABA)

Contact:

Laxman Joshi, Endri Martini and Hesti Lestari Tata
CRP/Institution: ICRAF

Short description of the tool:

The Rapid Agro-Biodiversity Appraisal (RABA) is a diagnostic tool designed to measure the perceptions of different stakeholders about biodiversity conservation and to assess the feasibility of establishing a 'rewards for environmental services' mechanism in a target area (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Biodiversity, natural resources and ecosystem services

Main focus: All three
Biophysical and ecological aspects
Socio-economic aspects
Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Case study: Rubber agroforests in Bungo district, Jambi province, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Kuncoro SA, van Noordwijk M, Martini E, Saipothong P, Areskoug V, Eka Dinata A & O'Connor T. 2006. Rapid Agrobiodiversity Appraisal (RABA) in the context of environmental service rewards. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/sea/projects/tulsea/sites/default/files/inrm_tools/06_TULSEA_RABA.pdf

26. Quick biodiversity survey (QBSur)

Contact:

Hesti Lestari Tata, Nurhariyanto, Pandam N. Prasetyo, Jihad, Laxman Joshi and Endri Martini
CRP/Institution: ICRAF

Short description of the tool:

The Quick Biodiversity Survey (QBSur) diagnoses the 'biodiversity health' of a landscape, including its agricultural components that are usually not considered as niches providing ecosystem services. QBSur provides information on the diversity of plants, birds and bats; the biodiversity gradient of areas with high and low biodiversity levels; and perceptions of local stakeholders on (agro-) biodiversity and their interests in conservation (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Data collection and database

Main theme:

Biodiversity, natural resources and ecosystem services

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The Quick Biodiversity Survey (QBSur) was conducted in rubber plantations in Dolok Merangir, Indonesia. It resulted in recommendations on how to improve biodiversity on the Bridgestone estate (Van Noordwijk et al., 2013).

References and further readings:

Kuncoro SA, van Noordwijk M, Martini E, Saipothong P, Areskoug V, Eka Dinata A & O'Connor T. 2006. Rapid Agrobiodiversity Appraisal (RABA) in the context of environmental service rewards. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Tata HL, Mulyoutami E, Janudianto, Sid Z, Ekadinata A, Widayati A, NIngsih H, Rahayu S, Ayat A, Nugroho P, Noerfahmy S & Taufik I. 2011. Recognizing biodiversity in rubber plantations. In: Tata HL, ed. Toward a biodiverse rubber estate: Quick Biodiversity Survey of Bridgestone Sumatra Rubber Estate, North Sumatra, Indonesia. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/sea/projects/tulsea/sites/default/files/inrm_tools/09_TULSEA_QBS.pdf

27. Rapid carbon stock appraisal (RaCSA)

Contact:

Meine van Noordwijk and Kurniatun Hairiah
CRP/Institution: ICRAF

Short description of the tool:

The Rapid Carbon Stock Appraisal (RaCSA) assesses the status of carbon stocks in a given geographical area and develops scenarios of carbon sequestration or restoration resulting from potential land-use and management changes. RaCSA integrates procedures for developing land-use scenarios that can enhance carbon sequestration, prevent land degradation, promote sustainable land productivity and increase people's livelihoods. RaCSA is designed to provide a basic level of locally relevant knowledge to inform discussions on emissions reductions. It introduces a scientifically sound methodological framework of accounting for carbon sinks, while focusing on activities that can improve local livelihoods and alleviate rural poverty. (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

RaCSA was applied in Nunukan district, East Kalimantan province, Indonesia, to monitor carbon stocks in an area where forest conversion, illegal logging and fire were causing substantial carbon emissions (Van Noordwijk et al., 2013).

References and further readings:

Hairiah K, Dewi S, Agus F, Velarde SJ, Ekadinata A, Rahayu S & van Noordwijk M. 2011. Measuring carbon stocks across land-use systems: a manual. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Hairiah K & Rahayu S. 2007. Pengukuran karbon tersimpan di berbagai macam penggunaan lahan. Measuring carbon stocks across land-use systems. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Hairiah K, Sitompul SM, van Noordwijk M, Palm CA. 2001. Methods for sampling carbon stocks above and below ground. ASB Lecture Note 4B. Bogor, Indonesia: International Centre for Research in Agroforestry.

Lusiana B, van Noordwijk M & Rahayu S. 2005. Carbon stocks in Nunukan, East Kalimantan: a spatial monitoring and modelling approach. Report from the carbon monitoring team of the Forest Resources Management for Carbon Sequestration project. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/sea/projects/tulsea/sites/default/files/inrm_tools/13_TULSEA_RaCSA.pdf

28. Reducing emissions from peatlands (REPEAT)

Contact:

Maswar, Meine van Noordwijk and Fahmuddin Agus

CRP/Institution: ICRAF

Short description of the tool:

Reducing Emissions from Peatlands (REPEAT) is a methodological tool designed to fill the gaps in our knowledge about peatlands. REPEAT simplifies collecting data and the subsequent consideration of land-use options (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:

Data collection and database

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

References and further readings:

Agus F, Hairiah K & Mulyani A. 2011. Measuring carbon stock in peat soil: practical guidelines. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia; Indonesian Centre for Agricultural Land Resources Research and Development.

Intergovernmental Panel on Climate Change (IPCC). 2013. 2013 Supplement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Tokyo: IGES. http://www.ipcc-nggip.iges.or.jp/home/docs/1105_WetlandsToC.pdf

Joshi L, Janudianto, van Noordwijk M & Pradhan UP. 2010. Investment in carbon stocks in the eastern buffer zone of Lamandau River Wildlife Reserve, Central Kalimantan province, Indonesia: a REDD+ feasibility study. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. http://worldagroforestrycentre.org/regions/southeast_asia/publications?do=view_pub_detail&pub_no=RP0268-11

Maswar. 2011. Kajian cadangan karbon pada lahan gambut tropika yang didrainase untuk tanaman tahunan. Assessment of carbon stocks in tropical peatlands drained for annual crops. PhD Thesis. Bogor, Indonesia: Program Studi Ilmu Tanah, Sekolah Pascasarjana, Institut Pertanian Bogor.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

29. Re-assessing oxygen supply and air quality (ROSAQ)

Contact:

Meine van Noordwijk and Betha Lusiana
CRP/Institution: ICRAF

Short description of the tool:

A storyline that remains popular in public discourse and policy making is that trees provide oxygen. While scientists may argue that there is an excess rather than shortage of oxygen in the atmosphere, there are important issues of air quality that trees and forests interact with. The Re-assessing Oxygen Supply and Air Quality (ROSAQ) tool provides some pointers to how these can be tackled as part of a landscape approach. The tool seeks to contribute to the identification of realistic roles of strategically placed trees and forests in improving air quality, while responding to commonly repeated concerns about oxygen supply (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:

Method or process facilitating discussions between actors

Main theme:

Other topics (Air quality)

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Case study: In 2008, Indonesia challenged Japanese scientists to check the balance between the amount of fresh oxygen produced by its protected forests and amounts of forest fire haze affecting neighbouring countries. This information could be an important way to counter repeated international protests over Indonesia's haze problems. (Van Noordwijk et al., 2013).

References and further readings:

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

30. Biofuel emission reduction estimator scheme (BERES): land-use history, production systems and technical emission factors

Contact:

Meine van Noordwijk, Ni'matul Khasanah and Sonya Dewi
CRP/Institution: ICRAF

Short description of the tool:

The Biofuel Emission Reduction Estimator Scheme (BERES) is an integrated assessment method for estimating carbon dioxide and other greenhouse gas emissions related to biofuel production. It includes three different phases of crop production processes within lifecycle analysis and is in line with EU-mandated calculations. The phases are 1) land conversion; 2) crop production; and 3) post-harvest commodity transport and processing. BERES was designed to provide a transparent approach to lifecycle analysis of the emissions associated with production of biofuel feedstocks, as a basis for calculating carbon footprints (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects

Scale:

Individual tree
Plot/Field

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

BERES was applied to 23 plantations in Indonesia that abided by what was considered 'good practice' and estimated whether the net emissions reduction of this 'good practice' was able to meet minimum European Union standards (Van Noordwijk et al., 2013).

References and further readings:

Khasanah N, van Noordwijk M, Ekadinata A, Dewi S, Rahayu S, Ningsih H, Setiawan A, Dwiyanti E & Octaviani R. 2012. The carbon footprint of Indonesian palm oil production. Technical Brief 25: palm oil series. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. http://worldagroforestry.org/regions/southeast_asia/publications?do=view_pub_detail&pub_no=PB0047-12

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/sea/Publications/files/leaflet/LE0154-09.pdf

31. Generic river flow at landscape level (GenRiver)

Contact:

Ni'matul Khasanah, Lisa Tanika, Betha Lusiana and Meine van Noordwijk
CRP/Institution: ICRAF
Website: http://apps.worldagroforestry.org/sea/Products/AFModels/genriver/genriver.htm

Short description of the tool:

Generic River Flow (GenRiver) is a semi-distributed, process-based model that extends a plot-level water balance to sub-catchment level. It was developed for data-scarce situations and is based on empirical equations. The model can be used: to explore the basic changes of river flow characteristics across spatial scales: from patch, sub -catchment to catchment; to improve our understanding of historical changes in river flow owing to land-use changes; to simulate the effects of land-cover and climate changes on the hydrological functions of a watershed (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Water

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field
Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

GenRiver was used to analyze the response to land-cover changes of Bialo watershed (11 417 km2), situated in Bantaeng and Bulukumba districts, South Sulawesi, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Moriasi DN, Arnold JG, Van Liew MW, Bingner RL, Harmel RD & Veith TL. 2001. Model evaluation guidelines for systematic quantification of accuracy in watershed simulations. American Society of Agricultural and Biological Engineers 20(3):885–900. https://swat.tamu.edu/media/1312/moriasimodeleval.pdf

Van Noordwijk M, Widodo RH, Farida A, Suyamto DA, Lusiana B, Tanika L & Khasanah N. 2011. Generic River and Flow Persistence models. User Manual Version 2.0. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. http://apps.worldagroforestry.org/sea/Publications/files/manual/MN0048-11/MN0048-11-1.pdf

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/downloads/Publications/PDFS/LE08332.PDF

32. Flow persistence (FlowPer)

Contact:

Lisa Tanika and Meine van Noordwijk

CRP/Institution: ICRAF

Short description of the tool:

The Flow Persistence (FlowPer) model produces an indicator that summarizes the relationship between rainfall and river flow and current (today) with previous (yesterday) river flow. The flow persistence value can indicate how well the watershed is buffering rainfall and thus avoiding flash floods. Flow persistence values of above 0.8 may reflect good watershed conditions, while values below 0.4 indicate a poorly buffered watershed. The values can be used as a basis for conditional environmental services' rewards (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Water

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

FlowPer was used to analyze the buffering capacity of the Upper Bialo watershed, South Sulawesi,

Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Van Noordwijk M, Widodo RH, Farida A, Suyamto DA, Lusiana B, Tanika L & Khasanah N. 2011. Generic River and Flow Persistence models. User Manual Version 2.0. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. http://apps.worldagroforestry.org/sea/Publications/files/manual/MN0048-11/MN0048-11-1.pdf

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster:

http://outputs.worldagroforestry.org/cgi-bin/koha/opac-detail.pl?biblionumber=37790

33. Rainfall simulator (RainyDay)

Contact:

Meine van Noordwijk, Lisa Tanika, Desi A. Suyamto, Rachmat Mulia, Betha Lusiana and Ai Farida
CRP/Institution: ICRAF
Website: https://github.com/danielbwright/RainyDay2

Short description of the tool:

Rainfall Simulator (RainyDay) generates daily rainfall based on annual rainfall characteristics and an assumption that rainfall patterns follow statistical distribution functions, such as Weibull and Gamma. The model takes into account day-to-day variations in rainfall events as well as different patterns of rainfall across time or seasons. The model operates in MS Excel (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Water

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

RainyDay was applied in Sumberjaya catchment, Lampung, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Van Noordwijk M, Widodo RH, Farida A, Suyamto D, Lusiana B, Tanika L & Khasanah N. 2011. GenRiver and FlowPer: Generic River and Flow Persistence models. User manual version 2.0. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. http://apps.worldagroforestry.org/sea/Publications/files/manual/MN0048-11/MN0048-11-1.pdf

Van Noordwijk M, Farida A, Suyamto D, Lusiana B & Khasanah N. 2003. Spatial variability of rainfall governs river flow and reduces effects of land use change at landscape scale: GenRiver and SpatRain simulations. In: Post DA, ed. Proceedings of MODSIM 2003: International Congress on Modelling and Simulation. Townsville, Australia: Modelling and Simulation Society of Australia and New Zealand. p. 572–577.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

34. Spatial rainfall (SpatRain)

Contact:

Meine van Noordwijk, Lisa Tanika, Desi A. Suyamto, Rachmat Mulia, Betha Lusiana and Ai Farida
CRP/Institution: ICRAF
Website: http://apps.worldagroforestry.org/sea/Products/AFModels/spatrain/spatrain.htm

Short description of the tool:

Spatial Rainfall (SpatRain) is a statistical tool to generate event-level rainfall maps across a watershed that represent the observed partial spatial correlation between daily rainfall at multiple locations. The results can be used by hydrological models that assess the influence of rainfall at watershed level on the scaling of river flow and its degree of buffering and flow persistence (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Water

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

SpatRain was used together with GenRiver to simulate the river flow of Way Besai River in Sumberjaya watershed, Lampung, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Van Noordwijk M, Widodo RH, Farida A, Suyamto D, Lusiana B, Tanika L & Khasanah N. 2011. GenRiver and FlowPer: Generic River and Flow Persistence models. User manual version 2.0. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. http://apps.worldagroforestry.org/sea/Publications/files/manual/MN0048-11/MN0048-11-1.pdf

Van Noordwijk M, Farida A, Suyamto D, Lusiana B & Khasanah N. 2003. Spatial variability of rainfall governs river flow and reduces effects of land use change at landscape scale: GenRiver and SpatRain simulations. In: Post DA, ed. Proceedings of MODSIM 2003: International Congress on Modelling and Simulation. Townsville, Australia: Modelling and Simulation Society of Australia and New Zealand. p. 572–577.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

35. Land-use-change impact assessment (LUCIA)

Contact:

Carsten Marohn, Georg Cadisch and Betha Lusiana

CRP/Institution: ICRAF

Website: https://lucia.uni-hohenheim.de/en

Short description of the tool:

The Land-Use Change Impact Assessment (LUCIA) model can be used to assess impacts of land-use changes on soil productivity and fertility, biomass production, watershed functions and environmental services. It operates at user-defined spatial and daily temporal resolution and has been used for landscapes of up to 50 x 50 km. It helps scientists and land-use planners simulate mid- to-long-term effects of land-use management and changes on environmental degradation and rehabilitation. It is explicit in the consequences of plot-level decision making by farmers and thus operates between the reach of detailed tree–soil–crop interaction models and models that operate at more aggregated watershed scale. LUCIA was designed to represent processes of water balance, erosion and sedimentation as well as nutrient balance and yield formation in a small catchment responding to plot-level management decisions (Van Noordwijk et al., 2013). LUCIA has been coupled to MPMAS (Mathematical Programming Multi Agent Systems) for agent-based decision making and to the LIVestock SIMulator (LIVSIM) for integrated crop livestock systems.

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Land use and land use change

Main focus:

Biophysical and ecological aspects

Scale:

Plot to landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

LUCIA was used to assess the potential impact of low-cost soil conservation methods on maize cultivation in upland areas, in Chieng Khoi, Son La province, Viet Nam, an area which represents the ongoing trend towards intensified maize-based agriculture in North-Western Viet Nam (Van Noordwijk et al., 2013). LUCIA has been applied in case studies in mountainous catchments of Southeast Asia and South China, pastoral areas and cropping systems in East and West Africa and agroforestry systems (Quesunguales) in Central America.

References and further readings:

Hörhold S & Marohn C. 2012. User manual for the Land Use Change Impact Assessment tool LUCIA. Hohenheim, Germany: Hohenheim University. https://lucia.uni-hohenheim.de/fileadmin/einrichtungen/lucia/lucia_user_manual.pdf

Liu H, Yang X, Blagodatsky S, Marohn C, Liu F, Xu J & Cadisch G. 2019. Modelling weed management strategies to control erosion in rubber plantations. Catena 172:345-355. https://doi.org/10.1016/j.catena.2018.08.041

Marohn C, Birner R, Troost C, Zijlstra M, Warth B, Bateki C, Descheemaeker K, Dickhöfer U, Berger T, Asch F & Cadisch, G. 2018. Rude awakening of a sleeping giant? Exploring costs and potentials of intensification options in African savannas. Presentation at FOOD 2030: Towards sustainable agri-food systems. 5-6 September 2018, University of Hohenheim, Stuttgart, Germany.

Marohn C & Cadisch G. 2011. Documentation and manual of the LUCIA model version 1.2. Stuttgart, Germany: Institute for Plant Production and Agroecology in the Tropics and Subtropics, University of Hohenheim. https://lucia.uni-hohenheim.de/

Marohn C, Cadisch G, Jintrawet A, Buddhaboon C, Sarawat V, Nilpunt S, Chinvanno S, Pannangpetch K, Lippe M, Potchanasin C, Dang VQ, Schreinemachers P, Berger T, Siripalangkanont P & Thanh TN. 2013. Integrated modeling of agricultural systems in mountainous areas. In: HL Fröhlich, P Schreinemachers, K Stahr, G Clemens. Sustainable land use and rural development in Southeast Asia: innovations and policies for mountainous areas. p. 367-432. New York: Springer.

Marohn C, Schreinemachers P, Quang DV, Berger T, Siripalangkanont P, Nguyen TT & Cadisch G. 2013. A software coupling approach to assess low-cost soil conservation strategies for highland agriculture in Vietnam. Environmental Modelling and Software 45: 116–128. https://doi.org/10.1016/j.envsoft.2012.03.020

Marohn C, Warth B, Troost C, Bateki C, Dickhöfer U, Berger T, Asch F, Birner R & Cadisch G. 2020. Landscape-scale interactions between pastures, crops, trees and cattle in savanna grassland systems. Presentation at iEMSs 14-18/09/2020, Brussels and full paper.

Marohn C, Weisshaidinger R, Nicolay G, Otinga A, Pohl A, Merckx R, Njoroge R, Koomson E, Kerre F, Wangaruro J, Njogo S, Munini B & Cadisch G. 2017. A Framework of Biophysical Measurements, Innovation Platforms and Modelling for Agricultural Stakeholders' Landscape-Scale Decisions. Presentation at Tropentag Conference, Bonn, 20-22 September 2017.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Warth B, Marohn C & Asch F. 2021. Improved simulation of plant-animal interactions in African savannas with the extended land use change model LUCIA.Ecological Modelling 446, 109496. https://doi.org/10.1016/j.ecolmodel.2021.109496

Yang X, Blagodatsky S, Marohn C, Liu H, Golbon R, Xu J & Cadisch G. 2019.Climbing the mountain fast but smart: Modelling rubber tree growth and latex yield under climate change. Forest Ecology & Management 439:55-69. https://doi.org/10.1016/j.foreco.2019.02.028

36. Polyscape

Contact:

Fergus Sinclair and Timothy Pagella
CRP/Institution: ICRAF

Short description of the tool:

Polyscape is a GIS framework designed to explore spatially explicit synergies and trade-offs amongst ecosystem services to support landscape management (from individual fields through to local landscapes of 1000 km2 scale). Polyscape currently maps the impacts of land-cover change on surface runoff, habitat connectivity, erosion, carbon sequestration and agricultural productivity. The tool also incorporates trade-off algorithms that allow visualisation of the impact of different land management decisions and, thus, can be useful for land-use planning at local landscape scales.

The objective of Polyscape is to represent the basic physical structure of a landscape along with the key spatial processes that influence ecosystem functions and create spatial dependencies between cause and effect. This is to be done in a way that is intuitive and communicates well with local stakeholders. The tool captures additional information and insights into the current situation before exploring future changes (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Land use and land use changes

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field
Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Polyscape was applied in the Sasumua watershed in upland Kenya (Van Noordwijk et al., 2013).

References and further readings:

Jackson B, Pagella T, Sinclair F, Orellana B, Henshaw A, Reynolds B, McIntyre N, Wheater H & Eycott A. 2013. Polyscape: a GIS mapping framework providing efficient and spatially explicit landscape-scale valuation of multiple ecosystem services. Landscape and Urban Planning 112:74–88. https://doi.org/10.1016/j.landurbplan.2012.12.014

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

37. Forest, agroforest, low-value landscape or wasteland (FALLOW)

Contact:

Desi A. Suyamto, Rachmat Mulia and Betha Lusiana
CRP/Institution: ICRAF

Short description of the tool:

Forest, Agroforest, Low-value Landscape or Wasteland (FALLOW) is a spatially explicit model that simulates the consequence of agents' land management decisions on overall landscape dynamics. It is useful for exploring how the changes in the landscape have an impact on carbon sequestration, biodiversity and watershed functions. FALLOW is particularly suited to simulate rural or peri-urban landscapes where land-based activities (that is, agriculture, forest extraction) are still the main source of livelihood. FALLOW proceeds in annual time steps at watershed scale.

FALLOW simulates the dynamics of land-use and land-cover changes that are local responses to external drivers, with various feedback loops, and assess the consequences of the resulting land-use mosaics on economic utilities (welfare and food security) and environmental services (for example, carbon stocks) (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Land use and land use changes

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

FALLOW model was used to explore the effect of land zoning on farmers' livelihoods and aboveground carbon sequestration in the Upper Konto catchment, East Java, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Lusiana B, Khususiyah N, Hairiah K, van Noordwijk M & Cadisch G. 2010. Trade-off analysis of land use change, livelihoods and environmental services in the Upper Konto catchment (Indonesia): prospecting land use options with the FALLOW model. LANDMOD2010 – Montpellier – February 3-5, 2010 www.symposcience.org. http://apps.worldagroforestry.org/downloads/Publications/PDFS/PP10139.pdf

Lusiana B, van Noordwijk M & Cadisch G. 2012. Land sparing or sharing? Exploring livestock fodder options in combination with land-use zoning and consequences for livelihoods and net carbon stocks using the FALLOW model. Agriculture, Ecosystems and Environment 159:145–160. https://doi.org/10.1016/J.AGEE.2012.07.006

Mulia R, Lusiana B & Suyamto D. 2013. Manual of FALLOW model. Version 2.1. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Mulia R, Widayati A, Suyanto, Agung P & Zulkarnain MT. 2013. Low carbon emission development strategies for Jambi, Indonesia: simulation and trade-off analysis using the FALLOW model. Mitigation and Adaptation Strategies for Global Change. https://doi.org/10.1007/s11027-013-9485-8

Suyamto DA, Mulia R, van Noordwijk M & Lusiana B. 2009. Fallow 2.0. Manual and Software. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Van Noordwijk M. 2002. Scaling trade-offs between crop productivity, carbon stocks and biodiversity in shifting cultivation landscape mosaics: the FALLOW model. Ecological Modelling 149:113–126. https://doi.org/10.1016/S0304-3800(01)00518-X

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/downloads/Publications/PDFS/LE08333.pdf

38. Ecological corridors (ECor): a distributed population model with gender specificity

Contact:

Meine van Noordwijk, Rachmat Mulia and Sonya Dewi

CRP/Institution: ICRAF

Website: Download ECor: http://www.worldagroforestry.org/sea/files/MetaPop001BV.zip.

Short description of the tool:

To counteract the effect of habitat fragmentation, the concept of restoring ecological corridors is popular in conservation circles. The expected effectiveness of such corridors depends strongly on the dispersal characteristics, which for species such as orangutan are strongly dependent on gender. A distributed population model allows ex ante impact predictions of various corridor designs (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Biodiversity, natural resources and ecosystem services

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Case study: ECor in Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Tata MH, van Noordwijk M, Mulyoutami E, Rahayu S, Widayati A & Mulia R. 2010. Human livelihoods, ecosystem services and the habitat of the Sumatran orangutan: rapid assessment in Batang Toru and Tripa. Project Report. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

39. REDD abacus SP

Contact:

Degi Harja, Sonya Dewi, Meine van Noordwijk, Andree Ekadinata, Arif Rahmanulloh and Feri Johana

CRP/Institution: ICRAF

Website: Tool download: https://www.worldagroforestry.org/output/tools/redd-abacus-sp-more

Short description of the tool:

REDD Abacus SP is the short name for Reducing Emissions from Deforestation and Forest Degradation Abatement Cost Curves and Simulator for Scenarios of Policies, a tool to estimate emissions from land-use and land-cover changes, which takes into account the dynamic heterogeneity of soil types, elevations, climate and other biophysical characteristics in a landscape. The tool can easily produce abatement cost curves and the resulting opportunity cost analysis of trade-offs between emission reduction and economic benefits. The tool uses Java programming language and can be run in any operating system (Windows, Mac, Linux etc.). The user interfaces can be easily translated into other languages. (Van Noordwijk et al., 2013).

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects

Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

REDD Abacus SP has been used extensively within LUWES activity, in Tanjung Jabung Barat district, Jambi province, Indonesia, to estimate opportunity-cost curves during the periods 1990–2000, 2000-2005 and 2005-2009 (Van Noordwijk et al., 2013).

References and further readings:

Harja D, Dewi S, van Noordwijk M, Ekadinata A & Rahmanulloh A. 2011. REDD Abacus SP: User Manual and Software. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Widayati A, Suyanto S & van Noordwijk M. 2011. Towards reduced emissions in a high-stake district. REALU project design for Tanjung Jabung Barat (Tanjabar), Jambi, Indonesia. Version 2.0. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

40. Rapid land tenure assessment (RaTA): understanding land tenure conflicts

Contact:

Gamma Galudra, Martua Sirait and Ujjwal Pradhan
CRP/Institution: ICRAF

Short description of the tool:

Rapid land tenure assessment (RaTA) aims to reveal the competing historical and legal claims over land-use and access rights among stakeholders who hold different rights and interests. RaTA clarifies the institutions and rules governing the management of natural resources and analyses the links between various claims and customary land laws and policies. RaTA seeks policy options and interventions to resolve land conflicts (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Governance, institutions and capacity development

Main focus:

Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Case study: RaTA in the misty mountain of Halimun Salak: a confusion of legal rights from multiple historic claims (Van Noordwijk et al., 2013).

References and further readings:

Galudra G, Sirait MT, Pasya G, Fay CC, Suyanto S, van Noordwijk M & Pradhan U. 2010. RaTA: a rapid land tenure assessment manual for identifying the nature of land tenure conflicts. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. https://www.unredd.net/documents/redd-papers-and-publications-90/other-sources-redd-papers-and-publications/safeguards-1/safeguards-and-social-impact-assessments-858/5663-rata-a-rapid-land-tenure-assessment-manual-for-identifying-the-nature-of-land-tenure-conflicts-5663.html

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

41. Why No Tree? (WNoTree) analysis of agroforestry constraints

Contact:

Meine van Noordwijk, Endri Martini and Suyanto
CRP/Institution: ICRAF

Short description of the tool:

A Why No Tree? (WNoTree) analysis examines five constraints to a re-greening revolution based on agroforestry: (i) property rights linked to land tenure and land-use restrictions; (ii) lack of access to high quality planting material of proven suitability; (iii) inadequate management skills and information often constrain production for high market values; (iv) over-regulation often restricts access to markets for farmer-grown timber and tree products, partly due to rules intended to curb illegal logging in natural forests or government plantations; (v) lack of reward mechanisms for the environmental services provided by agroforestry and/or high discount rate and lack of investment. The WNoTree surveys aim at identifying and addressing the most significant constraints to tree management and domestication, planting and harvesting, in the local context through focus-group discussions with farmers and local government agencies (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Agroforestry

Main focus:

Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Bertomeu M, & Roshetko JM. 2008. Domesticating Landscapes through Farmer-led Tree Cultivation: An *Agroforestation* Approach to Reforestation in Southeast Asia. Paper presented at the International Symposium on *Small-scale Rural Forest Use and Management: Global Policies versus Local Knowledge*. Gerardmer, France, July 23-27, 2008.

Roshetko JM, Snelder DJ, Lasco RD & van Noordwijk M. 2008. Future challenge: a paradigm shift in the forestry sector. In: Snelder DJ, Lasco RD, eds. Smallholder tree growing for rural development and environmental services. New York, USA: Springer Science and Business Media. p. 453–485. https://doi.org/10.1007/978-1-4020-8261-0_21

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

van Noordwijk M, Roshetko JM, Murniati, Delos Angeles M, Suyanto, Fay C & Tomich TP. 2008. Farmer Tree Planting Barriers to Sustainable Forest Management. In: DJ Snelder and R Lasco (eds). Smallholder Tree Growing for Rural Development and Environmental Services. pp. 429-451

Poster: http://apps.worldagroforestry.org/downloads/Publications/PDFS/LE08334.pdf

42. Fair and efficient REDD value chains allocation (FERVA)

Contact:

Meine van Noordwijk, Suyanto and Sandra Velarde

CRP/Institution: ICRAF

Short description of the tool:

Fair and Efficient REDD Value Chains Allocation (FERVA) is based on focus-group discussions with different stakeholder groups to combine efficiency and fairness principles in reducing emissions from deforestation, peat land and forest degradation, and other land-use changes in developing countries (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:

Method or process facilitating discussions between actors

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Van Noordwijk M, Dewi S, Swallow BM, Purnomo H & Murdiyarso D. 2007. Avoided deforestation with sustainable benefits (ADSB) in Indonesia. 1. Policy research brief. Avoided. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/sea/projects/tulsea/sites/default/files/inrm_tools/11_TULSEA_FERVA.pdf

43. Rapid assessment of institutional strengths, networks and actors (RISNA)

Contact:

Retno Maryani, Gamma Galudra, Reny Juita and Ujjwal Pradhan
CRP/Institution: ICRAF - RECOFTC

Short description of the tool:

Rapid Assessment of Institutional Strengths, Networks and Actors (RISNA) aims at: (i) identifying strengths and weaknesses of existing local institutions in charge of natural resource management to face policies and environmental changes; (ii) identifying particular structures and components within the institutions that should be strengthened to increase agilities in conserving and managing natural resources; (iii) providing tools for policy-makers that can be used to determine the capacity of an institution (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:

Method or process facilitating discussions between actors

Main theme:

Governance, institutions and capacity development

Main focus:

Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

RISNA has been applied in the village of Lubuk Beringin in Jambi province, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Akiefnawati R, Villamor GB, Zulfikar F, Budisetiawan I, Mulyoutami E, Ayat A & van Noordwijk M. 2010. Stewardship agreement to reduce emissions from deforestation and degradation (REDD): case study from Lubuk Beringin's Hutan Desa, Jambi Province, Sumatra, Indonesia. International Forestry Review 12:349–360. https://doi.org/10.1505/ifor.12.4.349

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

44. REDD/REALU site-level feasibility appraisal (RESFA)

Contact:

Laxman Joshi, Meine van Noordwijk and Janudianto
CRP/Institution: ICRAF

Short description of the tool:

Land-use and land-cover changes are a relevant part (about 15%) of the total human-induced emissions of greenhouse gasses that lead to global climate change. Reducing land-based emissions usually requires two things: (i) dealing with the direct drivers of land-use change that reduce carbon storage, for example forests conversion; and (ii) supporting sustainable livelihoods' options that are compatible with high carbon-stock landscapes with trees that provide goods and services. RESFA integrates a number of negotiation-support tools to lead to a decision point for local communities and proponents of activities under the mechanisms for reducing emissions from deforestation and forest degradation (REDD) and reducing emissions from all land uses (REALU) (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Joshi L, Janudianto, van Noordwijk M & Pradhan UP. 2010. Investment in carbon stocks in the eastern buffer zone of Lamandau River Wildlife Reserve, Central Kalimantan province, Indonesia: a REDD+ feasibility study. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. http://worldagroforestrycentre.org/regions/southeast_asia/publications?do=view_pub_detail&pub_no=RP0268-11

Janudianto, Mulyoutami E, Joshi L, Wardle DA & van Noordwijk M. 2011. Recognizing traditional tree tenure as part of conservation and REDD+ strategy: feasibility study for a buffer zone between a wildlife reserve and the Lamandau River in Indonesia's REDD+ pilot province. ASB Policy brief 22. Nairobi: ASB Partnership for the Tropical Forest Margins.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Poster: http://apps.worldagroforestry.org/downloads/Publications/PDFS/LE09148.pdf

45. Trade-off analysis for land-use scenarios (TALaS)

Contact:

Rachmat Mulia, Betha Lusiana and Meine van Noordwijk
CRP/Institution: ICRAF

Short description of the tool:

Trade-off Analysis for Land-use Scenarios (TALaS) is based on a suite of tools that carry out ex-ante analysis of the impact of development strategies on the trade-offs between livelihoods and ecosystem services. The tool combines the use of a spatially explicit land-use-change model (FALLOW), a land-use profitability analysis tool (LUPA) as well as other tools that aim to quantify ecosystem services, that is, biodiversity, carbon and hydrological functions. TALaS is useful for exploring suitable development strategies that can balance growth in the economy and livelihoods while maintaining or enhancing ecosystem services (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Llivelihoods and resilience

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The tool was used in Tanjung Jabung, Barat district, Jambi province, Eastern part of Sumatra, Indonesia (Mulia et al 2013; Van Noordwijk et al., 2013).

References and further readings:

Lusiana B, van Noordwijk M & Cadisch G. 2012. Land sparing or sharing? Exploring livestock fodder options in combination with land use zoning and consequences for livelihoods and net carbon stocks using the FALLOW model. Agriculture, Ecosystems and Environment 159: 145–160. https://doi.org/10.1016/J.AGEE.2012.07.006

Mulia R, Lusiana B & Suyamto D. 2013. Manual of FALLOW model. Version 2.1. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Mulia R, Widayati A, Suyanto, Agung P & Zulkarnain MT. 2013. Low carbon emission development strategies for Jambi, Indonesia: simulation and trade-off analysis using the FALLOW model. Mitigation and Adaptation Strategies for Global Change. https://doi.org/10.1007/s11027-013-9485-8

Suyamto D, Mulia R, van Noordwijk M, and Lusiana B. 2009. FALLOW 2.0 Manual and Software. World Agroforestry Centre, Bogor, Indonesia. 67p. http://apps.worldagroforestry.org/downloads/Publications/PDFS/MN16378.pdf

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

46. Scenario tools: land-use planning for low-emissions development strategies (LUWES)

Contact:

Sonya Dewi, Feri Johana and Andree Ekadinata
CRP/Institution: ICRAF

Short description of the tool:

Land-based actions to mitigate climate change, which are 'pro-poor' and oriented towards 'green' development, need spatially explicit land-use planning processes that are inclusive, informed and integrative. Bringing multi-stakeholder processes to life, beyond rhetoric, needs a breakthrough in political willingness, multi-stakeholder buy-in and technical capacities that allows negotiation platforms to operate. In this context, Land-use Planning for Low-emissions Development Strategies (LUWES): (i) provides a framework, guided steps and tools for local stakeholders to negotiate a low-emissions development strategy through land-use planning based on formal and informal allocations and actual biophysical status; and (ii) accommodates 'what if' scenarios and trade-off analyses as a basis for negotiations over best scenarios for climate-change mitigation (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The tool has been applied in several districts in Indonesia (Van Noordwijk et al., 2013).

References and further readings:

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Dewi S, Ekadinata A, Galudra G, Agung P & Johana F. 2011. LUWES: Land-use planning for low emission development strategy. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. http://www.asb.cgiar.org/PDFwebdocs/LUWES%20 2012%20V1.pdf

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

47. Capacity-strengthening approach to vulnerability assessment (CaSAVA)

Contact:

Sonya Dewi, Ni'matul Khasanah and Atiek Widayati
CRP/Institution: ICRAF

Short description of the tool:

The Capacity-Strengthening Approach to Vulnerability Assessment (CaSAVA) synthesizes local and scientific knowledge to identify existing livelihoods' assets (human, social, financial, physical and natural capital) and deficits at multiple landscape scales. The information for the synthesis comes from multiple stakeholders (for example, farmers, government officers and scientists) and is designed to enable local stakeholders (female and male farmers) to buffer and adapt to both economic (that is, fluctuating prices) and climate-related (for example, extreme weather events) shocks and hazards. CaSAVA is tailored for participatory approaches to collect information disaggregated by gender and, most importantly, to strengthen farmers' awareness of, and capacity for thinking about and articulating, otherwise latent problems. CaSAVA further facilitates the assessment results to develop conservation and livelihoods' strategies to increase farmers' resilience to shocks and hazards (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Livelihoods and resilience

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Landscape

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

At the time of writing, CaSAVA is being developed in South and Southeast Sulawesi provinces, Indonesia (Van Noordwijk et al., 2013).

Further example of application (2018): https://satoyama-initiative.org/case_studies/strengthening-smallholder-resilience-and-improving-ecosystem-services-provision-in-indonesia-experience-from-buol-district-central-sulawesi/

References and further readings:

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

48. Assessing and adopting social safeguards in all planned programs (AASSAPP)

Contact:

Sébastien de Royer, Gamma Galudra and Ujjwal Pradhan

CRP/Institution: ICRAF - RECOFTC

Short description of the tool:

The land-use planning process often prioritizes powerful interest groups who benefit financially from land and resources. 'Social safeguards' are procedures that ensure that projects take into consideration people's rights, aspirations and the 'do no harm' principle. They encompass: free, prior and informed consent; participation; resolution of land conflict; clarifying land and natural resources use-rights; livelihoods and food security; and poverty alleviation. The Assessing and Adopting Social Safeguards in All Planned Programs (AASSAPP) tool is meant to help local governments and communities go beyond compliance mechanisms and integrate social safeguards into the broader architecture of landscape management. The primary objective is to assess land-use planning and implementation based on the principles, criteria and indicators appropriate for social safeguards. The second objective is to adopt the appropriate principles, criteria and indicators in the mechanisms and regulations. (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:

Method or process facilitating discussions between actors

Main theme:

Governance, institutions and capacity development

Main focus:

Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

AASSAPP was used to assess the application of social safeguards in land-use planning in Jayapura district in the province of Papua (Van Noordwijk et al., 2013).

References and further readings:

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

49. RUPES role-play game (RPG)

Contact:

Grace B. Villamor, Beria Leimona and Meine van Noordwijk
CRP/Institution: ICRAF

Short description of the tool:

The Rewarding Upland Poor for Environmental Services (RUPES) project developed a role-play game (RPG) that simulated the options for land-use changes for villages in a tropical forest margin. The RPG aims at providing a schematized but recognizable representation of the decisions that villagers can make about land use, with consequences for food security and income. It is a learning process for those who play, observe and analyze. It also allows data capture for comparison between situations.

The game resembles the decision-making process gone through by villagers interacting with external agents. The agents offer opportunities for further logging and conversion of forests to monoculture tree plantations or incentives to protect environmental services. The game shows the complexity of negotiations under time pressure, with limited information about what the 'rules of the game' imply. Primarily meant as a learning tool for those playing, observing and analyzing the game, the results can also be compared between the results achieved in multiple replications of the game (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Land use and land use changes

Main focus: All three
Biophysical and ecological aspects
Socio-economic aspects
Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The role-play game was used by Villamor et al (2013) to explore the role of gender as a factor in decision making about alternative land-use options and in responses to new investment opportunities in a forest margin landscape in Jambi, Sumatra, Indonesia (Van Noordwijk et al., 2013).

References and further readings:

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Villamor GB & van Noordwijk M. 2011. Social role-play games vs individual perceptions of conservation and PES agreements for maintaining rubber agroforests in Jambi (Sumatra), Indonesia. Ecology and Society 16(3):27. http://dx.doi.org/10.5751/ES-04339-160327

Villamor GB, Desrianti F, Akiefnawati R, Amaruzaman S & van Noordwijk M. 2013. Gender influences decisions to change land-use practices in the tropical forest margins of Jambi, Indonesia. Mitigation and Adaptation Strategies for Global Change 2013:1–23. https://doi.org/10.1007/s11027-013-9478-7

50. Conservation auction and environmental services' enhancement (Con$erv)

Contact:

Beria Leimona
CRP/Institution: ICRAF

Short description of the tool:

Procurement auctions have been designed to efficiently allocate conservation contracts and reveal hidden information on the opportunity costs of supplying environmental services. The Conservation Auction and Environmental Services Enhancement (Con$erv) uses a step-by-step approach to go beyond an economic interpretation focused on prices and efficiency to encompass the social dimensions of learning, perceptions and fairness, which also require attention and, in so doing, offers an opportunity for deeper analysis of the motivations of stakeholders (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Biodiversity, natural resources and ecosystem services

Main focus:

Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Con$erv was used in the Sumberjaya watershed in Lampung, Indonesia, where soil erosion had broad implications for on-site and off-site damage (Van Noordwijk et al., 2013).

References and further readings:

Leimona B, Jack BK, Lusiana B & Pasha R. 2010. Designing a procurement auction for reducing sedimentation: a field experiment in Indonesia. Singapore: Economy and Environment Program for Southeast Asia.

Leimona B & Jack BK. 2010. Indonesia: a pilot PES auction in the Sumberjaya watershed. In: Paying for biodiversity: enhancing the cost-effectiveness of payments for ecosystem services. Paris: Organisation for Economic Co-operation and Development. p. 161–178.

Ajayi OC, Jack BK & Leimona B. 2012. Auction design for the private provision of public goods in developing countries: lessons from payments for environmental services in Malawi and Indonesia. World Development 40:1213–1223. https://doi.org/10.1016/J.WORLDDEV.2011.12.007

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

51. Multi-scale payments-for-environmental services' paradigms (MuScaPES)

Contact:

Beria Leimona, Sara Namirembe, Meine van Noordwijk and Peter A. Minang
CRP/Institution: ICRAF

Short description of the tool:

Beyond the umbrella term of 'payments for environmental services', a range of paradigms and associated mechanisms have emerged that differ in articulation and in economic, social and political assumptions. This tool can help clarify the range of possibilities and assist local, national and international proponents of PES and PES-like arrangements in choosing a locally appropriate paradigm and understand its relation with underlying motivations (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Biodiversity, natural resources and ecosystem services

Main focus:

Socio-economic aspects
Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Case study: CES, COS and CIS in Africa (Van Noordwijk et al., 2013).

References and further readings:

Namirembe S, Leimona B, Van Noordwijk M, Bernard F & Bacwayo KE. 2013. Co-investment paradigms as alternatives to payments for tree-based ecosystem services in Africa. Current Opinion in Environmental Sustainability. http://dx.doi.org/10.1016/j.cosust.2013.10.016

Van Noordwijk M, Agus F, Dewi S, Purnomo H, Lusiana B & Villamor GB. 2013. Reducing emissions from all land uses in Indonesia: motivation, expected funding streams and multi-scale policy instruments. ASB Policy brief 34. Nairobi, Kenya: ASB Partnership for the Tropical Forest Margins.

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

52. Integration

Contact:

Meine van Noordwijk, Beria Leimona, Sonya Dewi, Ujjwal Pradhan, Sara Namirembe, Delia Catacutan, James M. Roshetko and Peter A. Minang

CRP/Institution: ICRAF

Short description of the tool:

Some guidance is given on how the support of negotiations between stakeholders over crucial landscape issues can be organized in a multidisciplinary, multi-skilled team with awareness of the need for, and challenges of, communication across multiple knowledge systems, attitudes, skills and aspirations (Van Noordwijk et al., 2013).

Category of tool:

Decision-making supporting tool:

Method or process facilitating discussions between actors

Main theme:

Governance, institutions and capacity development

Main focus:

Governance aspects

Scale:

N/A

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

53. Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale.

Contact:

Vincent Bado
CRP/Institution: WLE / ICRISAT

Short description of the tool:

The goal of the project is to reduce food insecurity and improve livelihoods of poor people living in African drylands by restoring degraded land, and returning it to effective and sustainable tree, crop and livestock production, thereby increasing land profitability and landscape and livelihood resilience. The project, situated in the Niger, aims at developing good practice guidelines for restoring productive capacity of dryland and tools, methods and guidelines for scaling

Category of tool:

Decision-making supporting tool:
Manual or guidelines

Main theme:

Forest landscape restoration

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Farm
Landscape

Stage of development:

Under development or pilot-test at the time of writing

References and further readings:

Bado VB & Bationo A. 2018. Integrated Management of Soil Fertility and Land Resources in Sub-Saharan Africa: Involving Local Communities. Advances in Agronomy, Volume 150: 1-33. https://doi.org/10.1016/bs.agron.2018.02.001

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. *A joint stocktaking of CGIAR work on forest and landscape restoration.* Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

54. Mitigation potentials in Latin American landscapes through two carbon-intense restoration options: forest expansion and peat restoration

Contact:

Rosa María Román-Cuesta
CRP/Institution: CIFOR, FP5

Short description of the tool:

The tool aims at:

assessing the maximum mitigation potential of Latin American landscapes over a 40-year period through the two most carbon-intense restoration activities: forest expansion from non-assisted second-growth forests, and peatland avoided emissions from fire and drainage;

understanding how this potential is spatially distributed; and,

contrasting our estimates against other land-use mitigation options.

The tool produces a 250-m map of forest biomass accumulation potential (BAP, expressed in Mg/ha), synonym of Mitigation potential, based on the Atlas of Forest Landscape Restoration Opportunities (AFLRO) from WRI which contrasts current deforested and degraded forests against their potential baselines. Carbon densities are assigned to the existing range of forest biomes and conditions using a carbon density map (Avitabile et al., 2015). Four safeguards are applied to veil for food protection (cropland area) (ESA-CCA land cover maps 2010), biodiversity conservation of natural grasslands (natural savannahs and grasslands through WWF biomes), and reversal risks of fire (MODIS fire hotspots) and grazing (spatial distribution of livestock densities from Robinson et al., 2014). The tool uses Gumbricht et al. (2017) maps for peatland distribution, as well as draining percentages from Joosten et al. (2012), and fire from MODIS hotspots (Gitz et al., 2020).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects

Scale:

From Landscape to Continental

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The tool can be used governments and donors interested in prioritizing hotspot of mitigation potential in degraded forested landscapes in Latin America

References and further readings:

Avitabile V, Herold M, Heuvelink GBM, Lewis SL, Phillips OL, Asner GP, Armston J, Ashton PS, Banin L, Bayol N et al. 2015. An integrated pan-tropical biomass map using multiple reference datasets. First published 25 October 2015. *Global Change Biology*, 22 (4), pp. 1406–1420. https://doi.org/10.1111/gcb.13139

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. *A joint stocktaking of CGIAR work on forest and landscape restoration.* Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Gumbricht T, Roman-Cuesta RM, Verchot L, Herold M, Wittmann F, Householder E, Herold N & Murdiyarso D. 2017 An expert system model for mapping tropical wetlands and peatlands reveals South America as the largest contributor. First published 15 March 2017. *Global Change Biology*, 23(9), pp.3581–3599. https://doi.org/10.1111/gcb.13689

Joosten H, Tapio-Biström ML & Tol S (eds). 2012. *Peatlands – guidance for climate change mitigation through conservation, rehabilitation and sustainable use.* Second edition. Mitigation of Climate change in agriculture series No. 5. Published by the Food and Agriculture Organization of the United Nations and Wetlands International. Mitigation of Climate Change in Agriculture (MICCA) Programme. October 2012. http://www.fao.org/docrep/015/an762e/an762e.pdf

Robinson TP, Wint GRW, Conchedda G, Van Boeckel TP, Ercoli V, Palamara E, Cinardi G, D'Aietti L, Hay SI & Gilbert M. 2014. Mapping the global distribution of livestock. *Plos One*. https://doi.org/10.1371/journal.pone.0096084

Roman-Cuesta *et al.* (under submission) Mitigation potentials in Latin American landscapes through two carbon-intense restoration options: forest expansion and peat restoration. Global Change Biology.

55. Methods and tools to analyze tradeoffs between ecosystem services in restoration

Contact:

Bruno Locatelli
CRP/Institution: FTA flagship 5 / CIRAD and CIFOR

Short description of the tool:

Several methods were developed and applied for analyzing, modeling and mapping the effects of forest cover change on multiple ecosystem services and their implications for human wellbeing. We also developed methods to analyze the tradeoffs between ecosystem services resulting from changes in landscape management (Gitz et al., 2020). Methods included:

Measuring biodiversity and ecosystem services in the field (carbon, erosion) (Labrière et al., 2015)

Assessing perceptions of local communities regarding ecosystem services and their dependence on land use (Fedele et al., 2018)

Applying InVEST models to assess ecosystem services across time and space (Vallet et al., 2016)

Modeling ecosystem services spatially to extrapolate field measurements and assessing tradeoffs (Labrière et al., 2016)

Modeling ecosystem services spatially based on fuzzy logic and assessing tradeoffs (Locatelli et al., 2014)

Modelling the production possibility frontier of multiple ecosystem services in a landscape (Vallet et al., 2017)

Synthetizing studies on the temporal trajectories of multiple ecosystem services in mountains (Locatelli et al., 2017) Disentangling the effects of human actions on the delivery of ecosystem services (Fedele et al., 2017)

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Land use and land use changes

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The method was applied in Apurimac, Peru, by scientists in collaboration with local and regional decision makers from different sectors for starting an intersectoral discussion on landscape management from an analysis of trade-offs between ecosystem services (Gitz et al., 2020).

References and further readings:

Fedele G, Locatelli B & Djoudi H. 2017. Mechanisms mediating the contribution of ecosystem services to human well-being and resilience. Ecosystem Services 28A: 43-54. https://doi.org/10.1016/j.ecoser.2017.09.011

Fedele G, Locatelli B, Djoudi H & Colloff MJ. 2018. Reducing risks by transforming landscapes: Cross-scale effects of land-use changes on ecosystem services. PLoS ONE 13(4): e0195895. https://doi.org/10.1371/journal.pone.0195895

Labrière N, Laumonier Y, Locatelli B, Vieilledent G & Comptour M. 2015. Ecosystem services and biodiversity in a rapidly transforming landscape in northern Borneo. PLOS ONE 10(10): e0140423. https://doi.org/10.1371/journal.pone.0140423

Labrière N, Locatelli B, Vieilledent G, Kharisma S, Gond V, Basuki I & Laumonier Y. 2016. Spatial congruence between carbon and biodiversity across forest landscapes of northern Borneo. Global Ecology and Conservation 6: 105-120. https://doi.org/10.1016/j.gecco.2016.01.005

Locatelli B, Imbach B & Wunder S. 2014. Synergies and trade-offs between ecosystem services in Costa Rica. Environmental Conservation 41(1): 27-36. https://doi.org/10.1017/S0376892913000234

Locatelli B, Lavorel S, Sloan S, Tappeiner U & Geneletti D. 2017. Characteristic trajectories of ecosystem services in mountains. Frontiers in Ecology and the Environment 15(3): 150-159. https://doi.org/10.1002/fee.1470

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. *A joint stocktaking of CGIAR work on forest and landscape restoration.* Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Vallet A, Locatelli B, Levrel H, Brenes Pérez C, Imbach P, Estrada Carmona N, Manlay R & Oszwald J. 2016. Dynamics of ecosystem services during forest transitions in Reventazón, Costa Rica. PLOS ONE 11(7): e0158615. https://doi.org/10.1371/journal.pone.0158615

Vallet A, Locatelli B, Levrel H, Wunder S, Seppelt R, Scholes RJ & Oszwald J. 2018. Relationships between ecosystem services: Comparing methods for assessing tradeoffs and synergies. Ecological Economics 150: 96-106. https://doi.org/10.1016/j.ecolecon.2018.04.002

56. Enhancing the value of ecosystem services in pastoral systems (EVESPS) project

Contact:

Jason Sircely

CRP/Institution: WLE / ILRI

Short description of the tool:

Three SWAT models were constructed with spatiotemporally dynamic livestock populations, to provide for modeling of grazing management. The models were constructed using collaborative processes with resident members of local institutions and regional partners (APESS, a Burkinabe NGO, and Tana River County), and all simulation scenarios were created based on spatial stakeholder inputs. Local and regional partners' involvement in constructing the model and vetting of the model results enabled alignment of local knowledge with numerical simulation modeling (Gitz et al., 2020).

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Sustainable landscape management

Main focus: All three

Biophysical and ecological aspects

Socio-economic aspects

Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Two models were developed for use in the White and Black Volta portions, Province du Yatenga, Burkina Faso; and one model for the lower Tana River Basin of Tana River and Kitui Counties, Kenya (Gitz et al., 2020).

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. *A joint stocktaking of CGIAR work on forest and landscape restoration.* Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Sircely J & Seidou O. 2018. Modelling the effects of grazing management on ecosystem services in pastoral systems. ILRI Research Report 43. Nairobi, Kenya: ILRI. https://hdl.handle.net/10568/91682

57. G-Range global rangelands model

Contact:

Jason Sircely
CRP/Institution: CCAFS / ILRI
Website: http://www2.nrel.colostate.edu/projects/grange/index.php

Short description of the tool:

G-Range is an intermediate complexity simulation model primarily useful for global scale application over long time horizons. Its biogeochemical foundation from CENTURY is applied according to dynamic spatial cover of herbaceous and woody plants, and bare ground. Its main purpose is to capture and project rates for major ecosystem processes and services, especially forage and browse production, according to scenarios describing changes in management, climate, and atmospheric CO2 (Gitz et al., 2020).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Sustainable landscape management

Main focus:

Biophysical and ecological aspects

Scale:

Global scale, with potential for application at regional and national levels.

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

This global rangeland model can be used in formulating policy decisions based on projected future rangeland conditions – from deserts to tundra - and long-term system production potential, and as data inputs to other modelling frameworks (e.g., IMPACT) (Gitz et al., 2020).

References and further readings:

Boone R, Conant R & Sircely J. 2013. Adjustment and Sensitivity Analyses of a Beta Global Rangeland Model. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Denmark: Copenhagen. https://cgspace.cgiar.org/handle/10568/35129

Boone RB, Conant RT, Sircely J, Thornton PK & Herrero, M. 2018. Climate change impacts on selected global rangeland ecosystem services. Global Change Biology 24(3):1382-1393. https://cgspace.cgiar.org/handle/10568/90404

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

58. Catalogue of restoration and conservation initiatives in the tropical dry forests of northern Peru

Contact:

Evert Thomas, Rachel Atkinson, Tobias Fremout
CRP/Institution: FTA, FP1 / Bioversity International
Website: https://bioversityinternational.shinyapps.io/catalogo_restauracion_bosque_seco_Peru/

Short description of the tool:

This tool is a catalogue of current and past forest landscape restoration and conservation initiatives in the tropical dry forests of northern Peru. Conservation initiatives Seed sources, but also include protected areas that can serve as potential seed sources. The tool shows a map with the location of the initiatives, the user has the option to apply some filters to limit those shown on the map. When clicking on a project, the user can consult a short report with basic information on the initiative and contact details. The primary goal of the tool is to provide an overview of past and current restoration and conservation projects in the region, so that new projects can learn from these experiences.

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Forest landscape restoration

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field
Farm
Landscape

Stage of development:

Under development or pilot-test at the time of writing

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

59. The FORLAND project

Contact:

P. Sist and H. Dessard
CRP/Institution: ONF-I /CIRAD/ETH
Website: http://forland.io/

Short description of the tool:

The main objective of the FORLAND project (2018-2020) is to develop a new participative and easy-to-use Decision Support Systems (SDSS) for land-use decision makers (Gitz et al., 2020). FORLAND combines biophysical and socioeconomic data into a user-friendly portal and provide a 'collaborative platform' which promotes better coordination between science, planning and operational experts, and stakeholders. FORLAND can help: test the impact of different land-use management scenarios for land use management; build a consensus around shared long-term land-use visions and strategies; monitor land use changes and share progress with partners.

Category of tool:

Data-analysis supporting tool:
Data collection and database

Main theme:

Sustainable landscape management

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Landscape

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

FORLAND is developed, in collaboration with local stakeholders, in two case study regions in Scotland (Sunart and the Galloway; and Southern Ayrshire Biosphere).

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Websites:

https://www.forestresearch.gov.uk/research/forland-landscape-restoration/

https://www.onfinternational.org/en/forland/

60. Vegetation map for Africa including species selection tools

Contact:

Roeland Kindt, Lars Graudal
CRP/Institution: FTA, FP1 / ICRAF
Website: https://vegetationmap4africa.org/

Short description of the tool:

The vegetation map for Africa (Version 2.0) is available in different formats and is accompanied by an extensive documentation[15] of the floristic, physiognomic and other characteristics of the different vegetation types and useful woody species. It is complemented by a species selection tool[16], which can be used to 'find the right tree for the right place' and potential distribution maps[17] of the useful woody species that occur in eastern Africa (Gitz et al., 2020).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

Regional

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The map covers eight countries in Eastern and Southern Africa (Burundi, Ethiopia, Kenya, Malawi, Uganda, Rwanda, Tanzania, and Zambia) and can be used by all restoration practitioners with access to internet and/or smartphones for setting and implementing conservation and restoration priorities.

15 See: https://vegetationmap4africa.org/Documentation.html
16 See: https://vegetationmap4africa.org/Species/Species_selection_tool.html
17 See: https://vegetationmap4africa.org/Species/Species_distribution.html

References and further readings:

Dinerstein E, Olson D, Joshi A, Vynne C, Burgess ND, Wikramanayake E, Hahn N, Palminteri S, Hedao P, Noss R et al. 2017. An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm, BioScience, Volume 67, Issue 6, June 2017, Pages 534–545. https://doi.org/10.1093/biosci/bix014

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Watson J. & Venter, O. 2017. A global plan for nature conservation. Nature 550, pp.48–49. https://doi.org/10.1038/nature24144

61. Africa Soil Information Service (AfSIS)

Contact:

Keith Shepherd
CRP/Institution: WLE / ICRAF
Website: http://www.worldagroforestry.org/project/africa-soil-information-service-afsis-i

Short description of the tool:

AfSIS aims at narrowing Sub-Saharan Africa's soil information gap by providing a consistent baseline for monitoring soil ecosystem services. The AfSIS project area includes 17.5 million square km of continental Sub-saharan Africa (SSA) and almost 0.6 million square km of Madagascar (Gitz et al., 2020).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Soil

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Hengl T, Heuvelink GBM, Kempen B, Leenaars JGB, Walsh MG, Shepherd KD, Sila A, MacMillan RA, Mendes de Jesus J, Tamene L & Tondoh JE. 2015. Mapping Soil Properties of Africa at 250 m Resolution: Random Forests Significantly Improve Current Predictions. PLoS ONE 10(6): e0125814. https://doi.org/10.1371/journal.pone.0125814

Nocita M, Stevens A, van Wesemael B, Brown DJ, Shepherd KD, Towett E, Vargas R & Montanarella L. 2014. Soil spectroscopy: an opportunity to be seized. Global Change Biology, Volume 21, Issue 1, pp. 10-11. https://doi.org/10.1111/gcb.12632

Shepherd KD, Shepherd G & Walsh MG. 2015. Land health surveillance and response: A framework for evidence-informed land management. Agricultural Systems, Volume 132, January 2015, pp. 93-106. https://doi.org/10.1016/j.agsy.2014.09.002

Towett EK, Shepherd KD, Sila A, Aynekulu E & Cadisch G. 2015. Mid-Infrared and Total X-Ray Fluorescence Spectroscopy Complementarity for Assessment of Soil Properties. Soil Science Society of America Journal, Volume 79, Issue 5, September-October 2015, pp. 1375-1385. https://doi.org/10.2136/sssaj2014.11.0458

62. Methodology on bush encroachment mapping

Contact:

John Mutua
CRP/Institution: WLE / CIAT

Short description of the tool:

This methodology applies free and open-source GIS tools and open datasets for mapping bush encroachment in the Otjozondjupa region, Namibia (Gitz et al., 2020).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Land use and land use changes

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Authors built capacity to conduct bush encroachment mapping on the ground. In 2016, they collaborated with a team from Namibia's Ministry of Environment and Tourism (MET) to establish a baseline to measure Bush Encroachment (BE) among other Land Degradation Neutrality (LDN) indicators. The method was adapted locally and local scientists can now map and monitor bush encroachment. Twenty land resources management professionals were trained in remote sensing, geographic information systems (GIS) and digital soil mapping (DSM) technologies using open-source software. This enabled them to later produce LDN baselines for Omusati region, Namibia in the year 2018 (Gitz et al., 2020).

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Mutua J, & Nijbroek R. 2018. Measuring land degradation needs to be done from the ground up. Rural 21. https://www.rural21.com/english/archive/2018/01/detail/article/measuring-land-degradation-needs-to-be-done-from-the-ground-up.html?no_cache=1

Nijbroek Ravic, Mutua J, Soderstrom M, Piikki K, Kempen B & Hengari S. 2017. Pilot Project Land Degradation Neutrality (LDN), Namibia: Establishment of a baseline for land degradation in the region of Otjozondjupa. Harvard Dataverse. https://doi.org/10.7910/DVN/FA3ZJS

63. Digital soil maps for Mukuyu and Shikomoli -web applications and map books.

Contact:

Kristin Piikki and Mats Söderström.
CRP/Institution: WLE-RDL / CIAT

Short description of the tool:

Risk maps of soil nutrient deficiencies were produced for two villages in Western Kenya (Mukuyu and Shikomoli). The maps were provided to local farmers and extension officers through a mobile phone app and in the form of map books (English and Kiswahili). These maps can then be used by farmers to guide their soil management decisions (application of fertilizers or manure) or to decide on whether to take a soil sample and send it for analysis (Gitz et al., 2020).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Soil

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field
Farm
Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The tool was used in two villages of Western Kenya (Mukuyu and Shikomoli). The map books and the web applications were well received when presented to the end-users at participatory workshops. (Gitz et al., 2020).

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Web applications :

For Mukuyu village: http://bit.ly/Mukuyu_Soil2016

For Shikomoli village: http://bit.ly/Shikomoli_Soil2016

64. Landscape Doctor

Contact:

CRP/Institution: WLE / CIAT

Short description of the tool:

Understanding the complex interactions, feedbacks and spatial dynamics is essential to successfully restoring degraded landscapes and developing management plans for keeping other landscapes healthy. The Landscape Doctor is a set of decision tools that can be used by planners, investors and other decision-makers to diagnose problems, identify the best course of treatment and implement those considering site-and context-specificities (Gitz et al., 2020).

Category of tool:

Decision-making supporting tool:

Method or process facilitating discussions between actors

Main theme:

Sustainable landscape management

Main focus:

Biophysical and ecological aspects

Socio-economic aspects

Governance aspects

All aspects equally relevant.

Scale:

Landscape

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

The Landscape Doctor framework has been completed and tested in Ethiopia. Automation is underway. The Landscape Doctor framework is being tested under the Africa RISING project. Once completed will be scaled across the Sustainable Land Management Project (SLMP) watersheds in Ethiopia and beyond. Discussions are ongoing with the SLMP team to integrated this tool with EthioCAT – WOCAT version of Ethiopia.

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Woldearegay K, Tamene L, Mekonnen K, Kizito F & Bossio D. 2018. Fostering food security and climate resilience through integrated landscape restoration practices and rainwater harvesting/management in arid and semi-arid areas of Ethiopia. In: Leal Filho W., de Trincheria Gomez J. (eds) Rainwater-Smart Agriculture in Arid and Semi-Arid Areas. Springer, Cham. https://doi.org/10.1007/978-3-319-66239-8_3

Tamene L, Yaekob T, Ellison J & Mekonnen K. 2017. Integrated landscape management: Africa RISING R4D experiences in the Ethiopian highlands. https://www.slideshare.net/africa-rising/ar-n2africa-liveslulseged2016

Weblinks:

Africa RISING project:

https://africa-rising.net/

Posters:

http://www.worldagroforestry.org/downloads/Publications/PDFS/PO16126.pdf

https://cgspace.cgiar.org/bitstream/handle/10568/79168/ARethiopia_poster_kifle_nov16.pdf?sequence=1

Sustainable land management project:

https://www.weadapt.org/solutions-portal/sustainable-land-management-project-i-ethiopia-slmp-1

https://www.weadapt.org/solutions-portal/sustainable-land-management-project-2-ethiopia-slmp-2

65. Package 'mapsRinteractive'

Contact:

Kristin Piikki and Mats Söderström.

CRP/Institution: WLE-RDL / CIAT

Short description of the tool:

The tool is used to locally adapt and evaluate large-scale digital soil maps by use of local soil sample data. Large-extent maps are not always accurate enough for use in project areas of smaller extent. By use of a local soil sample dataset, large-extent maps can be locally adapted and evaluated. This may be a useful (cost and time effective) alternative to creating soil maps from scratch. (Gitz et al., 2020).

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Soil

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field

Farm

Landscape

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

The method (before it was implemented in the tool) has been used for Land Degradation Neutrality (LDN) baseline mapping by Nijbroek et al. (2018) and Söderström et al. (2017).

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Nijbroek R, Piikki K, Söderström M, Kempen B, Turner KG, Hengari S & Mutua J. 2018. Soil Organic Carbon Baselines for Land Degradation Neutrality: Map Accuracy and Cost Tradeoffs with Respect to Complexity in Otjozondjupa, Namibia. Sustainability. 2018; 10(5):1610. https://doi.org/10.3390/su10051610

Piikki K, Söderström M & Mutua J. 2020. Package 'mapsRinteractive'. Version 1.0.1 of December 1st, 2020. https://cran.r-project.org/web/packages/mapsRinteractive/mapsRinteractive.pdf

Söderström et al. 2017. Improved usefulness of continental soil databases for agricultural management through local adaptation. South African Journal of Plant and Soil, Volume 34, Issue 1, pp. 35-45. https://doi.org/10.1080/02571862.2016.1166400

66. The CIAT SOC App

Contact:

Rolf Sommer
CRP/Institution: CIAT
Website: http://ciatsocapp.github.io/index.html

Short description of the tool:

There has been quite some debate about the scope for mitigating climate change by soil organic carbon (SOC) sequestration. However, it seems there is a general lack of understanding of quantities and the time-dimension, as well as the possible contribution that SOC sequestration can play. The CIAT SOC App allows any user to calculate SOC sequestration potentials in space and time.

The CIAT SOC App is a soil organic content computation tool that computes SOC concentration and sequestration of a given soil and provides the results in user-friendly graphic and table formats. This open-access tool can be used by individuals, governments, NGOs, researchers, communities, and others. Source code can be shared upon enquiry (Gitz et al., 2020).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field
Farm
Landscape

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

The idea behind this tool has been used in various publications and has been presented widely. Authors have not true impact yet to report.

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Zomer RJ, Bossio DA, Sommer R & Verchot, L. 2017 Global Sequestration Potential of Increased Organic Carbon in Cropland Soils. Scientific Reports 7: 15554. https://doi.org/10.1038/s41598-017-15794-8

67. R package: 'SurfaceTortoise'

Contact:

Kristin Piikki and Mats Söderström.

CRP/Institution: WLE-RDL / CIAT

CRP/Flagship (if relevant):

Website:

Short description of the tool:

The tool is used to find optimal soil sampling locations based on spatial covariate(s), e.g. in land restoration projects (Gitz et al., 2020).

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Soil

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field

Farm

Landscape

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

The method (before it was implemented in the tool) has been used for Land Degradation Neutrality (LDN) baseline mapping by Nijbroek et al. (2018). No evidence of impact yet (Gitz et al., 2020).

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Nijbroek R, Piikki K, Söderström M, Kempen B, Turner KG, Hengari S & Mutua J. 2018. Soil Organic Carbon Baselines for Land Degradation Neutrality: Map Accuracy and Cost Tradeoffs with Respect to Complexity in Otjozondjupa, Namibia. Sustainability. 2018; 10(5):1610. https://doi.org/10.3390/su10051610

Piikki K, Söderström M & Mutua J. 2018. Package 'SurfaceTortoise'. Version 1.0.2 of October 2nd, 2020. Available online: https://cran.r-project.org/web/packages/SurfaceTortoise/SurfaceTortoise.pdf

68. Decision Analysis

Contact:

Keith Shepherd

CRP/Institution: WLE / ICRAF

Short description of the tool:

The Decision Analysis guide (Whitney et al., 2018) provides a scientific approach to produce reliable impact projections of agricultural development interventions that can help decision-makers efficiently allocate resources to enhance the effectiveness of policy decisions. The guide uses causal models – models that describe the mechanisms through which intervention impacts will be delivered – that are codeveloped by experts, stakeholders and analysts through facilitated participatory processes and then formalized as Bayesian Network (BN) models. BNs allow for the formal representation intervention impact pathways. They can work effectively with incomplete information, combine expert knowledge with other sources of information and allow for adequate consideration of risk.

Category of tool:

Decision-making supporting tool:

Manual or guidelines

Main theme:

Agriculture

Main focus:

Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The Decision Analysis guide was published in 2018.

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Shepherd K, Hubbard D, Fenton N, Claxton K, Luedeling E & de Leeuw J. 2015. Development goals should enable decision-making. Comment. Nature, Volume 523, 9 July 2015, pp. 152-154. https://www.nature.com/articles/53152a

Luedeling E, Oord AL, Kiteme B, Ogalleh S, Malesu M, Shepherd KD & De Leeuw J. 2015. Fresh groundwater for Wajir - ex-ante assessment of uncertain benefits for multiple stakeholders in a water supply project in Northern Kenya. Frontiers in Environmental Science, Vol. 3(16), 11 March 2015. https://doi.org/10.3389/fenvs.2015.00016

Whitney C, Shepherd K & Luedeling E. 2018. Decision analysis methods guide; Agricultural policy for nutrition. Working paper No. 275. World Agroforestry Centre. Nairobi. https://doi.org/10.5716/WP18001.PDF

69. Global Economic Assessment of Land Degradation and Improvement

Contact:

Ephraim Nkonya
CRP/Institution: PIM-WLE, CRP2 / IFPRI

Short description of the tool:

This tool provides analytical methods for the assessment of economics of land degradation (ELD), illustrated in 12 case study countries. The ELD approach seeks to capture not only the market value of crop and livestock products lost, but also all major terrestrial losses of ecosystem services due to land degradation. Twelve carefully selected national case-studies provide rich information about the costs of land degradation in various local contexts, as evaluated by local communities. The

12 countries account for 45% of the global population and are representative of all low- and middle-

income countries (Gitz et al., 2020).

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Land use and land use changes

Main focus:

Socio-economic aspects

Scale:

Global

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The ELD approach was developed in 12 case-study countries, including: Argentina, Bhutan, China, Ethiopia, India, Kenya, Malawi, Niger, Russia, Senegal, Tanzania and Uzbekistan (Gitz et al., 2020).

References and further readings:

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Nkonya E, Mirzabaev A & von Braun J (eds). 2016. Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development. International Food Policy Research Institute (IFPRI). Zentrum für Entwicklungsforschung, Center for Development Research, University of Bonn. https://link.springer.com/content/pdf/10.1007%2F978-3-319-19168-3.pdf

Website: https://www.ifpri.org/land-management

70. Land Degradation Surveillance Framework (LDSF)

Contact:

Leigh Ann Winowiecki, Tor-Gunnar Vågen, Nguyen Mai Phuong

CRP/Institution: FTA / ICRAF

Website: http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/

Short description of the tool:

The Land Degradation Surveillance Framework (LDSF) was developed as a response to a lack of methods for systematic landscape-level assessment of soil and ecosystem health. The methodology is designed to provide a biophysical baseline at landscape level, and a monitoring and evaluation framework for assessing processes of land degradation and the effectiveness of rehabilitation measures (recovery) over time. The framework provides field protocols for measuring indicators of the "health" of an ecosystem, including: vegetation cover, structure and floristic composition, historic land use, visible signs of soil degradation, tree and shrub biodiversity, soil erosion prevalence, soil health, soil organic carbon content, and soil infiltration capacity. Due to the complex nature of ecosystems, multiple perspectives are needed to understand ecosystem processes, and variability of ecological variables at different spatial scales. The nested hierarchical sampling design used in the LDSF is useful for developing predictive models with global coverage, while maintaining local relevance (Gitz et al., 2020).

Category of tool:

Decision-making supporting tool:

Manual or guidelines

Main theme:

Land use and land use changes

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Since 2005, the LDSF has been applied in over 250 landscapes (100 km^2 sites), in more than 30 countries across the global tropics, by governments, NGOs, CGIAR centres, donors, CRPs, to assess land and soil health, prioritize, monitor and track interventions (Gitz et al., 2020).

Land health maps produced using the LDSF are incorporated into the Decision Dashboards, accessible online.[18]

In particular, the LDSF methodology was used by ICRAF in Mai Son district, Son La province in Viet Nam to measure land health and estimate soil erosion prevalence in North-Western Viet Nam. In total, 160 plots of 1000 m^2 were randomly sampled across a site of 10 km x 10 km. The study benefitted from existing data in the LDSF database while contributing to global datasets, highlighting the importance of such global databases (FTA, 2020).

References and further readings:

Abegaz A, Winowiecki L A, Vågen TG, Langan S & Smith JU. 2016. Spatial and temporal dynamics of soil organic carbon in landscapes of the upper Blue Nile Basin of the Ethiopian Highlands. Agriculture, Ecosystems & Environment, Volume 218, 15 February 2016, pp. 190–208. https://doi.org/10.1016/j.agee.2015.11.019

Aynekulu E, Vagen TG, Shephard K & Winowiecki L. 2011. A protocol for modeling, measurement and monitoring soil carbon stocks in agricultural landscapes. Version 1.1. World Agroforestry Centre, Nairobi. http://apps.worldagroforestry.org/downloads/Publications/PDFS/TM11192.pdf

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Lohbeck M, Winowiecki L, Aynekulu E, Okia C & Vågen TG. 2018. Trait-based approaches for guiding the restoration of degraded agricultural landscapes in East Africa. Journal of Applied Ecology, 55(1), pp. 59-68. https://doi.org/10.1111/1365-2664.13017

Nguyen MP. 2020. Analysis of Options by Context for Scaling Agroforestry in Northwest Vietnam. A thesis submitted in fulfilment of the degree of Doctor of Philosophy in Agroforestry. School of Natural Sciences Bangor University, Bangor, United Kingdom. https://research.bangor.ac.uk/portal/files/34575568/2020NguyenPhd.pdf

Satdichanh M, Ma H, Yan K, Dossa GGO, Winowiecki LA, Vågen TG, Gassner A, Xu J & Harrison RD. 2018. Phylogenetic diversity correlated with aboveground biomass production during forest succession: Evidence from tropical forests in Southeast Asia. First published: 27 November 2018. Journal of Ecology, Volume 107, Issue 3, pp. 1419-1432. https://doi.org/10.1111/1365-2745.13112

UNEP. 2012. Sahel atlas of changing landscapes. Tracing trends and variations in vegetation cover and soil condition. United Nations Environment Programme, Nairobi. https://www.unenvironment.org/resources/report/sahel-atlas-changing-landscapes-tracing-trends-and-variations-vegetation-cover-and

Vågen TG & Winowiecki LA. 2013. Mapping of soil organic carbon stocks for spatially explicit assessments of climate change mitigation potential. Environmental Research Letters, Volume 8, Number 1. https://doi.org/10.1088/1748-9326/8/1/015011

Vagen TG & Winowiecki LA. 2020. The Land Degradation Surveillance Framework (LDSF). Field Guide. Revised version v2020. World Agroforestry Centre, Nairobi. http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/

18 See: http://landscapeportal.org/tools/

Vågen TG, Winowiecki LA, Abegaz A & Hadgu K. 2013. Landsat-based approaches for mapping of land degradation prevalence and soil functional properties in Ethiopia. Remote Sensing of Environment, Volume 134, July 2013, pp. 266-275. https://doi.org/10.1016/j.rse.2013.03.006

Vågen TG, Winowiecki LA, Neely C, Chesterman S, & Bourne M. 2018. Spatial assessments of soil organic carbon for stakeholder decision-making. A case study from Kenya. SOIL Volume 4, Issue 4, pp. 259-266. https://doi.org/10.5194/soil-4-259-2018

Vågen TG, Winowiecki LA, Tondoh JE, Desta LT & Gumbricht T. 2016. Mapping of soil properties and land degradation risk in Africa using MODIS reflectance. Geoderma, Volume 263, 1st February 2016, pp. 216-225. https://doi.org/10.1016/j.geoderma.2015.06.023

Vågen TG, Winowiecki LA, Twine W & Vaughan K. 2018. Spatial Gradients of Ecosystem Health Indicators across a Human-Impacted Semiarid Savanna. Journal of Environmental Quality, Volume 47, Issue 4, pp. 746-757. https://doi.org/10.2134/jeq2017.07.0300

Winowecki LA, Nguyen MP & Vagen TG. 2019. A report on "Assessing soil health in Son La, Vietnam".

Winowiecki LA, Vågen TG, Boeckx P & Dungait JAJ. 2017. Landscape-scale assessments of stable carbon isotopes in soil under diverse vegetation classes in East Africa: application of near-infrared spectroscopy. Published: 16 October 2017. Plant and Soil, Volume 421, pp. 259-272. https://doi.org/10.1007/s11104-017-3418-3

Winowiecki L, Vågen TG & Huising J. 2016. Effects of land cover on ecosystem services in Tanzania: A spatial assessment of soil organic carbon. Geoderma, Volume 263, 1st February 2016, pp. 274-283. https://doi.org/10.1016/j.geoderma.2015.03.010

Winowiecki LA, Vågen TG, Kinnaird MF & O'Brien TG. 2018. Application of systematic monitoring and mapping techniques: Assessing land restoration potential in semi-arid lands of Kenya. Geoderma, Volume 327, 1st October 2018, pp. 107-118. https://doi.org/10.1016/j.geoderma.2018.04.017

Winowiecki L, Vågen TG, Massawe B, Jelinski NA, Lyamchai C, Sayula G & Msoka E. 2016. Landscape-scale variability of soil health indicators: Effects of cultivation on soil organic carbon in the Usambara Mountains of Tanzania. Nutrient Cycling in Agroecosystems, Volume 105, pp. 263-274. https://doi.org/10.1007/s10705-015-9750-1

Poster:

https://www.foreststreesagroforestry.org/wp-content/uploads/2020/12/T3-148-FTA-Science-Conference-Nguyen-Mai-Phuong_Poster-Stream-3-Session-2.pdf

Presentation:

Bargues-Tobella A. 2020. Soil and groundwater recharge or surface runoff? Landscape-scale assessments of soil infiltrability across the global tropics. Presentation at the FTA Science Conference September 2020.

Weblinks:

https://theconversation.com/lessons-from-kenya-on-how-to-restore-degraded-land-98178

http://landscapesportal.org/blog/2018/01/15/finding-evidence-for-land-restoration-strategies/

Sentinel Landscapes (SL) Explorer[19]: http://landscapeportal.org/slExplorer/

19 Allow the exploration of LDSF data from 27 LDSF sites.

71. Manual for the ecological and productive monitoring of secondary forests of Mesoamerica (FOREST-MONITOR)

Contact:

Diego Delgado
CRP/Institution: CATIE

Short description of the tool:

This manual, developed in 2018, aims at addressing the problem of deforestation. It helps monitoring secondary forests at farm and landscape levels, focusing mainly on biophysical aspects. It provides useful guidelines to support decision-making for forest management, making secondary forests more productive and enhancing their conservation values.

Category of tool:

Decision-making supporting tool:
Manual or guidelines

Main theme:

Sustainable forest management

Main focus:

Biophysical and ecological aspects

Scale:

Farm
Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The manual has guided the establishment of a monitoring system to assess the impacts of management in the Florence Forest, owned by CATIE, in Costa Rica. The manual is expected to support the management of secondary forests in Costa Rica.

References and further readings:

Delgado D, Serrano JJ, Vílchez S & Morales JP. 2018. Manual para el monitoreo ecológico y productivo de bosques secundarios latifoliados de Mesoamérica. CATIE/ IKI/ CGIAR Serie Técnica no. 143. 49p. http://hdl.handle.net/11554/8986

72. Package for Community Ecology and Suitability Analysis (BiodiversityR)

Contact:

Roeland Kindt
CRP/Institution: ICRAF
Website: https://cran.r-project.org/web/packages/BiodiversityR/index.html

Short description of the tool:

The BiodiversityR tool can support species selection and selection of seed zones for collection and distribution of planting materials. It allows the calibration of suitability models and the production of habitat suitability maps for baseline, future or past bio-climates. It uses statistical methods of biodiversity and community ecology, which are useful in monitoring restoration progress, as well as bioclimatic and topographic terrain indices, and soil information. Initially designed by ICRAF scientists for scientist, students, and tree-seed centers in 2007, this tool was progressively improved from 2012 onwards. It can be used in any part of the world.

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

This statistical tool has been widely used across the world. Since 2012, *BiodiversityR* has been installed from the server 117,940 times.

73. Africa Tree Finder (AfricaTreeFinder)

Contact:

Roeland Kindt
CRP/Institution: ICRAF
Website: https://play.google.com/store/apps/details?id=com.icraf.gsl.africatreefinder&hl=en

Short description of the tool:

This easy-to-use App, developed by ICRAF in 2015, shows data on the distribution of indigenous tree species in different natural vegetation types, combined with information on the products and services that the tree species can provide. It arms local community members, government agencies, private sector owners, and other land managers with useful information to select the best tree species for landscape restoration or agroforestry effort. This tool is useful for species selection, conservation planning, climate change research and seed zonation

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

Landscape
National
Regional
Global

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

The tool was tested in two countries in Eastern Africa, with a plan to extend to 6 more countries in Africa

74. Useful Tree Species for Africa (UsefulTree)

Contact:

Roeland Kindt

CRP/Institution: ICRAF

Website: https://www.worldagroforestry.org/output/useful-tree-species-africa

Short description of the tool:

The Useful Tree Species for Africa (UsefulTree) tool (Version 1.1) was developed in 2011 by ICRAF and Landscape Denmark under the UNEP-GEF Carbon Benefits Project to facilitate the selection of suitable species. An implicit objective is landscape diversification by providing a large number of candidate species.

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Regional (Continental Africa)

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The tool can be used in Africa (excluding Madagascar) in the areas covered by the maps.

UsefulTree is an open access tool that can be accessed through Google Earth following the link: http://www.worldagroforestry.org/downloads/africamap/2012/Africa_Vegetation_2012.kmz

References and further readings:

Kindt R, Osino D, Orwa C, Nzisa A, van Breugel P, Graudal L, Lillesø JPB, Kehlenbeck K, Dietz J, Nyabenge M, Jamnadass R & Neufeld H. 2011. Useful Tree Species for Africa. A species selection tool based on The Vegetation Map of Africa. World Agroforestry Centre (ICRAF), Nairobi, Kenya. Forest & Landscape Denmark. http://old.icraf.org/downloads/africamap/Suggestions%20for%20using%20the%20maps.pdf

Kindt R, Osino D, Orwa C, Nzisa A, van Breugel P, Graudal L, Lillesø JPB, Kehlenbeck K, Dietz J, Nyabenge M, Jamnadass R & Neufeld H. 2011. Useful Tree Species for Africa. A species selection tool based on The Vegetation Map of Africa. Suggestions for selecting tree species for a particular site and purpose. World Agroforestry Centre (ICRAF), Nairobi, Kenya. Forest & Landscape Denmark. http://old.icraf.org/downloads/africamap/Suggestions%20for%20selecting%20tree%20species.pdf

Kindt R, Orwa C, van Breugel P, Graudal L, Lillesø JPB, Kehlenbeck K, Neufeld H & Jamnadass R. 2012. Useful Tree Species for Africa Version 1.1. A species selection tool based on The Vegetation Map of Africa. How the Useful Tree Species for Africa tool was created. World Agroforestry Centre (ICRAF), Nairobi, Kenya. Forest & Landscape Denmark. https://worldagroforestry.org/sites/default/files/AfricaVeg_Main_2012.pdf

75. Ecoregions2017

Contact:

Roeland Kindt
CRP/Institution: ICRAF
Website: https://ecoregions2017.appspot.com/

Short description of the tool:

The Ecoregions2017 tool, developed by ICRAF in 2017, provides potential natural vegetation maps in various areas of interest to help researchers identify priority areas for restoration and conservation. This new map covers and describes the 846 ecoregions that represent our living planet. This tool is useful for species selection, conservation planning, climate change research and seed zonation.

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

Global

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Dinerstein E, Olson D, Joshi A, Vynne C, Burgess ND, Wikramanayake E, Hahn N, Palminteri S, Hedao P, Noss R, et al. 2017. An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm. BioScience, Volume 67, Issue 6, June 2017, pp. 534-545. https://doi.org/10.1093/biosci/bix014

76. Agroforestry Species Switchboard (AgroforestrySwitchboard)

Contact:

Roeland Kindt

CRP/Institution: ICRAF

Website: http://www.worldagroforestry.org/products/switchboard/

Short description of the tool:

The Agroforestry Species Switchboard, developed by ICRAF in 2013, is a "one-stop-shop" to retrieve data about a particular plant species across a wide range of information sources. Version 2.0 of the Switchboard documents the presence of a total of 172,395 plant species, and 3,979 taxa at infraspecific level, across 35 web-based information sources. When available, hyperlinks to selected taxa in particular information sources are provided. In total, Version 2.0 of the Switchboard provides 307,404 and 6,159 hyperlinks at species and infraspecific levels, respectively. The Switchboard also provides links to check on the correct spelling of particular species, and on synonyms and current names. The Switchboard cross-links ICRAF various databases by establishing a centralized naming system. The Switchboard includes various databases developed by ICRAF that can also qualify as restoration tools.[20]

Category of tool:

Data-analysis supporting tool:

Data collection and database

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

Global

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Website:

https://www.worldagroforestry.org/output/agroforestry-species-switchboard-20-synthesis-information-sources-support-tree-research-and

ICRAF databases referred to by the Switchboard, with links to individual species:

Agroforestree Database (http://www.worldagroforestry.org/output/agroforestree-database).

This database provides information on the management, use and ecology of over 600 tree

20 see http://www.worldagroforestry.org/output/agroforestry-species-switchboard-14 under the heading of 'ICRAF databases, with links to individual species'. Particularly relevant are the Agroforestree database and the RELMA-ICRAF Useful Tree Species manuals.

species which can be used in agroforestry systems globally. It is a good starting point for understanding more about many cultivated trees in smallholders' farms (see tool #77).

Tree Seed Suppliers Directory (http://www.worldagroforestry.org/output/tree-seed-suppliers-directory). This directory provides the most extensive available compiled information on global suppliers of seed and microsymbionts for over 5,000 tree and shrub species.

African Wood Density Database (http://worldagroforestry.org/treesnmarkets/wood/data.php?id=1). This database provides air-dry wood density data for over 900 indigenous and exotic tree species found in Africa. It was developed in parallel with the Global Wood Density Database (see below).

RELMA-ICRAF Useful Trees (http://www.worldagroforestry.org/usefultrees/index.php). These species-based factsheets provide information on the useful trees and shrubs of Eritrea, Ethiopia, Kenya, Tanzania, Uganda and Zambia, assembled as part of a series of Regional Land Management Unit (RELMA)-ICRAF publications (published first in the 1990s and 2000s). Information on ecology, uses, propagation, management, local names and botanical names is included.

Genetic Resources Unit Database (http://www.worldagroforestry.org/products/grunew/index.php/seeds/searchbyname). This database indicates accessions of trees and shrubs that are conserved and/or supplied for research purposes by ICRAF's Genetic Resources Unit.

Tree Functional Attributes and Ecological Database (http://db.worldagroforestry.org). This database provides information on the properties and attributes of trees. It includes information on geographic distributions, ecological requirements, growth rates, uses and product value chains (see tool #11).

Useful Tree Species for Africa Map (produced with the University of Copenhagen [Forest and Landscape Denmark]; http://www.worldagroforestry.org/output/useful-tree-species-africa). This interactive vegetation map tool enables the selection of useful tree species for planting at given locations anywhere in Africa using Google Earth for visualisation purposes. The Switchboard indicates which species are listed in this tool (see tool #74).

vegetationmap4africa (produced with the University of Copenhagen; http://www.vegetationmap4africa.org/). This map tool shows the distribution of 1,022 plant species across Burundi, Ethiopia, Kenya, Uganda, Rwanda, Tanzania and Zambia using Google Earth, based on a high resolution potential natural vegetation map of eastern and southern Africa. It can be used to help select tree species for planting at given locations in mapped countries (see tool #60).

Other portals and databases referred to by the Switchboard, with links to individual species (The date when hyperlinks were established is given in *italics*.)

African Orphan Crops Consortium (AOCC; http://africanorphancrops.org; *August 2018*). AOCC's goal is to sequence, assemble, annotate and publish in open-access databases the genomes of 101 traditional African food crops to support improvements in their production, through linking with plant breeders. This will help provide long lasting solutions for Africa's nutritional security.

Árboles de Centroamérica (OFI-CATIE; http://www.arbolesdecentroamerica.info; *July 2018*; in Spanish). This sourcebook provides factsheets for 204 indigenous Mesoamerican tree species. It describes species' biologies and uses across the full spectrum of on-farm planting, ecological restoration and natural regeneration situations.

Ecocrop (FAO; http://ecocrop.fao.org/ecocrop/srv/en/home; *August 2018*). This database provides descriptions, including climate and soil requirements and uses, for more than 2,500 plant species.

eHALOPH (University of Sussex; https://www.sussex.ac.uk/affiliates/halophytes/; *July 2018*; **new database** for Switchboard Version 2.0). This database provides descriptions of halophytes (salt tolerant plants), including the 1,554 species that were included in James Aronson's 1989 publication *HALOPH: a data base of salt tolerant plants of the world*.

Especies para restauración (IUCN; http://www.especiesrestauracion-uicn.org/especies.php; *August 2018*; in Spanish [translate]). This database provides factsheets on mostly Mesoamerican plant species with information including botanical and local names,

distributions, habitats, and propagation and silvicultural methods, with a view to supporting restoration initiatives.

EUFORGEN (European forest Genetic Resources Programme; http://www.euforgen.org/species/; *August 2018*). For 107 species, the website provides a short species description, distribution maps and technical guidelines for genetic conservation and use.

Feedipedia (INRA, CIRAD, AFZ and FAO; https://www.feedipedia.org/; *July 2018*; **new database** for Switchboard Version 2.0). This is an open-access information system on animal feed resources. It provides information on the nature, occurrence, chemical composition, nutritional value and safe use of nearly 1,400 livestock feeds globally.

GRIN-Global World Economic Plants (USDA; https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearcheco.aspx; *July 2018*; **new database** for Switchboard Version 2.0). Species listed are those that were retrieved by a specialised query on World Economic Plants among the GRIN-Global Taxonomy for Plants.

MAPFORGEN (LAFORGEN; http://www.mapforgen.org/; *August 2018*; in Spanish and English). This atlas for the conservation of forest genetic resources provides modelled distribution maps that indicate the conservation status of 100 socio-economically important tree and shrub species indigenous to Latin America and the Caribbean (see tool #107).

New World Fruits Database (Bioversity International; http://nwfdb.bioversityinternational.org/list/; *August 2018*). This database provides information on fruit and plant uses, and distributions and origins, for over 1,200 fruit species from North and South America.

NewCROP Database (Purdue University; http://nwfdb.bioversityinternational.org/list/; *August 2018*). The NewCROP (New Crops Resource Online Program) database is an information-rich site related to crop plants that was developed by the Purdue University Center for New Crops and Plant Products.

OPTIONs Pesticidal Plants Database (OPTIONs; http://projects.nri.org/options/background/plants-database; *August 2018*). This database, constructed to optimise the application of predominantly indigenous plants as pesticides in Africa, provides factsheets on use.

Pacific Island Agroforestry Species (AGROFORESTRY.NET; http://www.agroforestry.net/2014-03-04-10-18-01; *August 2018*). Species-specific chapters of a 2006 publication covering the ecology, economics and culture of Pacific Island agroforestry can be downloaded individually.

PROTA4U (PROTA; http://www.prota4u.org/; *August 2018*) The Plant Resources of Tropical Africa online database (PROTA4U) provides information on the plant resources of Tropical Africa, including on uses, botany, ecology, genetic resources and available literature.

Seed Leaflets (University of Copenhagen [Forest and Landscape Denmark, formerly the Danida Forest Seed Centre]; http://www.sl.ku.dk/rapporter/seed-leaflets; *August 2018*). These species-specific leaflets provide short descriptions of tropical trees, with particular emphasis on seed issues, including appropriate methods for seed harvest, treatment, storage and sowing.

SoFT (CSIRO, CIAT and ILRI; http://www.tropicalforages.info/; *August 2018*). The Selection of Forages for the Tropics (SoFT) tool provides information on 180 forage species, including on plants' agronomy, feed value, production potential and seed production.

The tropiTree Database (JHI and ICRAF; http://ics.hutton.ac.uk/tropiTree/; *August 2018*). The Tropical Tree Expressed Transcripts, SSR Markers and Primer Pairs (tropiTree) Database provides assembled expressed transcripts from an RNA-seq study of a set of 24 important tropical trees, along with markers designed to amplify microsatellites discovered within sequences.

The Wood Database (Eric Meier; http://www.wood-database.com; *August 2018*). The database provides profiles for a range of several hundred woods used globally, including information on specific gravity, modulus of rupture, shrinkage, grain and workability.

USDA Food Composition Databases (USDA; https://ndb.nal.usda.gov/ndb/foods; *August 2018*). These databases provide information on nutrient content (minerals, vitamins, etc.) for more than 8,000 different food items.

Useful Tropical Plants Database (http://tropical.theferns.info/; *August 2018*). This database contains information on the edible, medicinal and many other uses of more than 10,000 plants that can be grown in tropical regions.

Portals specific to potentially invasive species referred to by the Switchboard, with links to individual species

(The date when hyperlinks were established is given in *italics*.)

CABI Invasive Species Compendium (CABI; http://www.cabi.org/isc; *August 2018*). This compendium provides information on invasive organisms globally, including uses, means of dispersal, risks, invasiveness impacts and means of control.

Global Invasive Species Database (IUCN; http://www.iucngisd.org/gisd/; *August 2018*). This database was developed and is managed by the Invasive Species Specialist Group of the IUCN Species Survival Commission. It provides information about alien and invasive species, including plants, which negatively impact native biodiversity and natural areas.

Global Register of Introduced and Invasive Species (IUCN; http://www.griis.org/; *March 2019*). GRIIS hosted by the Invasive Species Specialist Group (ISSG) compiles annotated and verified country-wise inventories of introduced and invasive species. Development and population of the GRIIS was undertaken by the ISSG within the framework of activities of the Information Synthesis and Assessment Working Group of the Global Invasive Alien Species Information Partnership.

77. Agroforestree Database

Contact:

Roeland Kindt
CRP/Institution: ICRAF
Website: http://apps.worldagroforestry.org/treedb2/

Short description of the tool:

The Agroforestree (AFT) Database is a species reference and selection guide for agroforestry trees. This database provides information on the management, use and ecology of over 600 tree species which can be used in agroforestry systems globally. It is a good starting point for understanding more about many cultivated trees in smallholders' farms.

Category of tool:

Data-analysis supporting tool:
Data collection and database

Main theme:

Agroforestry

Main focus:

Biophysical and ecological aspects

Scale:

Global

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Website:

http://www.worldagroforestry.org/output/agroforestree-database

78. Tree seeds for farmers (TreeSeed)

Contact:

Roeland Kindt

CRP/Institution: ICRAF

Website: https://www.worldagroforestry.org/output/tree-seeds-farmers-toolkit-and-reference-source

Short description of the tool:

The 'Tree seeds for farmers (TreeSeed)' toolkit, developed in 2006, provides technical information on the best methods, from seed collection to field planting, for obtaining good genetic and physiological quality seeds and seedlings of a great diversity of agroforestry species. This toolkit, based on a review of existing documentation and extension materials on seed production, provides links towards a wealth of other useful references.

This toolkit complements existing materials on seed production in two fundamental ways. Firstly, it provides information on how joint strategies can be made by the various actors and stakeholders in scaling-up tree planting in defined regions. Secondly, it explores in further detail the option of developing sustainable systems that provide quality material by involving the private sector in seed production. The final section of the toolkit primarily focuses on tree nursery management. The toolkit contains three parts:

PART I: Strategies for scaling up seed production

PART II: Technical guidelines in seed production

PART III: The private sector and seed production

This toolkit, specifically designed as a training tool, can be of help for the wide range of actors and stakeholders that are involved in scaling-up agroforestry systems. Its format is designed to answer the questions that various actors may have in relation to seed production.

Category of tool:

Decision-making supporting tool:

Manual or guidelines

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Socio-economic aspects

Scale:

National

Global

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Buruchara R, Mukankusi C & Ampofo K. 2010. Bean Disease and Pest Identification and Management. Handbooks for small-scale seed producers. Handbook 4. International Center for Tropical Agriculture (CIAT). http://www.portalecosus.com/uploads/bean-disease-and-pest-identification-procedure/Bean%20disease%20and%20pest%20identification%20procedure.pdf

David S. 1998. Producing bean seed. Handbooks for small-scale seed producers. Handbook 1. Network on Bean Research in Africa, Occasional Publications Series, No. 29. CIAT, Kampala, Uganda. https://www.pabra-africa.org/wp-content/uploads/dlm_uploads/2016/02/PRODUCING20BEAN20SEED2C20Handbook2012C2019982C20English20version_0.pdf

David S & Oliver B. 2002. Business skills for small-scale seed producers. Handbooks for small-scale seed producers. Handbook two. International Center for Tropical Agriculture (CIAT). http://ciat-library.ciat.cgiar.org/articulos_ciat/handbook_2_english.pdf

David S & Oliver B. 2002. Business skills for small-scale seed producers: a trainer's guide. Handbooks for small-scale seed producers. Handbook three. International Center for Tropical Agriculture (CIAT). http://tropicallegumes.icrisat.org/wp-content/uploads/2016/02/BUSINESS-SKILL-FOR-SMALL-SCALE-SEED-Handbook_III.pdf

Del Castillo R & Roshetko JM. 1998. Agroforestry seed technology and nursery management: a training manual. Bogor, Indonesia: Institute of Agroforestry; International Centre for Research in Agroforestry Southeast Asia Regional Program; Winrock International; Rockefeller Brothers Fund

Jaenicke H. 1999. Good tree nursery practices. Practical guidelines for research nurseries. World Agroforestry Centre (ICRAF), Nairobi, Kenya. 90 pp. http://apps.worldagroforestry.org/Units/Library/Books/PDFs/17_Good_tree_nursery_practices.pdf?n=44

Kindt R, Lillesø JPB, Mbora, A, Muriuki J, Wambugu C, Frost W, Beniest J, Aithal A, Awimbo J, Rao S & Holding-Anyonge C. 2006. Tree Seeds for Farmers: a Toolkit and Reference Source. World Agroforestry Centre (ICRAF), Nairobi. https://www.worldagroforestry.org/sites/default/files/Toolkit.pdf

Longman KA. 1993. Rooting cuttings of tropical trees. Tropical Trees: Propagation and Planting Manuals. Volume 1. February 1993. Commonwealth Science Council. http://www.fao.org/3/AD231E/AD231E00.htm

Longman KA. 2003. Raising seedlings of tropical trees. Tropical Trees: Propagation and Planting Manuals. Volume 2. February 2003. Commonwealth Science Council. http://www.fao.org/3/AD230E/AD230E00.htm

Longman KA. 1998. Growing good tropical trees for planting. Tropical Trees: Propagation and Planting Manuals. Volume 3. January 1998. Commonwealth Science Council. http://www.fao.org/3/AD228E/AD228E00.htm

Longman KA. 1995. Preparing to plant tropical trees. Tropical Trees: Propagation and Planting Manuals. Volume 4. January 1998. Commonwealth Science Council. http://www.fao.org/3/AD229E/AD229E00.htm

Mulawarman, Roshetko JM, Sasongko SM & Iriantono D. 2003. Tree seed management. Seed sources, seed collection and seed handling. A field manual for field workers and farmers. TFRI Extension Series No. 152. World Agroforestry Centre (ICRAF), Winrock International in collaboration with Indonesia Forest Seed Project, Bogor, Indonesia. 54 p. http://apps.worldagroforestry.org/downloads/Publications/PDFS/B11955.pdf

Mulawarman, Roshetko JM, Sasongko SM & Iriantono D. 2004. Seed Source Establishment and Management. 368-377 pp. In: G.R Elevitch (ed) The Overstroy Book: Cultivating connections with trees, 2nd Edition. Permanent Agriculture Resources (PAR). P 526.

Muriuki J, Roshetko JM & Nyoka I. 2012 Tree nursery practices In: Dawson, I., Harwood, C., Jamnadass, R. and Beniest, J. (eds). Agroforestry tree domestication: a primer. Nairobi: World Agroforestry Centre (ICRAF) pp 70–79

Roshetko JM, Tolentino EL, Jr, Carandang WM, Bertomeu M, Tabbada AU, Manurung G & Yao CE. 2010. Tree nursery sourcebook. Options in support of sustainable development. Bogor, Indonesia. World Agroforestry Centre (ICRAF), SEA Regional Office & Winrock International. 52 p

Schmidt LH. 2000. Guide to handling of tropical and subtropical forest seed. DANIDA Forest Seed Centre, Humlebaek, Denmark. 532 p. https://ign.ku.dk/english/employees/forest-nature-biomass/?pure=en%2Fpublications%2Fguide-to-handling-of-tropical-and-subtropical-forest-seed(04448600-8813-11df-928f-000ea68e967b).html

Wightman KE. 1999. Good tree nursery practices. Practical guidelines for community nurseries. World Agroforestry Centre (ICRAF), Nairobi, Kenya. 95 p. http://apps.worldagroforestry.org/downloads/Publications/PDFS/B10715.pdf

Website:

Florabank guidelines for best practice for seed collection and use: https://florabank.org.au/

Nursery manuals (ICRAF): http://apps.worldagroforestry.org/NurseryManuals/Nursery.htm

79. Standard for the management of secondary forests in Costa Rica (SFMStandard)

Contact:

Roger Villalobos
CRP/Institution: CATIE

Short description of the tool:

The Costa Rica´s standard for the management of secondary forests, defined by decree No. 39952 of November 9th 2016[21], is the official instrument that governs the technical aspects of the management of secondary forests for the sustainable production of timber and non-timber products, including the sustainability of forest cover restored in landscapes through natural secondary succession. The standard consists of explicit guidelines that regulate the procedures to plan and implement sustainable management. The standard is directed to forestry professionals who by law must develop, have approved and monitor forest management plans. The standard defines legal requirements for the approval of management plans and offers clear technical guidelines for the sustainable management of secondary forests.

This standard was constructed in a participatory manner, involving business and academic sectors, concerned with the forest management. The standard facilitates improved governance and participatory approaches to the management of secondary forests on private land for the production of timber and non-timber products.

Category of tool:

Decision-making supporting tool:

Manual or guidelines

Main theme:

Sustainable forest management

Main focus:

Biophysical and ecological aspects

Governance aspects

Scale:

National

Stage of development:

Effective use on the ground (mature tool)

21 See: http://www.pgrweb.go.cr/scij/Busqueda/Normativa/Normas/nrm_texto_completo.aspx?nValor1=1&nValor2=82889&nValor3=106166

References and further readings:

Comisión Nacional de Sostenibilidad. 2018. Estándares de sostenibilidad para el manejo de bosques secundarios: principios, criterios e indicadores, código de prácticas y manual de procedimientos.

McGinley K & Finegan B. 2003. The ecological sustainability of tropical forest management: evaluation of the national forest management standards of Costa Rica and Nicaragua, with emphasis on the need for adaptive management. Forest Policy and Economics Volume 5, Issue 4, December 2003, pp. 421-431. https://doi.org/10.1016/S1389-9341(03)00040-6

McGinley K, Alvarado R, Cubbage F, Diaz D, Donoso PJ, Jacovine LAG, De Silva FL, MacIntyre C & Zalazar EM. 2012. Regulating the Sustainability of Forest Management in the Americas: Cross-Country Comparisons of Forest Legislation. Forests Volume 3, Issue 3, pp. 467-505. https://doi.org/10.3390/f3030467

80. Active restoration of secondary forests in Central America (ARSF)

Contact:

Jean Pierre Morales
CRP/Institution: CATIE

Short description of the tool:

A set of tools can contribute to active restoration of secondary forests in Central America (ARSF):

demonstration areas, covering various ecosystems, where sustainable forest management models can be explored and tested;

ACTIVA-CATIE[22], a business platform (virtual marketplace) connecting forest owners with investors.

Technical tools were developed, such as the forestry guide and the monitoring manual. These tools provide examples of how to establish, use and monitor demonstration areas and business platforms. This set of tools enables generating and scaling up innovations in secondary forest management, policies and links with private investment.

Category of tool:

Decision-making supporting tool:
Manual or guidelines

Main theme:

Forest landscape restoration

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Farm
Landscape
National

Stage of development:

Effective use on the ground (mature tool)

22 See: https://activa.catie.ac.cr/web/

Example(s) of effective use:

The development of technical tools such as the forestry guide and the monitoring manual has served in the training of about 250 technicians in the region in the regional and national courses we have developed. Through the business platform, more than 18 forestry ventures have been trained in 2018, and 83 companies connected in the forestry business conference developed in Costa Rica.

Moreover, more than 250 companies of the forest sector in Guatemala are now connected to a virtual store[23] where they can present their products.

23 See: E-commerce Forestal (Guatemala): http://www.forestmarketgt.com/

81. Stakeholder Approach to Risk Informed and Evidence Based Decision Making (SHARED Decision Hub)

Contact:

Mieke Bourne, Constance Neely and Sabrina Chesterman.
CRP/Institution: ICRAF
Website: http://www.worldagroforestry.org/shared

Short description of the tool:

The 'Stakeholder Approach to Risk Informed and Evidence Based Decision Making (SHARED)' method, developed in 2013 by ICRAF, brings together diverse actors across sectors, institutions and scales to address complex development challenges, using a systems approach that recognizes social, economic and environmental drivers of degradation while building the wide-ranging relationships needed to contribute to solutions. The SHARED method aims at fostering evidence-based decision-making integrating different knowledge domains. It enables integrated planning, enhances stakeholder engagement and interactions and encourages multi-stakeholder partnerships.

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Forest landscape restoration

Main focus: All three.

Biophysical and ecological aspects
Socio-economic aspects
Governance aspects

Scale:

Landscape
National
Global

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

SHARED has been applied at sub-national, national and international levels, in collaboration with development partners, government agencies and departments, private sector, communities and research institutions. SHARED has been applied in 15 countries in Africa to date and applied in global syntheses. Within the Regreening Africa project, the SHARED tool is being used to support scaling of land restoration work through wider practice and policy work over 500,000 hectares of land.

Case study: SHARED was used in 2013-2018 in Turkana County, Kenya, in collaboration with Turkana Country Government, UN agencies and NGO partners, for the development of an integrated five-year development plan.[24]

References and further readings:

Neely C, Bourne M, Chesterman S, Kouplevatskaya-Buttoud I, Bojic D & Vallée D. 2017. Implementing 2030 Agenda for Food and Agriculture: Accelerating Impact through Cross-Sectoral Coordination. World Agroforestry Centre (ICRAF) and Food and Agricultural Organization of The United Nations (FAO), Rome. http://www.fao.org/3/a-i7749e.pdf

Vagen TG, Winowiecki LA, Neely C, Chesterman S & Bourne M. 2018. Spatial assessments of soil organic carbon for stakeholder decision-making. A case study from Kenya. SOIL Discuss. 14p. https://doi.org/10.5194/soil-2017-37

Poster:

Decision Dashboards information sheet: https://www.worldagroforestry.org/sites/agroforestry/files/out-put/attachments/Decision%20dashboards%20information%20sheet.pdf)

24 See: https://www.worldagroforestry.org/sites/agroforestry/files/out-put/attachments/Turkana%20handbook_Draft3-lowres.pdf

82. On-farm Bamboo inventory mobile application (OnfarmBamboo)

Contact:

Jayaraman Durai and Trinh ThangLong from INBAR, and Hoang Viet Anh from Green Field Consulting & Development (GFD)

CRP/Institution: INBAR

Website: https://play.google.com/store/apps/details?id=com.gfd.apps.INBAR.Global

Short description of the tool:

OnfarmBamboo is a mobile application, connected to an end-to-end platform[25], dedicated to the assessment and geo-localization of bamboo resources outside bamboo forests, production bamboo forests and bamboo plantations, for the development of a sustainable supply-chain which could provide additional income and employment opportunities for the farmers and growers. This bamboo survey mobile application tool simplifies and standardizes the process of data collection, transmission and centralized storage, management and quality check, analysis and visualization. This application enhances transparency and enables near-time, user-friendly and ready-to-use data analysis.

Category of tool:

Data-analysis supporting tool:

Data collection and database

Main theme:

Other topics (Assessment and geo-localization of bamboo resources)

Main focus:

Biophysical and ecological aspects

Scale:

Global

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The tool was basically developed to collect the on-farm bamboo data specifically in Ethiopia, Kenya and Uganda as part of Dutch-Sino East Africa Bamboo Development Programme. The tool was later updated to cover all the bamboo growing countries under INBAR Global Assessment of Bamboo and Rattan (GABAR) Programme. This tool can be easily adapted to any other tree species of combination of tree species.

25 INBAR Bamboo Monitoring System. See: http://bambooafrica.inbar.int

83. International Database on REDD+ projects and programs (ID-RECCO)

Contact:

Thuy Pham, Christopher Martius

CRP/Institution: CIFOR

Website: http://www.reddprojectsdatabase.org/

Short description of the tool:

The 'International Database on REDD+ projects linking Economic, Carbon and Communities data (ID-RECCO) was developed in 2014 by CIFOR, Economics Chair of Paris-Dauphine University(France), CIRAD (Montpellier, France) and IFRI (University of Michigan, United States) This collaborative database, updated in 2016, 2018 and 2020, aims to enhance knowledge and transparency on REDD+ projects and programs by centralizing detailed information on REDD+ projects[26] and organizing this information in a format facilitating research and analyses.

Category of tool:

Data-analysis supporting tool:

Data collection and database

Main theme:

Climate change, GHG and carbon stocks

Main focus: All three

biophysical and ecological aspects

socio-economic aspects

governance aspects

Scale:

Global

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

As of December 2020, the ID-RECCO database contains 624 projects/programs, out of which 416 are active.

26 The database contains up to 110 variables per project/program.

References and further readings:

Duchelle AE, Seymour F, Brockhaus M, Angelsen A, Larson AM, Moeliono M, Wong GY, Pham TT and Martius C. REDD+: lessons from national and subnational implementation. Ending tropical deforestation: a stock-take of progress and challenges. **Working paper.** World resources institute, CIFOR. https://wriorg.s3.amazonaws.com/s3fs-public/ending-tropical-deforestation-redd-lessons-implementation.pdf

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Simonet G, Agrawal A, Bénédet F, Cromberg M, de Perthuis C, Haggard D, Jansen N, Karsenty A, Liang W, Newton P, Sales AM, Schaap B, Seyller C & Vaillant G. 2018. ID-RECCO, International Database on REDD+ projects and programs, linking Economic, Carbon and Communities data. version 4.1. http://www.reddprojectsdatabase.org/

Simonet G & Seyller C. 2015. ID-RECCO, a new collaborative work tool to improve knowledge on REDD+ projects: sources, methodology and data. Chaire Economie du Climat. Université Paris-Dauphine CDC Climat. Working Paper n°2015-08. September 2015. http://www.chaireeconomieduclimat.org/wp-content/uploads/2015/09/15-09-Cahier-R-2015-08-Simonet-Seyller.pdf

Stickler CM, Duchelle AE, Ardila JP, Nepstad DC, David OR, Chan C, Rojas JG, Vargas R, Bezerra TP, Pritchard L, Simmonds J, Durbin JC, Simonet G, Peteru S, Komalasari M, DiGiano ML & Warren MW. 2018. The State of Jurisdictional Sustainability. San Francisco, USA: Earth Innovation Institute/Bogor, Indonesia: Center for International Forestry Research/ Boulder, USA: Governors' Climate & Forests Task Force Secretariat. https://earthinnovation.org/state-of-jurisdictional-sustainability/

Presentation at the FTA Science Conference, September 2020:

Duchelle A et al. 2020. Evaluating the impacts of different types of REDD+ interventions on forests and people.

Useful websites:

CIFOR press release: https://www.cifor.org/corporate-news/comprehensive-redd-tool-id-recco-is-updated-and-now-hosted-by-the-center-for-international-forestry-research/

CIFOR toolboxes: http://www.cifor.org/gcs/publications/toolboxes/

84. Guidebook on agroforestry-based restoration in Brazil (AFSGuide)

Contact:

Andrew Miccolis

CRP/Institution: ICRAF

Short description of the tool:

The main goal of the AFS Guidebook, developed by ICRAF in 2016, is to guide the use of agroforestry systems (AFS) to restore altered and degraded areas through strategies and techniques that reconcile conservation with social and economic benefits. This guidebook provides, for NGOs, government agencies, universities, practitioners and farmers, a comprehensive approach and practical guidance on how to assess the local context, and how to design, establish and manage successional agroforests adapted to that context. It includes 11 main options geared towards the Brazilian Cerrado and Caatinga biomes but that can be adapted elsewhere. The Guidebook is divided into five main sections:

Socio-environmental benefits and challenges of agroforestry systems,

Strategies to overcome the challenges,

Methods and techniques to implement restoration-oriented agroforests, beginning with an approach to socio-environmental diagnoses,

Financial planning and design of agroforestry arrangements, in addition to a variety of practical methods to implement and manage systems, and

Options for agroforestry systems that can be adopted in some of the most common contexts found in the two biomes.

Category of tool:

Decision-making supporting tool:

Manual or guidelines

Main theme:

Agroforestry

Main focus: All three

Biophysical and ecological aspects

Socio-economic aspects

Governance aspects

Scale:

Plot/Field

Farm

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

This guidebook has been tested and applied throughout Brazil, mainly in Brazilian Cerrado (Central Savannhas), Caatinga (Drylands), Atlantic Rainforest and Amazon eco-regions since 2017.

References and further readings:

Miccolis,A, Peneireiro FM, Marques HR, Vieira DLM, Arco-Verde MF, Hoffmann MR, Rehder T & Pereira AVB. 2016. Restauração ecológica com sistemas agroflorestais: como conciliar conservação com produção. *Brasília, DF: Instituto Sociedade, População e Natureza - ISPN. Centro Internacional de Pesquisa Agroflorestal* – ICRAF, 266 p. http://apps.worldagroforestry.org/downloads/Publications/PDFS/MN17387.pdf

Miccolis A, Peneireiro FM, Marques HR, Vieira DLM, Arco-Verde MF, Hoffmann MR, Rehder T & Pereira AVB. 2019. *English eds.* Agroforestry Systems for Ecological Restoration: How to reconcile conservation and production: Options for Brazil's Cerrado and Caatinga biomes. Technical Guidebook. http://apps.worldagroforestry.org/downloads/Publications/PDFS/B19034.pdf

Websites in English and Portuguese:

https://www.worldagroforestry.org/blog/2019/10/01/restoring-land-agroforestry-new-guide-published

https://www.matanativa.com.br/guia-tecnico-de-restauracao-ecologica/

http://quintalflorestal.com.br/category/manuais-textos-e-livros/

85. REDD+ Benefit Sharing Knowledge Tree Toolbox

Contact:

Thuy Pham
CRP/Institution: CIFOR
Website: https://www2.cifor.org/knowledge-tree/

Short description of the tool:

The Knowledge Tree Toolbox, developed by CIFOR in 2016, is a well-organized website which provides an easy access to synthesized information related to experiences with REDD+ projects, programs and policies. The toolbox is designed to help academics, practitioners and general public navigate the complexity of sharing benefits from the REDD+ mechanism.

Category of tool:

Data-analysis supporting tool:
Data collection and database

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Socio-economic aspects
Governance aspects

Scale:

Landscape
National
Global

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

As of September 2019, the toolbox has been accessed more than 4,100 times.

References and further readings:

Website:

CIFOR toolboxes: http://www.cifor.org/gcs/publications/toolboxes/

86. REDD+ Cost Model

Contact:

Erin Sills and Noah Greenberg
CRP/Institution: CIFOR
Website: https://www2.cifor.org/redd-benefit-sharing/resources/tools/redd-cost-model/

Short description of the tool:

The REDD+ Cost Model was developed by CIFOR in 2016 to improve decision- making about REDD+ by providing greater clarity about its costs. It is an open-access, Excel-based budgeting and forecasting tool that facilitates the analysis of subnational REDD+ initiatives. It provides a framework for collecting data on implementation costs incurred by the entities involved in REDD+ on the ground, ensuring that budgeting is thorough and prompting users to consider costs across various budget categories and project functions. The model can be used for both ex post analysis of costs incurred to date and ex ante projection of future budget needs.

The use of a structured and consistent framework for costing serves several purposes in addition to facilitating and automating budget calculations. First, it supports exploration of how to optimally design and maintain project functions over time. Second, it ensures that budgeting is rigorous and facilitates the understanding of multiple and diverse costs. Third, by using a consistent structure and approach, it allows for comparisons of costs across initiatives. Finally, the model provides various means to classify costs, supporting intra-project cost analysis and, ultimately, decision-making on the scaling up of REDD+ initiatives.

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Socio-economic aspects
Governance aspects

Scale:

Landscape
National

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

As of September 2019, the REDD+ Cost Model has been downloaded more than 700 times.

References and further readings:

Greenberg N, Sills E, Horuodono H & Clement K. 2016. User Manual for the REDD+ Cost Model. https://www2.cifor.org/redd-benefit-sharing/resources/tools/redd-cost-model/

Website:

CIFOR toolboxes: http://www.cifor.org/gcs/publications/toolboxes/

87. CarboScen

Contact:

Website: https://www2.cifor.org/gcs/toolboxes/carboscen/

Short description of the tool:

CarboScen is a relatively simple bookkeeping tool to compute ecosystem carbon stocks in dynamic landscapes where there are changes not only in land use, but also in carbon densities due to a legacy of past land uses. Computing ecosystem carbon for an area experiencing changes in land use is not trivial, as carbon densities change slowly after land-use changes. CarboScen is a simple tool, based on carbon pools and densities, typically used with an annual time step. It assumes that carbon density asymptotically approaches a value, set for each given land-use type. CarboScen is particularly adapted for landscapes with spatially relatively homogenous soils and climate, multiple land uses, and changes between these leading to slow changes in carbon densities. Thanks to its simplicity, it is particularly suitable for participatory planning, rapid assessment of project carbon potential, and educational use.

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

CarboScen was used to analyse the carbon implications of future land scenarios in ten landscapes, in five countries around the world (Larjavaara et al., 2017).

References and further readings:

Larjavaara M, Kanninen M,Ashraful Alam S, Mäkinen A & Poeplau C. 2017. CarboScen: a tool to estimate carbon implications of land-use scenarios. First published: 28 February 2017. Ecography. Volume 40, Issue 7, pp. 894-900. https://doi.org/10.1111/ecog.02576

Website:

CIFOR toolboxes: http://www.cifor.org/gcs/publications/toolboxes/

88. The Indonesian National Carbon Accounting System (INCAS)

Contact:

Website: http://www.incas-indonesia.org/

Short description of the tool:

The Indonesian National Carbon Accounting System (INCAS), developed by the Indonesian Ministry of Environment and Forestry, in partnership with CIFOR and with the support of other governmental agencies, is a systematic approach for Measurement, Reporting and Verification (MRV) of GHG emissions, including for REDD+ activities. It is also designed to support Indonesia's broader requirements under the United Nations Framework Convention on Climate Change (UNFCCC). It allows GHG reporting for the Agriculture, Forestry and Other Land Use (AFOLU) sectors, and tracking progress against the country's emissions reduction targets. The INCAS is designed as a Tier 3 level GHG accounting system. It generates detailed information on historical, present, and future projections of emissions and removals from land-based activities. It can be scaled to provide GHG accounting at provincial and district levels.

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Climate change, GHG and carbon stocks

Main focus:

Biophysical and ecological aspects

Scale:

National

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

To date, the INCAS has been used to produce an annual account of GHG emissions and removals on all of Indonesia's forest and peatland for 2001–2012 from key activities related to REDD+, namely: deforestation, forest degradation, sustainable management of forests, and enhancement of forest carbon stocks. Emissions from biological oxidation and fire on disturbed peatlands are also included. In the future, the INCAS will be expanded to include full coverage of AFOLU sectors.

References and further readings:

Website:

CIFOR toolboxes: http://www.cifor.org/gcs/publications/toolboxes/

89. The Indonesian Peatland Network (IPN) Toolbox

Contact:

Daniel Murdiyarso
CRP/Institution: CIFOR-ICRAF
Website: https://www2.cifor.org/ipn-toolbox/ (in Indonesian language)

Short description of the tool:

This toolbox is a collection of lecture materials in PowerPoint aimed to understand the challenges and opportunities offered by peatlands in Indonesia in relation with climate change mitigation and adaptation. The materials are suitable for students, scientists and practitioners who are interested to understand the role of peatlands in climate change mitigation and adaptation.

Category of tool:

Decision-making supporting tool:
Manual or guidelines

Main theme:

Climate change, GHG and carbon stocks

Main focus: All three

Biophysical and ecological aspects
Socio-economic aspects
Governance aspects

Scale:

National
Global

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The materials were used and continue to be used for training beginners. While the materials and examples are from and about Indonesia, the contextual framework is applicable for global purposes.

References and further readings:

Website:

CIFOR toolboxes: http://www.cifor.org/gcs/publications/toolboxes/

90. The Sustainable Wetlands for Mitigation and Adaptation Program (SWAMP) Toolbox

Contact:

Daniel Murdiyarso

CRP/Institution: CIFOR-ICRAF

Website: https://www2.cifor.org/swamp-toolbox/

Short description of the tool:

The Sustainable Wetlands for Mitigation and Adaptation Program (SWAMP) Toolbox is a collection of PowerPoint presentations developed to guide users in understanding the importance of wetlands ecosystems as carbon reservoirs for climate change adaptation and mitigation strategies. The Toolbox covers five themes:

Wetlands and climate change

Wetlands for climate change adaptation

Wetlands for climate change mitigation

Carbon projects development in wetlands ecosystems

Beyond carbon

Category of tool:

Decision-making supporting tool:

Manual or guidelines

Main theme:

Climate change, GHG and carbon stocks

Main focus: All three

Biophysical and ecological aspects

Socio-economic aspects

Governance aspects

Scale:

Landscape

National

Global

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The materials can be used for teaching students and orienting negotiators who are keen to familiarize themselves with peatland and climate change related issues

References and further readings:

Website:

CIFOR toolboxes: http://www.cifor.org/gcs/publications/toolboxes/

91. The Forests Climate Change Toolbox

Contact:

Levania Santoso

CRP/Institution: CIFOR-ICRAF

Website: https://www2.cifor.org/fcctoolbox/

Short description of the tool:

The Forests and Climate Change Toolbox is a collection of PowerPoint presentations, developed to build understanding and technical proficiency on issues related to climate change and forests including mitigation, adaptation, carbon accounting and markets, and biofuels. It covers five topics:

Integrating climate change into forestry

Climate change and forests – exploring the interlinkages

All you need to know about adaptation

Why is carbon accounting important?

Climate change mitigation mechanisms, markets and projects

The role of biofuels

Category of tool:

Decision-making supporting tool:

Manual or guidelines

Main theme:

Climate change, GHG and carbon stocks

Main focus: All three

Biophysical and ecological aspects

Socio-economic aspects

Governance aspects

Scale: N/A

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Website:

CIFOR toolboxes: http://www.cifor.org/gcs/publications/toolboxes/

92. Diversity for Restoration (D4R)

Contact:

Evert Thomas, Rachel Atkinson, Tobias Fremout, Barbara Vinceti, Marius Ekue, Rachel Claus.
CRP/Institution: Alliance of Bioversity International and CIAT, and partner organizations
Website: https://www.diversityforrestoration.org/

Short description of the tool:

The Diversity for Restoration tool (D4R) is a tool to guide the selection of tree species and seed sources for the climate-resilient restoration of tropical forest landscapes. Depending on user-defined inputs, including restoration site location, local site conditions (e.g., steep slopes, compacted soils), and restoration objectives (e.g., bird conservation, timber production), the tool recommends tree species combinations and seed sourcing areas that best match these inputs. Recommended species and seed sourcing areas take into account the predicted future climatic conditions. Species-specific propagation information and basic monitoring suggestions are also provided. The tool is intended to support decision making for anyone planning tree planting and seed sourcing in tropical forest landscapes, regardless of the purpose or restoration approach.

Category of tool:

Decision-making supporting tool:
Manual or guidelines

Main theme:

Forest landscape restoration

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The D4R tool, initially designed for tropical dry forest in Colombia, has now been out-scaled to the tropical dry forests of north-western Peru and southern Ecuador, and to the countries of Burkina Faso and Cameroon.

FTA trained 198 people in the application of the D4R tool in Peru (see tool #58), built local capacity to support nursery establishment, community-led seed harvest and propagation projects, and directly supported community protection of degraded dry tropical forest. Another new restoration project (GEF 7, which began in 2020) led by IUCN, FAO and MINAM is reported to have expressed interest to apply the tool to support the restoration of 2,278 ha in Peru.

In Colombia, the Department of Antioquia, Empresas Publicas de Medellin used the map-based tool to guide species selection to plant over an area where forest had been lost due to the construction of a hydroelectric power dam. Overall, because of these contributions, it is estimated that FTA informed resilient planting for 13,010 ha of degraded land under restoration (FTA, In preparation).

The D4R tool is being extended in Africa (Ethiopia), Asia (Malaysia, northern Thailand), as well as being adapted to support tree species selection in cacao agroforestry systems in Latin-America and coffee agroforestry systems in India.

References and further readings:

Fremout T, Thomas E, Taedoumg H, Briers S, Gutiérrez-Miranda CE, Alcázar-Caicedo C, Lindau A, Mounmemi Kpoumie H, Vinceti B, Kettle C, Ekué M, Atkinson R, Jalonen R, Gaisberger H, Elliott S, Brechbühler E, Ceccarelli V, Krishnan S, Vacik H, Wiederkehr-Guerra G, Salgado-Negret B, González MA, Ramírez W, Moscoso-Higuita LG, Vásquez Á, Cerrón J, Maycock C & Muys B. 2021. Diversity for Restoration (D4R): guiding the selection of tree species and seed sources for climate-resilient restoration of tropical forest landscapes. Journal of Applied Ecology. Accepted Author Manuscript. https://doi.org/10.1111/1365-2664.14079

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

FTA. Outcome evidencing and impact estimation: addressing the high prevalence of degraded land and ecosystem services (Challenge 2). An integrative study of the Forests, Trees, and Agroforestry Research Program (2010-2020). In preparation

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Thomas E, Alcázar C, Hiquita LGM, Osorio LF, Salgado-Negret B, González M, Parra M, Bozzano M, Loo J, Jalonen R & Ramírez W. 2017. The importance of species selection and seed sourcing in forest restoration for enhancing adaptive potential to climate change: Colombian tropical dry forest as a model. CBD Tech. Ser. 89, pp. 122–132. https://www.cbd.int/doc/publications/cbd-ts-89-en.pdf

Website:

Catálogo de experiencias de restauración y conservación en los bosques secos del norte del Perú: https://bioversityinternational.shinyapps.io/catalogo_restauracion_bosque_seco_Peru/

Presentation:

Fremout T et al. 2020. Diversity for restoration: a climate-smart and scalable decision support tool for species selection and seed sourcing contributing to long-term restoration success. Presentation at the FTA Science Conference, September 2020.

93. Global Geoinformatics Options by Context (GeOC)

Contact:

Quang Bao Le
CRP/Institution: CRP-DS / ICARDA
Website: https://geoc.mel.cgiar.org/

Short description of the tool:

The Global Geo-informatic Options by Context (GeOC) tool is a web-based geoinformatics tool, developed by the CGIAR Research Program on Dryland Systems to support the implementation of sustainable land management (SLM) practices, fitted to the social-ecological context at global, regional and national scales. GeOC integrates standardized SLM databases such as WOCAT with spatially explicit data on socio-ecological drivers and impacts of land use/management practices to derive plausible soil and water conservation options across different contexts. A 'use-case approach' that provides multiple entry points for diverse needs and preferences of users makes the tool more useful and easier-to-use. This approach includes the following three typical use-cases: (1) searching for implemented SLM options within a user-defined context, (2) searching similar contexts for a given SLM option, and (3) evaluation of land degradation/improvement by context that would be important for assessing gaps in achieving LDN.

Category of tool:

Data-analysis supporting tool:
Data collection and database

Main theme:

Sustainable landscape management

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

National
Regional
Global

Stage of development:

Under development or pilot-test at the time of writing

References and further readings:

ICARDA, iMMAP and Codeobia. 2017. Global Geo-Informatics Options by Contexts (GeOC): Installation Guide (for programmers). The International Center for Agricultural Research in Dry Areas, Amman, Jordan. https://mel.cgiar.org/reporting/download/hash/UdMCjdiy

Le QB, Thomas R & Bonaiuti E. 2017. Global Geo-informatics Options by Context (GeOC) Tool for Supporting Better Targeting and Scaling-out of Sustainable Land Management: Designing the System and Use Cases. Amman, Jordan: International Center for Agricultural Research in the Dry Areas (ICARDA). https://hdl.handle.net/20.500.11766/7358

Website:

https://cgiarmel.atlassian.net/wiki/spaces/MEL/pages/15794182/GeOC+Programmer+Guide+-+Global+Geo-informatics+Options+by+Contexts

94. STAMP4 Irrigation: Stakeholder Task Alignment Matrix for Public-Private-Producer Partnerships in Irrigation

Contact:

Ruth Meinzen-Dick
CRP/Institution: IFPRI

Short description of the tool:

To be successful, Public-Private Partnerships (PPPs) need to engage with complexity. The 'Stakeholder-Task Alignment Matrix for Public-Private-Producer Partnerships for Irrigation' (STAMP4 Irrigation) tool was developed to identify key actors and clarify their complex roles and responsibilities in irrigation development. The framework developed in this project help identify a broader range of options for PPPs, not only the large-scale systems that are often favored by governments. It helps irrigation agencies to consider smallholders as potential investors in irrigation, and discuss policy options to improve outcomes of both large and small-scale PPP systems.

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Governance, institutions and capacity development

Main focus:

Socio-economic aspects
Governance aspects

Scale:

Landscape

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

The STAMP4 Irrigation tool was piloted-tested in the Bagamoyo Sugar PPP project in Tanzania, and was reported to be very helpful, to both government and the private sector investors. Government officials, private sector investors, and local farmers appreciated how the process helped clarify expectations and improve communication.

References and further readings:

Bernier, Q. 2015. Public private partnerships for irrigation: Expanding access or increasing inequality. IFPRI. CGIAR Research Program on Water Land and Ecosystems. Project Note 01. August 2015. https://ebrary.ifpri.org/digital/collection/p15738coll2/id/129347

Maganga FP. 2016. Assessing Models of Public Private Partnerships for Irrigation Development in Africa: Experiences from Kilombero and Mbarali Districts, Tanzania.

Website:

Assessing Models of Public-Private Partnerships for Irrigation Development in Africa (AMPPPIDA): https://gtr.ukri.org/project/70DAD985-82E2-4296-9431-BB17497D0114

95. Agrobiodiversity Index

Contact:

Roseline Remans
CRP/Institution: Bioversity International
Website: https://www.agrobiodiversityindex.org/

Short description of the tool:

To manage agrobiodiversity, we need to measure it. The Agrobiodiversity Index is an innovative tool that brings together data about the agrobiodiversity that people sell and eat, grow and conserve, and provides insights into food system functioning. The Agrobiodiversity Index measures biodiversity across three domains usually disconnected: nutrition, agriculture and genetic resources. It is an action-oriented tool that identifies policy and business levers, good practices and areas for improvements, risks and opportunities, to increase use and conservation of agrobiodiversity for sustainable food systems.

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Biodiversity, natural resources and ecosystem services

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

National

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The first version of the Agrobiodiversity Index methodology (1.0) was released in March 2019. The Agrobiodiversity Index team is going to release an updated version of the methodology (2.0) by 2020 both as a peer-reviewed paper in a scientific journal and as a report. The first Agrobiodiversity Index report (Bioversity International, 2019) assessed dimensions of agrobiodiversity in ten countries to measure food system sustainability, focusing on risk and resilience. Countries receive an overall Agrobiodiversity Index score that indicates their progress in using and safeguarding agrobiodiversity to create sustainable food systems. They receive also individual scores for their progress for healthy diets, sustainable production and genetic resource conservation.

References and further readings:

Bioversity International. 2019. Agrobiodiversity Index Report 2019: Risk and Resilience. Rome, Italy. Bioversity International. https://hdl.handle.net/10568/100820

96. Landscape Planning and Management Tool (LAPMAT)

Contact:

Lulseged Desta

CRP/Institution: Alliance of Bioversity International and CIAT

Website: https://alliancebioversityciat.org/tools-innovations/landscape-planning-and-management-tool-lapmat

Short description of the tool:

The 'Landscape Planning and Management Tool' (LAPMAT) was developed to facilitate land management decision-making. LAPMAT is a user-friendly, menu-oriented interactive graphical user interface that can aid decision makers identify hotspot areas of soil erosion and evaluate the effects of alternative land use management practices at a catchment scale. The modelling framework and its interfaces are designed to guide the user through a series of menus that allow: (1) inputting model parameters, adjusting coefficients, visualizing input parameters and executing the model; (2) changing land use and management practices and re-evaluating potential consequences; (3) viewing results in tabular, graphical or map form side-by-side; and (4) (re)-evaluating the respective impacts of management/conservation options. Since LAPMAT allows users handle the selection of management/planning options and provides fast and responsive outputs, it can assist in effective multi-stakeholder negotiations over land-use planning where the minimization of land/water degradation is the ultimate goal.

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Sustainable landscape management

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The framework has been applied to assess the severity of soil erosion and simulate the impact of different land management practices using the Revised Universal Soil Loss Equation (RUSLE) adjusted for sediment delivery ratio in an example catchment of northern Ethiopia. The results showed average sediment yield rate of 55 t ha^{-1} y^{-1}. Conservation measures targeted at high soil loss areas and gullies reduced sediment yield by about 80%.

References and further readings:

Tamene L, Le QB & Vlek PLG. 2014. A Landscape Planning and Management Tool for Land and Water Resources Management: An Example Application in Northern Ethiopia. Water Resources Management, Volume 28, pp. 407-424. https://doi.org/10.1007/s11269-013-0490-1

Tamene L, Adimassu Z, Ellison J, Yaekob T, Woldearegay K, Mekonnen K, Thorne P & Le QB. 2017. Mapping soil erosion hotspots and assessing the potential impacts of land management practices in the highlands of Ethiopia. Geomorphology, Volume 292, 1st September 2017, pp. 153-163. https://doi.org/10.1016/j.geomorph.2017.04.038

97. Participatory Gender Training for Community Groups

Contact:

Stephanie Leder
CRP/Institution: WLE / IWMI
Website: https://wle.cgiar.org/solutions/participatory-gender-training-community-groups

Short description of the tool:

The International Water Management Institute (IWMI), lead center for the CGIAR Research Program on Water, Land and Ecosystems (WLE), developed a manual for critical discussions on gender norms, roles and relations (Leder et al., 2016). This manual explains in detail how to conduct a three-hour gender training workshop, especially as part of a larger development project. Participants in such workshop are invited to reflect on their own gender perceptions, critically discuss gender roles at home and in the community, and develop bargaining skills through role play. The activities and discussions arise from science-based learning theories, with the intent of radically flattening predominant top-down communication structures.

Category of tool:

Decision-making supporting tool:
Manual or guidelines

Main theme:

Gender

Main focus:

Socio-economic aspects
Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Leder S, Das D, Reckers A & Karki E. 2016. Participatory gender training for community groups. A manual for critical discussions on gender norms, roles and relations. CGIAR Research Program on Water, Land and Ecosystems (WLE), International Water Management Institute (IWMI). https://cgspace.cgiar.org/bitstream/handle/10568/77585/ultra%20compressed%20final%20gender%20manual.pdf?sequence=1

98. Watershed Game for Practitioners

Contact:

CRP/Institution: WLE / IFPRI

Website: https://gamesforsustainability.org/practitioners/#watershed-game

Short description of the tool:

In this Experimental Game, participants experience asymmetries in a watershed between upstream and downstream players. The players make decisions on land use and whether they want to provide or accept payments to compensate the downstream consequences of upstream players' decisions. A manual has been developed to help participants conduct this game (Cardenas and Andres Ramos, 2006).

Category of tool:

Decision-making supporting tool:

Manual or guidelines

Main theme:

Water

Main focus: All three

Biophysical and ecological aspects

Socio-economic aspects

Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Cardenas JC & Andres Ramos P. 2006 Manual de juegos económicos para el análisis del uso colectivo de los recursos naturales, Centro Internacional de la Papa. English version available at: https://gamesforsustainability.org/wp-content/uploads/2019/03/WatershedGame.pdf

Website: https://gamesforsustainability.org/

99. Groundwater Game for Practitioners

Contact:

Ruth Meinzen-Dick and Marco Janssen
CRP/Institution: PIM - WLE / IFPRI
Website: http://gamesforsustainability.org/2015/12/05/groundwater-game-for-practitioners

Short description of the tool:

IFPRI developed a Groundwater Game Practitioner's manual (CAPRi, 2017) to help participants make decisions about which crop to plant where crops have different water requirements. Such Experimental Games help structure the debate around groundwater resources and groundwater consumption. They can trigger discussions around viewing water as a common good rather than as a private good and catalyze collective action for sustainable groundwater management.

Category of tool:

Decision-making supporting tool:
Manual or guidelines

Main theme:

Water

Main focus: All three
Biophysical and ecological aspects
Socio-economic aspects
Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

This Groundwater Game has been experimented in villages in Karnataka and Andhra Pradesh[27], India, helping village communities to debate on each other's crop choices within the limits of water availability.

27 See a 30 min video about the Andhra Pradesh experience at: https://youtu.be/__zEprQaO_U

References and further readings:

CAPRi (CGIAR Systemwide Program on Collective Action and Property Rights). 2017. Groundwater Game Practitioner's Manual. International Food Policy Research Institute: Washington, DC. https://gamesforsustainability.org/Groundwater_Game_for_Practitioners_Manual.pdf

Website: http://gamesforsustainability.org

100. Evaluating Land Management Options (ELMO)

Contact:

Lulseged Desta
CRP/Institution: WLE / CIAT
Website: https://wle.cgiar.org/evaluating-land-management-options-elmo

Short description of the tool:

The Evaluating Land Management Options (ELMO), developed by CIAT, offers a participatory approach to evaluating land management options from farmers' perspectives. Land degradation is not solely a result of farmers not having access to or knowing about the 'right' technologies; rather, farmers may reject more sustainable land use practices due to a host of social or economic reasons, such as the technology being too time consuming, requiring too much labor or being too expensive to implement. The ELMO tool allows structured discussions and prioritization exercises that shed light on farmers' likes and dislikes of different land management options. It can help scientists better understand farmers' perception and reasoning, enabling them to better support successful and long-lasting changes to land use practices.

Category of tool:

Decision-making supporting tool:
Manual or guidelines

Main theme:

Sustainable landscape management

Main focus: All three
Biophysical and ecological aspects
Socio-economic aspects
Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Emerson L, Snyder K & Cordingley J. 2015. Evaluating Land Management Options (ELMO): a participatory tool for assessing farmers' sustainable land management decision preferences and trade-offs. October 2015. International Center for Tropical Agriculture (CIAT), Regional Office for Africa, Nairobi. https://wle.cgiar.org/cgspace/resource/10568-68989

101. The shade canopy of cocoa (SCC)

Contact:

CRP/Institution: CATIE

Short description of the tool:

An illustrated manual, directed to farmers, was developed at CATIE, as part of the Central American Cacao Project, to highlight the importance of shade canopy for cocoa plantations. Shade canopy can improve cocoa plants' productivity and resilience and can also produce other goods or ecosystem services. The manual distinguishes six main types of cocoa production systems, from cocoa without shade to cocoa agroforests. The manual also presents a detailed five-step diagnosis method to help farmers optimize their shade canopy given their specific context and cocoa production system.

The Central American Cacao Project (PCC) at CATIE (Tropical Agricultural Research and Higher Education Center) aims to increase the productivity, diversity and financial and environmental value of the cacao plantations of at least 6,000 Central American families. Working closely with cacao farming families, the Project creates alliances with other partners in the region in order to enhance the social interactions, competitiveness and business capacity of the producers' organizations and improve the living conditions of their members. The Project promotes efforts to increase the knowledge and skills of farming families and students at agricultural schools, technical colleges and agronomy faculties, for the sustainable production of cacao. The Project also offers equal opportunities as well as economic, social and cultural responsibilities for men and women of all ages and from different ethnic in all its spheres of action.

Category of tool:

Decision-making supporting tool:

Manual or guidelines

Main theme:

Agroforestry

Main focus:

Biophysical and ecological aspects

Socio-economic aspects

Scale:

Farm

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

Somarriba-Chavez E, Quesada-Chaverri F, Orozco-Aguilar L, Cerda-Bustillos R, Villalobos-Rodriguez M, Orozco-Estrada S, Astorga-Domian C, Deheuvels O, Say-Chavez E & Villegas-Caceres R. 2011. The Shade Canopy of Cocoa. Technical series. Extension materials No. 5. Collection Field Schools. Central American Cacao Project. CATIE. https://www.researchgate.net/publication/324362700_The_Shade_Canopy_of_Cocoa

Somarriba E, Orozco-Aguilar L, Cerda R & López-Sampson A. 2018. Analysis and design of the shade canopy of cocoa-based agroforestry system. In: Umaharan P (ed.). Achieving sustainable cultivation of cocoa. Burleigh Dodds Science Publishing, Cambridge, UK. pp. 469-499. https://doi.org/10.19103/AS.2017.0021.29

102. A diagnostic for collaborative monitoring in forest landscape restoration

Contact:

Manuel R Guariguata and Kristen Evans
CRP/Institution: CIFOR

Short description of the tool:

A collaborative, multi-scalar and multi-site monitoring approach can provide the basis for social learning and adaptive management, both of which are essential processes for Forest landscape restoration (FLR). Through a literature review, Guariguata and Evans (2019) identified 42 core success factors, to be assessed at local, subnational, and national levels at different stages in the planning and implementation of FLR, determinant for successful collaborative monitoring in FLR. They synthesized them into a diagnostic vetted by 20 global experts. This diagnosis tool provides practical guidance on best practices: specifically, how to start collaborative monitoring, and more generally, how to plan, prepare for, and evaluate FLR activities. The diagnostic explicitly addresses issues of scale, including multiple sites, governance levels, and changes over time.

Category of tool:

Decision-making supporting tool:
Manual or guidelines

Main theme:

Forest landscape restoration

Main focus: All three
Biophysical and ecological aspects
Socio-economic aspects
Governance aspects

Scale:

Landscape
National

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

Not yet tested on the ground at the time of writing

References and further readings:

Guariguata MR & Evans K. 2019. A diagnostic for collaborative monitoring in forest landscape restoration. Restoration Ecology, Volume 28, Issue 4, pp. 742-749. https://doi.org/10.1111/rec.13076

103. Food Tree and Crop Portfolios (FTCP)

Contact:

Stepha McMullin
CRP/Institution: ICRAF
Website: http://apps.worldagroforestry.org/products/nutrition/index.php/home/

Short description of the tool:

The 'Priority Food Tree and Crop Food Composition' database contains information on the composition of selected tree foods and crops with geographical Sub-Saharan Africa. The current version (version 1) contains 132 foods (out of 99 species) and 30 nutrient components. All component values are presented per 100 g edible portion on fresh weight basis. In addition to actual food composition values the database includes scores for all foods for whether they are a "high source", "source", "present, but low source", or "not a source" of selected micronutrients (iron, vitamin A, folate and vitamin C). Searches can be done in the database by food name, scientific name or by food group.

The database was created during the implementation of the "Food Tree and Crop Portfolios (FTCP)" developed by ICRAF. The portfolios are combinations of indigenous/underutilized and exotic food tree and crop species that can potentially provide year-round nutritious foods to address harvest and nutrient gaps in local diets (McMullin et al., 2019). The database can be used for dietary assessments, the development of education materials, the selection of nutritious species for agricultural domestication and breeding programs and many more activities. It is a work in progress and will be updated on a regular basis.

Category of tool:

Data-analysis supporting tool:
Data collection and database

Main theme:

Food security and nutrition

Main focus:

Biophysical and ecological aspects

Scale:

Regional

Stage of development:

Under development or pilot-test at the time of writing

References and further readings:

McMullin S, Njogu K, Wekesa B, Gachuiri A, Ngethe E, Stadlmayr B, Jamnadass R, Kehlenbeck K. 2019. Developing fruit tree portfolios that link agriculture more effectively with nutrition and health: a new approach for providing year-round micronutrients to smallholder farmers. Published: 12 September 2019. Food Security, Volume 11, pp. 1355-1372. https://doi.org/10.1007/s12571-019-00970-7

Stadlmayr B, McMullin S & Jamnadass R. 2019. Priority Food Tree and Crop Food Composition Database: A User Guide. Version 1. Nairobi: World Agroforestry. http://apps.worldagroforestry.org/products/nutrition/downloads/Priority%20Food%20Tree%20and%20Crops%20Food%20Composition%20Database%20A%20User%20Guide.pdf

Poster:

FTCP: https://www.foreststreesagroforestry.org/wp-content/uploads/2021/01/T2-123-McMullin-et-al-2020-Portfolios-FTA-Science-Conference-Final-Version.pdf

104. Digital maps of secondary forests in four Central American countries

Contact:

CRP/Institution: CATIE

Website: https://geocatie.maps.arcgis.com/apps/MapSeries/index.html?appid=6237c93e8a63402da30ddd5374d958f7

Short description of the tool:

CATIE, in collaboration with the International Climate Initiative (IKI), launched the Secondary Forests Project to support the sustainable management of secondary forests as productive ecosystems in four countries of Central America (i.e. Costa Rica, El Salvador, Guatemala and Honduras). CATIE developed a spatially explicit model to identify the sites offering biophysical characteristics[28] most adapted to the plantation and/or sustainable management of secondary forests.

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Sustainable forest management

Main focus:

Biophysical and ecological aspects

Scale:

Regional

Stage of development:

Under development or pilot-test at the time of writing

References and further readings:

Website:

International Climate Initiative (IKI): https://www.apccolombia.gov.co/node/2250

28 Among these characteristics figure: current land cover, distance to road, slope, deforestation pressure (i.e. distance to areas deforested between 2000 and 2017), distance to protected areas,

105. Generation of knowledge for decision making in secondary natural succession

Contact:

Bryan Finegan
CRP/Institution: CATIE

Short description of the tool:

Through research in secondary forests in dry life zones, information is available for decision-making related to the restoration of forests and landscapes. The research generated an ecological database on forest types and publications for different target audiences that can support the active restoration of secondary forests by informing decision-making.

Category of tool:

Data-analysis supporting tool:
Data collection and database

Main theme:

Forest landscape restoration

Main focus:

Biophysical and ecological aspects

Scale:

Farm
Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The research was carried out in the Nicoya Peninsula, Costa Rica, in a landscape of 200,000 hectares undergoing forest restoration since the 1970s when changes in market forces and the national political environment led to the collapse of livestock in the zone. A network of plots was located in secondary forests of different ages and within an altitudinal range of 54-828 m above sea level. In the plots vegetation included trees, palms and lianas. The results of the research can potentially support the restoration of forests in similar climatic zones of Central America.

References and further readings:

Granda Moser V, Finegan B, Ramos Bendaña ZS, Molina A & Detlefsen G. 2015. Potencial de manejo de bosques en un paisaje forestal restaurado a través de la sucesión natural secundaria en Guanacaste, Costa Rica: composición, diversidad y especies maderables. CATIE, Turrialba, Costa Rica: Boletín Técnico. Technical Series.

Granda Moser V, Finegan B, Ramos Bendaña ZS, Molina A & Detlefsen G. 2015. Bosques secundarios en potreros abandonados: potencial para la recuperación de la biodiversidad y provisión de productos de madera en la península de Nicoya, Costa Rica. CATIE, Turrialba, Costa Rica, Síntesis para Decisores Policy Brief PB 20.

Base de datos Bosques secundarios de la Península de Nicoya, Costa Rica.

Contact: Diego Delgado (CATIE)

106. Mapping Ecosystem Services to Human Well-being (MESH)

Contact:

Fabrice DeClerck, Sarah Jones, Natalia Estrada Carmona
CRP/Institution: WLE / Alliance of Bioversity International and CIAT
Website: https://naturalcapitalproject.stanford.edu/software/mesh

Short description of the tool:

Mapping Ecosystem Services to Human well-being is an integrative modelling platform that calculates and maps ecosystem services supply under different landscape management scenarios. MESH has built-in scenario generation tools, multiple ecosystem services supply evaluation, visualization of output maps and automated reprogramming functionalities.

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Biodiversity, natural resources and ecosystem services

Main focus:

Biophysical and ecological aspects

Scale:

Landscape, regional global

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

DeClerck FAJ, Jones S, Wood S, Attwood S, Bossio D, Girvetz E, Chaplin-Kramer B, Enfors E, Fremier A, Gordon L, Kizito F, Lopez Noriega I, Matthews N, McCartney M, Meacham M, Noble A, Quintero M, Remans R, Soppe R, Willemen L& Zhang W. 2016. Agricultural ecosystems and their services: the vanguard of sustainability? Current Opinion in Environmental Sustainability. 23:92–99. https://doi.org/10.1016/j.cosust.2016.11.016

Johnson J & Jones S. 2019. Mapping Ecosystem Services to Human Well-being: a toolkit to support integrated landscape management for the SDGs. Ecological Applications 29(8), p.e01985. https://doi.org/10.1002/eap.1985

Willemen L, Jones S, Estrada Carmona NE & DeClerck F. 2017. 7.3.2 Ecosystem Service Maps in Agriculture. In: Burkhard, B. and J. Maes (eds). Mapping Ecosystem Services. Advanced Books. https://doi.org/10.3897/ab.e12837

Wood S, Jones S, Johnson JA, Brauman K, Chaplin-Kramer R, Fremier A, Girvetz E, Gordon LJ, Kappel C, Mandle L, Mulligan M, O'Farrell P, Smith WK, Willemen L, Zhang W & DeClerck F. 2018. Distilling the role of ecosystem services in the Sustainable Development Goals. Ecosystem Services. Ecosystem Services 29 (2018) 70–82. https://doi.org/10.1016/j.ecoser.2017.10.010

107. Mapforgen

Contact:

Evert Thomas
CRP/Institution: Bioversity International

Short description of the tool:

The distribution, diversity and conservation status of tropical and subtropical tree species is often poorly known. This makes it difficult to define and establish adequate conservation strategies of these important resources for timber, food, fibre and other tree products. MAPFORGEN is a collaborative platform of researchers and institutions that presents information to support the conservation of 100 socioeconomically important woody perennial species native to Latin America. It presents distribution maps and indicators of conservation status in combination with novel threat analysis. For those species with molecular marker data available, innovative genetic diversity analyses are being presented to prioritize populations for the conservation of the species' genetic resources. In addition, data on the reproductive biology of these species is provided. This is basic information to develop conservation strategies, and has been collected systematically for the prioritized tree species. The atlas is intended for students and professionals working in forest genetic resources or in forestry and nature conservation in general, and all those who want to know more about forest genetic resources.

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

Regional

Stage of development:

Terminated (no longer maintained)

References and further readings:

Van **Zonneveld M, Thomas E, Alcázar-Caicedo C, van Damme V, Castaneda Alvarez N, Salcedo J & Scheldeman X.** 2013. MAPFORGEN Atlas for the conservation of forest genetic resources. January 2013.

Website (now closed): http://www.mapforgen.org

108. Landscape Assessment of Financial Flows (LAFF)

Contact:

Bas Louman, Seth Shames, and Gabija Pamerneckyte
CRP/Institution: Tropenbos International

Short description of the tool:

Collaborative landscape initiatives have demonstrated enormous potential to mobilize stakeholders across sectors, supporting them to work together toward shared objectives of landscape regeneration. To support these landscape initiatives, Tropenbos International and EcoAgriculture Partners partnered to develop the Landscape Assessment of Financial Flows (LAFF) methodology (Shames et al., 2019). LAFF has been designed to facilitate the participatory identification and characterization of major flows of finance in the landscape and, thereby, better understand how a landscape's financial system does or does not support integrated landscape objectives. This practical two-phase approach helps stakeholders identify local sources of finance for new investment ideas, find the current financial flows that are most in need of transformation, and better understand the elements of a landscape's financial context that require support.

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Sustainable landscape management

Main focus:

Socio-economic aspects
Governance aspects

Scale:

Landscape

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

This methodology has now been applied in two pilot landscapes (i.e., the Gunung Tarak landscape in West Kalimantan, in Indonesia; and the Juabeso-Bia and Sefwi Wiawso landscape in the Western Region of Ghana) (Louman et al., 2020).

References and further readings:

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Louman B, Shames S, Pamerneckyte G, Owusu Ansah M & Koesoetjahjo I. 2020. Landscape Assessment of Financial Flows (LAFF) - Lessons learned from pilot implementation. Tropenbos International and EcoAgriculture Partners: Wageningen, the Netherlands. https://inclusive-finance.tropenbos.org/file.php/2342/180820-laff-lessons-learned.pdf

Shames S, Louman B & Scherr S. 2019. The Landscape Assessment of Financial Flows - A Methodology. Tropenbos Internationald and EcoAgriculture Partners: Wageningen, the Netherlands. iv + 36 pp. https://www.tropenbos.org/resources/publications/the+landscape+assessment+of+financial+flows+-+a+methodology

Poster:

LAFF: https://www.foreststreesagroforestry.org/wp-content/uploads/2020/12/T1-178-BasLouman-etal-NEW.pdf

109. Trait-based tree species vulnerability mapping to guide conservation and restoration efforts

Contact:

Tobias Fremout, Hannes Gaisberger, Viviana Ceccarelli, Evert Thomas
CRP/Institution: Alliance Bioversity International – CIAT
Website:
https://tree-diversity.shinyapps.io/vulnerability_Peru_Ecuador/
https://tree-diversity.shinyapps.io/vulnerability_central_africa/

Short description of the tool:

Understanding the vulnerability of tree species to anthropogenic threats is important for the efficient planning of restoration and conservation efforts. Starting from the method developed by Gaisberger et al. (2017), a methodology was developed to map the vulnerability of tree species to four current threats (fire, habitat conversion, overgrazing, and overexploitation) and climate change. The methodology involves the use of ensemble modelling to predict species distribution ranges, freely accessible spatial datasets to map threat exposures, and a trait-based scoring approach to estimate species-specific sensitivities to different threats. Species-specific vulnerability maps are then constructed from the product of the exposure maps and the sensitivity estimates.

Based on the vulnerability mapping results, an explicit planning strategy for species-specific restoration and conservation actions is proposed: (i) *in-situ* conservation of tree populations and seed collection for tree planting activities in areas with low vulnerability to climate change and current threats, (ii) *ex-situ* conservation or translocation of populations in areas with high climate change vulnerability, and (iii) active planting or assisted regeneration in areas under high current threat vulnerability but low climate change vulnerability, provided that interventions are in place to lower threat pressure.

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Forest landscape restoration

Main focus:

Biophysical and ecological aspects

Scale:

Landscape
National
Regional

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

The methodology has been applied in the tropical dry forests of Peru and Ecuador (Fremout et al., 2020), and is currently being applied in Central Africa (Ceccarelli et al., in preparation) and south-east Asia (Gaisberger et al., in preparation). In the first two cases, the maps are available in an online application (see links above), while the maps of the mapping in south-east Asia are available on the www.tree-diversity.org platform (see tool #114). The maps of the first two studies will also be made available on this platform.

References and further readings:

Ceccarelli V, Ekué M, Fremout T, Gaisberger H, Kettle C, Taedoumg H, Wouters H, Vanuytrecht E, De Ridder K & Thomas E. Vulnerability mapping of 100 priority tree species in Central Africa to guide conservation and restoration efforts. In preparation.

Fremout T, Thomas E, Gaisberger H, Van Meerbeek K, Muenchow J, Briers S, Gutierrez-Miranda CE, Marcelo-Peña JL & Kindt R. 2020. Mapping tree species vulnerability to multiple threats as a guide to restoration and conservation of tropical dry forests. Global Change Biology, Volume26, Issue 6, June 2020, pp. 3552-3568. https://doi.org/10.1111/gcb.15028

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Gaisberger H, Fremout T, Kettle CJ, Vinceti B, Kemalasari D, Kanchanarak T, Thomas E, Serra-Diaz JM, Svenning JS, Slik F, Eiadthong W, Palanisamy K, Ravikanth G, Bodos V, Sang J, Warrier RR, Wee AKS, Elloran C, Tolentino Ramos L, Henry M, Akhter Hossain MD, Theilade I, Laegaard S, Bandara KMA, Panduka Weerasinghe D, Changtragoon S, Yuskianti V, Wilkie P, Hoang Nghia N, Elliott S, Pakkad G, Tiansawat P, Maycock C, Bounithiphonh C, Mohamed R, Nazre M, Nur Siddiqui B, Lee SL, Lee CT, Farhanah Zakaria N, Hartvig I, Lehmann L, Dzulkifli David DB, Barnekow Lillesø JP, Phourin C, Yongqi Z, Ping H, Volkaert HA, Graudal L, Hamidi A, Thea S, Sreng S, Boshier D, Tolentino Jr., E, Ratnam W, Aung MM, Galante M, Fatimah Md Isa S, Quoc Dung N, Thi Hoa T, Chan Le T, Miah MD, Lateef Mohd Zuhry A, Alawathugoda D, Azman A, Pushpakumara G, Sumedi N, Siregar IZ, Kyung Nak H, Linsky J, Barstow M, Koh LP & Jalonen R. Tropical and subtropical Asia's valued tree species under threat. In preparation.

Gaisberger H, Kindt R, Loo J, Schmidt M, Bognounou F, Da SS, Diallo OB, Ganaba S, Gnoumou A, Lompo D, Lykke AM, Mbayngone E, Nacoulma BMI, Ouedraogo M, Ouédraogo O, Parkouda C, Porembski S, Savadogo P, Thiombiano A, Zerbo G & Vinceti B. 2017. Spatially explicit multi-threat assessment of food tree species in Burkina Faso: A fine-scale approach. PLoS One 12, 1–26. https://doi.org/10.1371/journal.pone.0184457

Poster:

https://www.foreststreesagroforestry.org/wp-content/uploads/2020/12/T2-31-Fremout-poster-FTA-conference.pdf

110. High resolution species distribution modelling across Africa: Atlases and decision-support tools to select suitable species and their seed sources for 150+ priority tree species

Contact:

Roeland Kindt

CRP/Institution: ICRAF

Websites:

www.worldagroforestry.org/atlas-central-america;

http://landscapeportal.org/

Short description of the tool:

ICRAF, in collaboration with Bioversity International, CATIE and Hivos, recently published an atlas of habitat suitability maps for 100 tree species widely used for shade in Central American coffee or cocoa agroforestry systems[29] (de Sousa et al. 2019). Using similar methods of species distribution modelling, habitat suitability maps were prepared for 150 tree species native or exotic to Africa. These maps are already available from ICRAF's landscape portal[30] include KML layers that can be uploaded in Google Earth.

Maps are currently being prepared for a species atlas and an interactive portal documenting 'what to plant where'. Applying the likelihood scale recommended by the IPCC, habitat change maps are based on the middle of the 21st century for two Representative Concentration Pathways. The calibration methods applied (Valavi et al. 2019) were also integrated into the BiodiversityR software package to facilitate wider application (Kindt, 2019). These maps will allow future climate planning to support tree-based livelihoods and environmental services.

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Biodiversity, natural resources and ecosystem services

Main focus:

Biophysical and ecological aspects

Scale:

Regional

Stage of development:

Under development or pilot-test at the time of writing

29 See: www.worldagroforestry.org/atlas-central-america

30 See: http://landscapeportal.org/

References and further readings:

de Sousa K, van Zonneveld M, Holmgren M, Kindt R & Ordonez JC. 2019. The future of coffee and cocoa agroforestry in a warmer Mesoamerica. Scientific Reports 9, Article number: 8828(2019) https://doi.org/10.1038/s41598-019-45491-7

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Kindt R. 2018. Ensemble species distribution modelling with transformed suitability values. Environmental Modelling & Software, Volume 100, February 2018, pp. 136–145. https://doi.org/10.1016/j.envsoft.2017.11.009

Kindt, R. 2019. BiodiversityR: Package for Community Ecology and Suitability Analysis. Version 2.11-3. https://cran.r-project.org/web/packages/BiodiversityR/index.html (see tool #72).

Valavi R, Elith J, Lahoz-Monfort JJ & Guillera-Arroita G. 2019. BlockCV: An R package for generating spatially or environmentally separated folds for k-fold cross-validation of species distribution models. Methods in Ecology and Evolution, Volume 10, Issue 2, pp. 225-232. https://doi.org/10.1111/2041-210X.13107

Booth TH. 2018. Species distribution modelling tools and databases to assist managing forests under climate change. Forest Ecology and Management, Volume 430, 15 December 2018, pp. 196-203. https://doi.org/10.1016/j.foreco.2018.08.019

Presentation:

Kindt R et al. 2020. High resolution species distribution modelling across Africa. Atlases and decision-support tools to select suitable species and their seed sources for 150+ priority tree species. Presentation at FTA Science Conference, September 2020.

111. Shademotion

Contact:

Eduardo Somarriba
CRP/Institution: FTA / CATIE
Website: https://www.shademotion.net/

Short description of the tool:

The analysis of shade patterns is central to the design and management of trees in agricultural landscapes. Shademotion is an internet-based software that simulates the shade patterns of tree and facilitate the optimal design and management of shade canopy in coffee or cocoa plantations (see also tool #101). Shademotion helps graphically, quickly and easily design and test tree shade canopies in terms of the number of hours of shade received by each point (grid cell) on a plot with trees. Shademotion handles large plots, anywhere on Earth, whether horizontal or tilted planes, any number of trees in any spatial configuration on the plot, tree features (monthly leaf fall, crown size, form and transparency), any time interval, from a snap photo to a full swing simulation over the entire life cycle of the plantation (say 30 years) with tree growth data provided by the user. Shademotion considers tree crowns as regular geometric 3-D objects with variable dimensions and other characteristics (e.g. monthly leaf phenology) and simulate the movement of the Sun to estimate the number of hours of shade projected by the crowns of the trees on every point of the plot over the simulation period (FTA, 2020).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Agroforestry

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field

Stage of development:

Effective use on the ground (mature tool)

References and further readings:

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Somarriba E, Orozco-Aguilar L, Cerda R & López-Sampson A. 2018. Analysis and design of the shade canopy of cocoa-based agroforestry system. In: Umaharan P (ed.). Achieving sustainable cultivation of cocoa. Burleigh Dodds Science Publishing, Cambridge, UK. pp. 469-499. https://doi.org/10.19103/AS.2017.0021.29

Somarriba E, Zamora R, Malek M, Vargas E, Sinclair F & Quesada F. 2020. ShadeMotion: the analysis of tree shade patterns tutorial. Serie Técnica. Manual Técnico no. 145. CATIE, Turrialba, Costa Rica. ShadeMotion version 5.1.41. https://shademotion.net/files/tutorials/en/ShadeMotion_v5.pdf

Presentation:

Somarriba E. 2020. The Software ShadeMotion. From analytic geometry to shade canopy design in agroforestry system. Presentation at the FTA Science Conference, September 2020.

Video: https://www.youtube.com/watch?v=olINafoQ4fM

112. Shade Tree Advice

Contact:

Nguyen Mai Phuong and Clément RIGAL
CRP/Institution: FTA / ICRAF
Website: https://www.shadetreeadvice.org/

Short description of the tool:

In agroforestry systems (AFS), associated trees provide multiple ecosystem services and contribute to: (i) improve soil fertility; (ii) buffer climate extremes and adapt to climate change; (iii) provide refuge for biodiversity and to crop auxiliaries; and (iv) diversify on-farm revenues (with fruits, timber, fuelwood, fodder, medicinal products, honey...) and reduce exposure to price volatility, particularly for crop commodities such as coffee or cocoa. There is an untapped wealth of knowledge gained by farmers over generations on agroforestry practices and ecosystem services and disservices provided by trees on their farms. The 'Shade Tree Advice' tool invite farmers and practitioners to select: (i) their country, region and crop of interest; (ii) the ecosystem services they expect from shade trees. Based on this information, and on a database gathering the expert advice of farmers interviewed in different regions, the tool suggest a list of appropriate shade tree species, ranking them according to their degree of suitability.

Category of tool:

Data-analysis supporting tool:
Data collection and database

Main theme:

Agroforestry

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field
Farm

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

This tool has been applied in Yunnan (China), Central Laos, and Northwest Viet Nam and studies are ongoing in Nicaragua, Central Vietnam, Cameroon and Colombia to expand its geographical coverage (FTA, 2020).

References and further readings:

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Lépine M. 2018. Connaissances locales des services écosystémiques dans les systèmes agroforestiers à base de caféiers au Laos. MSc Thesis. Angers, France. 104 p.

Nguyen MP. 2020. Chapter 5: Case study: Potential to expand coffee agroforestry systems in Northwest Vietnam. Pp. 65-78. In: Analysis Of Context And Options For Scaling Agroforestry In Northwest Vietnam. Doctoral Thesis, University of Bangor, Wales. https://research.bangor.ac.uk/portal/files/34575568/2020NguyenPhd.pdf

Rigal C, Vaast P & Xu J. 2018. Using farmers' local knowledge of tree provision of ecosystem services to strengthen the emergence of coffee-agroforestry landscapes in southwest China. PloS One, 13 (9): 18 p. https://doi.org/10.1371/journal.pone.0204046

Van der Wolf J, Jassogne L, Gram G & Vaast P. 2019. Turning Local Knowledge On Agroforestry Into An Online Decision-Support Tool For Tree Selection In Smallholders' Farms. Experimental Agriculture, 55(S1), pp. 50-66. https://doi.org/10.1017/S001447971600017X

Presentations at the FTA Science Conference, September 2020:

Rigal C et al. 2020. Young shade tree provision of ecosystem services. First lessons from a large-scale conversion from coffee monoculture to agroforestry in Yunnan Province, China.

Mai Phuong N et al. 2020. Local agroforestry knowledge and development of an online decision-support tool (shadetreeadvice.org) for selection of trees to be associated to coffee in South-East Asia and beyond.

113. Regreening Africa App

Contact:

Tor-Gunnar Vågen, Susane Chomba and colleagues

CRP/Institution: FTA / ICRAF

Short description of the tool:

The Regreening Africa App is a free mobile-based Android application, developed by ICRAF, for unstructured (or crowd-sourced) data collection of interventions, allowing implementing partners, extension agents and farmers to collect information on how farmers manage and protect trees on their farms. This Application was developed under the Regreening Africa project, which targets to regreen one million ha of degraded land and restore livelihoods of 500,000 households in eight African countries (Ethiopia, Ghana, Kenya, Mali, Niger, Rwanda, Senegal and Somalia). The App includes four modules focusing on: (i) tree planting; (ii) farmer managed natural regeneration (FMNR); (iii) nursery establishment and management; and (iv) training. The App aims at facilitating data collection, near-real time monitoring and verification and combines remote-sensing information from Earth Observation platforms and field data collection, using the Land Degradation Surveillance Framework (LDSF, see tool #70).

The App can be downloaded on Google Play store.[31]

Category of tool:

Data-analysis supporting tool:
Data collection and database

Main theme:

Agroforestry

Main focus:

Biophysical and ecological aspects
Socio-economic aspects

Scale:

Farm
National
Regional

Stage of development:

Effective use on the ground (mature tool)

31 See: https://play.google.com/store/apps/details?id=com.icraf.gsl.regreeningafrica&hl=en&gl=US

References and further readings:

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Gitz V, Place F, Koziell I, Pingault N, van Noordwijk M, Meybeck A & Minang P. 2020. A joint stocktaking of CGIAR work on forest and landscape restoration. Working Paper 4. Bogor, Indonesia: The CGIAR Research Program on Forests, Trees and Agroforestry (FTA). https://doi.org/10.17528/cifor/007669

Regreening Africa. 2020. The Regreening Africa App. User Guidelines. https://regreeningafrica.org/wp-content/uploads/2020/01/Regreening_Africa_App_User_Guide_English-1.pdf

Presentation at the FTA Science Conference, September 2020:

Vågen TG et al. 2020. Disruptive use of earth observation and machine learning to quantify and monitor regreening efforts and change in land health at scale.

Useful website:

Regreening Africa project: https://regreeningafrica.org/

114. The Tree Diversity Database

Contact:

Riina Jalonen
CRP/Institution: FTA / Alliance of Bioversity International and CIAT
Website: https://www.tree-diversity.org/

Short description of the tool:

Tree species and their populations respond to threats differently, depending on their local uses, functional traits and genetic composition. Understanding the diversity of these responses helps: (i) assess the vulnerability of forest ecosystems to threats, as well as impacts on the provision of ecosystem services; and (ii) design effective conservation and restoration strategies. Species-specific distribution and vulnerability maps feed the Tree Diversity database, managed by the Alliance of Bioversity International and CIAT, an interactive data portal which gathers information for hundreds of native tree species across Africa, Asia, and Latin America. This database can be used to: (i) develop species-specific conservation and management plans; (ii) identify synergies between species and/or countries; (iii) identify target species and possible seed sources for restoration.

Category of tool:

Data-analysis supporting tool:
Data collection and database

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

Regional
Global

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Combining information on current and future species distributions, threat exposure and sensitivity, the Alliance of Bioversity International and CIAT produced species-specific vulnerability maps, covering 17 Asian tropical and subtropical countries[32] for 65 native Asian tree species and for different threats (including habitat conversion, overexploitation, fire, overgrazing

32 Namely: Bangladesh, Bhutan, Brunei, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, the Philippines, Singapore, Sri Lanka, Thailand, Timor Leste and Vietnam, from the Indo-Malayan floristic realm; and Papua New Guinea from the Oceanian realm.

and climate change) (Fremout et al., 2020; Jalonen et al., 2021). Species were selected starting from country priority species lists and validating these with a regional network of experts.

In parallel, the APFORGIS project (2017-2019), implemented by Bioversity International and the 'Asia Pacific Forest Genetic Resources Programme' (APFORGEN), aiming at filling the knowledge gaps for genetic conservation of priority tree species in Asia, seeks to develop: (i) dynamic distribution maps for at least 50 Asian tree species; (ii) decision-support tools for the establishment of genetic conservation units for different species; (iii) a roadmap for establishing an Asian network of genetic conservation units.

References and further readings:

Dinerstein E, Olson D, Joshi A, Vynne C, Burgess ND, Wikramanayake E, Hahn N, Palminteri S, Hedao P, Noss R, Hansen M, et al. 2017. An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm. Bioscience, 67(6), pp. 534-545. Epub 2017 Apr 5. PMID: 28608869; PMCID: PMC5451287. https://doi.org/10.1093/biosci/bix014

Fremout T, Thomas E, Gaisberger H, Van Meerbeek K, Muenchow J, Briers S, Gutierrez-Miranda, CE, Marcelo- Peña JL, Kindt R, Atkinson R, Cabrera O, Espinosa CI, Aguirre-Mendoza Z & Muys B. 2020. Mapping tree species vulnerability to multiple threats as a guide to restoration and conservation of tropical dry forests. Global Change Biology 26, 3552-3568 (First published: 5 February 2020). https://doi.org/10.1111/gcb.15028

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Gaisberger H, Kindt R, Loo J, Schmidt M, Bognounou F, Da SS, Diallo OB, Ganaba S, et al. 2017. Spatially explicit multi-threat assessment of food tree species in Burkina Faso: A fine-scale approach. PLoS ONE 12, e0184457 eCollection 2017 (7 September 2017). https://doi.org/10.1371/journal.pone.0184457

Jalonen R, Gaisberger H, Vinceti B & Kettle C. 2021. Conservation priorities for native Asian tree species from a multi-threat assessment. In: Pingault, N., Meybeck, A. & Laumonier, Y. (eds). *Asia-Pacific Forest Sector Outlook: Roadmap for primary forest conservation in Asia and the Pacific*. Report of the FAO-CIFOR/FTA online expert workshop, 23-25 March 2021. https://www.foreststreesagroforestry.org/wp-content/uploads/2021/07/FTA-FAO-Primary-Forestry-Workshop-23-25-March-2021-Final_Report.pdf

Serra-Diaz JM, Enquist BJ, Maitner B, Merow C & Svenning JC. 2017. Big data of tree species distributions: how big and how good? Forest Ecosystems 4, 30 (2017). https://doi.org/10.1186/s40663-017-0120-0

Presentations:

Jalonen R et al. 2020. Nature-based solutions require adaptive capacity: a case study of the climate vulnerability of Asian tree species. Presentation at the FTA Science Conference, September 2020.

Jalonen R et al. 2021. Conservation priorities for native Asian tree species from a multi-threat assessment. Presentation at the FAO/FTA online expert workshop on primary forests. March 2021.

Useful website:

APFORGIS: www.apforgen.org/activities/apforgis

115. Land-Use Planning for Multiple Environmental Services (LUMENS)

Contact:

Website:

https://www.lumens.id/ (in Indonesian Language)

Download LUMENS for free: https://sourceforge.net/projects/lumens/

Short description of the tool:

LUMENS (Land Use Planning for Multiple Environmental Services), developed by ICRAF, is a spatially explicit modelling platform that simulates ecological and economics outcomes of land uses and land use changes scenarios. Providing ex-ante impacts of various management options, LUMENS can inform negotiations among policy-makers and other stakeholders. LUMENS runs effectively with minimum data inputs, matching conditions in many developing countries where detailed data can be lacking. Three regulating ecosystem services are regularly modelled by LUMENS for each land use change scenario: (i) habitat quality and configuration for biodiversity; (ii) carbon emissions and sequestration; and (iii) watershed services (Roshetko et al., 2021). The LUMENS model comprises four modules: (i) Planning Unit Reconciliation (PUR) to determine zonation or planning units; (ii) Quantification of Environmental Services (QUES); Trade-off Analysis of Regional Economy (TA); and Scenario Simulation and Development (SCIENDO).

Category of tool:

Data-analysis supporting tool:

Modelling and mapping

Main theme:

Land use, land use changes

Main focus:

Biophysical and ecological aspects

Socio-economic aspects

Scale:

Landscape

National

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

LUMENS planning has been used to produce provincial Green Growth development plans in South Sumatra, Jambi, Aceh, Papua and West Papua. The national government has endorsed the use of LUMENS for land-based climate change mitigation for all provinces in Indonesia. LUMENS has also been used in Lam Dong province, Viet Nam for the provincial Green Growth action plan and will be tested in Sri Lanka (Roshetko et al., 2021).

References and further readings:

Dewi S, Ekadinata A, Nugraha A & Indiarto D. 2015. Land-Use Planning for Multiple Environmental Services (Lumens). World Agroforestry Centre (ICRAF) Southeast Asia Regional Program, Bogor, Indonesia. http://old.worldagroforestry.org/region/sea/publications/detail?pubID=3447

Dewi S, Ekadinata A, Indiarto D, Nugraha A & van Noordwijk M. 2014. *Empowering local stakeholders for planning, Indonesia.* In: Chavez-Tafur J & Zagt RJ. (eds). *Towards Productive Landscapes.* Wageningen, the Netherlands: Tropenbos International, Wageningen, the Netherlands. http://www.tropenbos.org/file.php/1742/etfrn56web.pdf

Dewi S, Ekadinata A, Indiarto D, Nugraha A & van Noordwijk, M. 2015. *Negotiation support tools to enhance multifunctioning landscapes.* In: Minang, P.A., van Noordwijk, M., Freeman, O.E., Mbow, C., de Leeuw, J. & Catacutan, D. (eds). *Climate-Smart Landscapes: Multifunctionality In Practice.* Nairobi, Kenya: World Agroforestry Centre (ICRAF).

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Mulia R, Hoan Trong Do, Van Thanh Pham, Tan Quang Nguyen, S. Dewi, A. Ekadinata, A. Dwiputra, A. Nugraha, F. Johana, Khanh Quoc Nguyen, & Dung Kim Thi Nguyen. 2019. Technical Report: "*Green Growth Action Plan for Lam Dong Province for the Period of 2021 – 2030, Vision to 2050*". World Agroforestry (ICRAF) Vietnam.

Roshetko JM, Pingault N, Quang Tan N, Meybeck A & Gitz V. Forthcoming. *Innovative technologies in support of sustainable forest management in Asia and the Pacific.* Food and Agriculture Organization of the United Nations (FAO), Rome. Center for International Forestry Research (CIFOR), Bogor, Indonesia. CGIAR Research Program on Forests, Trees and Agroforestry (FTA).

Website:

LUMENS: http://greengrowthvietnam.worldagroforestry.org/en/assessment-tools-and-input-data/land-use-planning-multiple-environmental-services-lumens/

116. FAO framework methodology for climate change vulnerability assessment of forests and forest-dependent people

Contact:

Alexandre Meybeck, Simone Rose, and Vincent Gitz.
CRP/Institution: FTA / CIFOR

Short description of the tool:

In the face of climate change, immediate action is needed to build resilience into forests and forest-dependent people's livelihoods. Vulnerability assessment is a necessary first step in identifying adaptation options targeted at the most vulnerable areas and people and adapting them for specific contexts. The vulnerability of a system is a function of its exposure to change, its sensitivity to such change, and its capacity to adapt to it. The FAO framework methodology (FAO and CIFOR, 2019) aims to provide practical technical guidance, good practices and principles, for practitioners to conduct forest vulnerability assessment in a given landscape in the context of climate change, and to facilitate the use of appropriate tools and methods. The framework is structured along the following steps: (i) define the objectives, scope and means; (ii) describe the situation and state of forests and trees in the considered landscape, as well as actual or potential changes over time; (iii) gather information on legal status, institutions and governance; (iv) describe the number and characteristics of forest-dependent people; (v) assess climate change and climate-related risk in the region where the forest is located; (vi) evaluate the potential impacts of climate change on forests and trees, as well as their specific vulnerabilities; (vii) evaluate the potential impacts of climate change on forest-dependent people, and their specific vulnerabilities; (viii) communicate the results and move ahead, sharing the findings with stakeholders and promoting adaptation options.

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Climate change, GHG and carbon stocks

Main focus: All three
Biophysical and ecological aspects
Socio-economic aspects
Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Tropenbos International, in collaboration with partners, adapted and applied the FAO framework methodology in two landscapes (Ketapang-Kayong Utara landscape in Indonesia; and Juabeso-Bia and Sefwi-Wiawso landscape in Ghana). They identified and discussed the major strengths and weaknesses of the application of the FAO methodology in a landscape context, and provided recommendations to improve the methodology and its usefulness for planning climate actions at the landscape level (FTA, 2020; Widayati et al., 2021).

References and further readings:

FAO and CIFOR. 2019. FAO Framework Methodology for Climate Change Vulnerability Assessments of Forests and Forest Dependent People. FAO Forestry Paper 183. Rome. http://www.fao.org/3/ca7064en/ca7064en.pdf

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Lasco RD, Pulhim FB, Roshetko JM & Banaticia MRN. 2004. LULUCF Climate Change Mitigation Projects in the Philippines: A Primer. World Agroforestry Centre (ICRAF), Southeast Asia Regional Research Programme, Los Banos, Philippines. 73p.

Widayati A, Louman B, Mulyoutami E, Purwanto E, Kusters K & Zagt R. 2021. Communities' Adaptation and Vulnerability to Climate Change: Implications for Achieving a Climate-Smart Landscape. Land, 10(8), 816. https://doi.org/10.3390/land10080816

117. The role of multi-stakeholder forums in subnational jurisdictions: Methods training manual and tools for in-depth field research

Contact:

Anne M Larson, Juan Pablo Sarmiento Barletti, and Harlem Mariño

CRP/Institution: FTA-PIM / CIFOR

CRP/Flagship (if relevant): FTA / PIM

Website: https://www2.cifor.org/gcs/modules/multilevel-governance/multi-stakeholder-forums

Short description of the tool:

Multi-stakeholder forums (MSFs) have received much attention from policy makers, practitioners and researchers for their potential as a more sustainable and democratic approach to decision making. However, some actors critique their incapacity to tackle power inequalities. In this context, this manual, developed by CIFOR and consisting of a collection of structured questionnaires, can help MSF participants, scientists and other stakeholders, evaluate the equity and effectiveness of these decision-making initiatives and find ways to optimize their outcomes (Sarmiento Barletti and Larson, 2019). CIFOR also developed a tool, called “How are we doing?”, directed only to forum participants, to reflect on the process, progress and priorities of their MSF and define an action plan for improvement. This tool structures the discussions along the four following stages: (i) the selection stage to choose the question/statement of interest for evaluation; (ii) the voting stage to rank the questions and come to a consensus; (iii) the reflection stage on the selected statements to identify the key lessons learned from discussion and the key challenges and plans for improvement; (iv) summary/action stage.

Category of tool:

Decision-making supporting tool:

Method or process facilitating discussions between actors

Main theme:

Governance, institutions and capacity development

Main focus:

Governance aspects

Scale:

Landscape

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

This method was used for a comparative study on the equity and effectiveness of the processes and outcomes of 14 MSFs, set-up around land use and land-use change and located in 4 countries (Brazil – 4 case studies, Ethiopia – 2, Indonesia – 4 and Peru – 4) (Sarmiento Barletti and Larson, 2019).

References and further readings:

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Sarmiento Barletti JP & Larson AM. 2019. The role of multi-stakeholder forums in subnational jurisdictions: Methods training manual and tools for in-depth field research. CIFOR: Bogor, Indonesia. https://www.cifor.org/publications/pdf_files/Books/BSarmientoBarletti1801.pdf

Sarmiento Barletti JP & Larson AM. 2019. The role of multi-stakeholder forums in subnational jurisdictions: Framing literature review for in-depth field research. Occasional Paper #194. CIFOR: Bogor, Indonesia. https://www.cifor.org/publications/pdf_files/OccPapers/OP-194.pdf

Sarmiento Barletti JP & Larson AM. 2020. 'How are land-use multi-stakeholder forums affected by their contexts? Perspectives from two regions of the Peruvian Amazon', in J. Innes and W. Nikolakis (eds.) The Wicked Problem of Forest Policy. Cambridge: Cambridge University Press.

Sarmiento Barletti JP, Larson AM, Hewlett C & Delgado D. 2020. Designing for engagement: A Realist Synthesis Review of how context affects the outcomes of multi-stakeholder forums on land use and/or land-use change. World Development 127:104753. https://doi.org/10.1016/j.worlddev.2019.104753

Sarmiento Barletti et al. (Forthcoming) How are we doing? (Currently in design for publication/website preparation)

Presentations at the FTA Science Conference, September 2020:

Larson A et al. 2020. Participation for inclusive and sustainable landscapes, or why achieving more equitable and resilient multi-stakeholder forums require reflexive and adaptive learning.

Larson A. 2020. How are we doing? A tool to reflect on the process, progress and priorities of your multi-stakeholder forum.

Sarmiento Barletti JP & Larson AM. 2020. Participation in a state of (climate) urgency: Lessons from a comparative study of multistakeholder forums.

118. One Map Initiative to support land-use and development planning in Papua and South Sumatra, Indonesia

Contact:

Mukhammad Thoha Zulkarnain
CRP/Institution: FTA / ICRAF

Short description of the tool:

One of the biggest obstacles to land use planning throughout Indonesia is the lack of available, accurate, and easily accessible data and information on biophysical data, such as land suitability, socio-economic characteristics, and land-related policies and regulations. In 2015, the Government of Indonesia launched the One Map Policy to optimize and align geospatial information systems nation-wide around one standard, one database and one geoportal. However, implementation faces numerous challenges at the subnational level, due to: (i) the lack of local technical capacity; and (2) the lack of clear principles, procedures and guidelines. In this context, ICRAF scientists conducted a three-year study to strengthen the capacity of local governments (South Sumatra and Papua provinces) in developing and managing their one map systems[33], by providing them the needed technical tools and how-to guidelines. They develop a tool to assess, before and after the study, the capacity of stakeholders in developing and managing a one-map system. They developed a technical, semi-automated tool to allow stakeholders to compile, integrate, and synchronize their data and information. They adopted the Planning Unit Reconciliation module of LUMENS (Land Use Planning for Multiple Environmental Services, see tool #115), as well as the Drivers-Pressure-State-Impact-Response (DPSIR) approach to assist stakeholders in formulating the options to solve the data conflicts and inconsistencies (FTA, 2020).

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Land use and land use changes

Main focus:

Biophysical and ecological aspects

Scale:

Landscape
National

Stage of development:

Effective use on the ground (mature tool)

33 that contains relevant data and information on land-uses, land-use related factors and development.

References and further readings:

Burkhard B & Müller F. 2008. Driver–Pressure–State–Impact–Response. Encyclopaedia of Ecology, 967–970. https://doi.org/10.1016/b978-008045405-4.00129-4

Dewi S, Ekadinata A, Nugraha A & Indiarto D. 2015. Land-Use Planning for Multiple Environmental Services (Lumens). World Agroforestry Centre (ICRAF) Southeast Asia Regional Program, Bogor, Indonesia. http://apps.worldagroforestry.org/region/sea/publications/detail?pubID=3447

FTA. 2020. Forests, trees and agroforestry, science for transformational change. Book of Abstracts. FTA 2020 Science Conference. 14-18 and 21-25 September 2020. CGIAR Research Program on Forests, Trees and Agroforestry. https://www.cifor.org/publications/pdf_files/FTA/Book-of-Abstracts.pdf

Presentations:

Abidin, HZ. 2018. One Map Policy and Acceleration of Base map in Large Scale. Geomatics National Seminar. https://doi.org/10.13140/RG.2.2.35097.06240 (in Indonesian language)

Thoha Zulkarnain M et al. 2020. One map initiative to support land-use and development planning in Papua and South Sumatra, Indonesia. Presentation at the FTA Science Conference, September 2020.

Website:

One Map Initiative – A single land database for Indonesia: https://sig-gis.com/projects/one-map-indonesia/

119. The Economics of Ecosystem Restoration (TEER) initiative

Contact:

Blaise Bodin, Vincent Gitz

CRP/Institution: FAO and CIFOR/FTA

Website: http://www.fao.org/in-action/forest-landscape-restoration-mechanism/our-work/gl/teer/en/

Short description of the tool:

The lack of baseline data and consistent information on the costs and benefits of ecosystem restoration hinders further investments on restoration activities weakening capacity to achieve the global restoration goals. To fill this gap FAO and FTA launched 'The Economics of Ecosystem Restoration' (TEER), in collaboration with other member organizations of the Global Partnership on Forest and Landscape Restoration (GPFLR). The initiative has developed and a common protocol to collect standardized data on costs and benefits of restoration projects across countries and biomes with a 'TEER template'. The ultimate objective of the TEER initiative is to constitute a global database that could serve as a reference point for governments, international donors, private investors, project managers, scientists and other stakeholders, for the ex-ante estimation of costs and benefits of future restoration projects in all major biomes and across a wide range of contexts worldwide, based on information from comparable projects on which data has been collected through a standardized framework. Such a reference database could offer decision-makers and restoration practitioners a wide range of restoration options and help them better understand their costs and expected benefits in different contexts, thus assisting them in the prioritization of their restoration investments in a world of constrained resources.

Category of tool:

Data-analysis supporting tool:

Data collection and database

Main theme:

Forest landscape restoration

Main focus:

Socio-economic aspects

Scale:

Global

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

This TEER template has been discussed, reviewed and validated by a panel of experts representing all TEER partner organizations. The template was then translated in five languages and pilot-tested in Summer 2020 in seven restoration projects over six different countries (Brazil, Lebanon, Mozambique, Niger, Peru and Zambia). 87 restoration interventions were described

over 20 intervention units. Overall, more than 3,000 data points were collected. The template was refined according to the feedbacks received.

References and further readings:

Bodin B, Garavaglia V, Pingault N, Ding H, Wilson S, Meybeck A, Gitz V, d'Andrea S & Besacier C. 2021. A standard framework for assessing the costs and benefits of restoration: introducing The Economics of Ecosystem Restoration (TEER). First Published: 31 July 2021. Restoration Ecology, e13515. https://doi.org/10.1111/rec.13515

Ding H, Faruqi S, Wu A, Altamirano JC, Anchondo Ortega A, Verdone M, Zamora Cristales R, Chazdon R & Vergara W. 2017. Roots of prosperity – The economics and finance of restoring lands. Published 19 December 2017. Washington, DC, World Resource Institute. https://files.wri.org/s3fs-public/roots-of-prosperity_0.pdf

FAO. 2019. The Economics of Ecosystem Restoration (TEER). Assessing benefits and costs of Forest and Landscape Restoration. Report of the technical meeting held on 5-7 February 2019, FAO Headquarters, Rome.

FAO. 2019. The Economics of Ecosystem Restoration (TEER). Assessing benefits and costs of Forest and Landscape Restoration. Concept note, 20 March 2019

Pingault N, Bodin B, Garavaglia V, Ding H, Meybeck A, Besacier C & Gitz V. (Forthcoming). The Economics of Ecosystem Restoration (TEER) initiative. Submitted to the XV World Forestry Congress, Seoul, Republic of Korea, May 2022.

120. Farmer Demonstration Trials (FDTs)

Contact:

James M. Roshetko, Prariknyo Purnomosidhi
CRP/Institution: ICRAF
CRP/Flagship (if relevant):
Website:

Short description of the tool:

In many communities, farmers are adjusting from a situation of 'open-access forests' to one where trees are scarce. These farmers often lack the tree-planting skills necessary to develop viable tree farming systems. Well-intended top-down development efforts to help farmers expand tree resources often achieved little, because species selection, plantation design, and location are often imposed without considering farmers' objectives or market opportunities. Active farmer participation is essential to develop successful tree farming systems that address the biophysical and socioeconomic conditions faced by farmers.

The "Farmer Demonstration Trials" (FDTs) tool is a participatory approach to design, establish and manage evaluation trials. The objectives of the trials can be for research, development or both. Researchers, extension staff and farmers work together to establish and manage the trials under farmers' actual biophysical, socioeconomic, and management conditions. FDTs can be used to: i) test and demonstrate the advantages of good germplasm (species, provenance, varieties, clones or seed sources); ii) test and demonstrate the advantages silvicultural practices and tree-crop combinations; iv) inspire farmer/NGO innovation; v) serve as a future source of on-farm germplasm; and vi) serve as a venue for farmer-to-farmer training and information exchange.

Category of tool:

Decision-making supporting tool:
Method or process facilitating discussions between actors

Main theme:

Livelihoods and resilience

Main focus:

Socio-economic aspects

Scale:

Farm

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Roshetko et al. (2005) describe farmer demonstration trials (FDT) and summarizes the experiences in developing FDT with smallholder farmers and non-government organizations (NGOs) in Indonesia. The approach has been used across Indonesia for diverse timber, fruit and commodity tree crops.

References and further readings:

Galudra G, Pradhan UP & Sirait MT. 2013. Rapid land tenure assessment (RaTA): understanding land tenure conflicts. In: Van Noordwijk M, Lusiana B, Leimona B, Dewi S & Wulandari D (eds). 2013. *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

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Roshetko JM, Purnomosidhi P & Mulawarman. 2005. Farmer Demonstration Trials: Promoting tree planting and farmer innovation in Indonesia. In: J Gonsalves, T Becker, A Braun, J Caminade, D Campilan, H De Chavez, E Fajber, M Kapiriri and R Vernooy (eds). *Participatory Research and Development for Sustainable Agriculture and Natural Resource Management: A Sourcebook,* Laguna, Philippines, International Potato Center (CIP); Ottawa, Canada, International Development Research Centre; Rome, Italy, International Fund for Agricultural Development. 3 vols. pp 384-392. http://apps.worldagroforestry.org/downloads/Publications/PDFS/pp05084.pdf

Roshetko JM, D Rohadi, A Perdana, G Sabastian, N Nuryartono, AA Pramono, N Widyani, P Manalu, MA Fauzi, P Sumardamto, & N Kusumowardhani. 2013. Teak agroforestry systems for livelihood enhancement, industrial timber production, and environmental rehabilitation. *Forests, Trees, and Livelihoods* 22 (4): 241-256 https://doi.org/10.1080/14728028.2013.855150

Tukan CMJ, Roshetko JM, Budidarsono S, & Manurung GS. 2006. Market chain improvement: linking farmers to markets in Nanggung, West Java, Indonesia. *Acta Hort.* 699: 429–438. https://doi.org/10.17660/ActaHortic.2006.699.51

121. CacaoDiversity

Contact:

Evert Thomas, Viviana Ceccarelli
CRP/Institution: Alliance Bioversity International – CIAT
CRP/Flagship (if relevant):
Website: https://www.cacaodiversity.org/

Short description of the tool:

Cacao is one of the most important cash crops in many tropical countries. Cacao is characterized by a wide genetic diversity which is especially high in South America. This diversity represents a key resource to promote the long-term sustainability of cacao cultivation. Cacao cultivation is vulnerable to and already affected by climate change around the world. The introduction of propagation material tolerant to climate change in cacao farms represents one of the most promising options to adapt cacao cultivation to climate change. On the other hand, cacao export from South American countries has recently been impacted by the EU Regulation No. 488/2014 (enforced in 2019) which places a maximum allowable limit to the concentrations of cadmium in cacao that can be exported to the European market.

The CacaoDiversity tool have been developed to provide location-specific information about how to improve sustainability of cacao farms in South America. On the tool, the user can select the coordinates of his/her farm in the map, and the tool generates an automatic report with information about the future impact of climate change on cacao cultivation and guide the selection of propagation material adapted to local condition and appropriate for climate change adaptation on the specific farm. The tool also includes information on the likely cadmium content in soil and cacao beans on the farm, and more features are expected to be included. The tool is currently available for Peru and Ecuador, and will be later expanded to other countries in Latin America. The tool is available both in English and Spanish.

Category of tool:

Data-analysis supporting tool:
Modelling and mapping

Main theme:

Seeds, genetic diversity and tree-site matching

Main focus:

Biophysical and ecological aspects

Scale:

Plot/Field
Farm
National

Stage of development:

Under development or pilot-test at the time of writing

Example(s) of effective use:

References and further readings:

Ceccarelli V, Fremout T, Zavaleta D, Lastra S, Imán Correa S, Arévalo- Gardini E, Armando Rodriguez C, Cruz Hilacondo W & Thomas E. 2021. Climate change impact on cultivated and wild cacao in Peru and the search of climate change tolerant-genotypes. Diversity and Distributions. 27(8), 1-15. https://doi.org/10.1111/ddi.13294

Ceccarelli V, Lastra S, Loor Solórzano RG, Wenceslao Chacón W, Nolasco M, Sotomayor Cantos IA, Plaza Avellán LF, Aracelly López D, Fernández Anchundia FM, Dessauw D, Orozco-Aguilar L & Thomas, E. Conservation and use of cacao genetic resources by gene banks and nurseries in six Latin American countries. Accepted in Genetic Resources and Crop Evolution.

Thomas E, Atkinson R, Yovera F, Lastra S, Arango K, Pezo A, Zavaleta D, Ladd B, Duran Y, Alguilar J, Tames M, Ramos A, Rodriguez C, Cruz W, Cosme R, Chavez CR, Espinoza E, Remigio J, Garcia S, La Torre B, Alegre J, Mendoza L, Schubert J, Murrieta E, Palma H & Andrade AM. The distribution of cadmium in soil and cacao beans in Peru. The Alliance of Bioversity and CIAT, Lima, Peru. In preparation.

122. Guideline on mangrove restoration: lessons learned

Contact:

Rosa Maria Román-Cuesta; Claudia Teutli, Jorge Herrera, Diana Cisneros

CRP/Institution: CIFOR

CRP/Flagship (if relevant): 3

Website:

Short description of the tool:

This guideline leverage 10 years of successful mangrove restoration in Yucatán-Mexico, led by CINVESTAV-UNAM researchers. With more than 1,000 hectares successfully restored, this valuable tool navigates practitioners on the steps to follow, the variables to consider, and the indicators to monitor in order to guarantee a cost-effective restoration that leads to ecological, social and economic benefits. Examples of social and economic effectiveness of restoration are also included in this tool.

Category of tool:

Decision-making supporting tool:

Manual or guidelines

Main theme:

Forest landscape restoration

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Regional

Global

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Celestun, Sisal, Progreso, Dzilam Bravo, Rio Lagartos, Cancun, Puerto Morelos, Mahahual, Chetumal (Yucatan, Mexico)

References and further readings:

Herrera-Silveira JA, Teutli-Hernández C, Gómez Ruiz PA & Comí F. 2020. Restauración ecológica de manglares de México. Chapter 33 in: Rivera-Arriaga E, Azuz-Adeath I, Cervantes Rosas OD, Espinoza-Tenorio A, Silva Casarín R, Ortega-Rubio A, Botello AV & Vega-Serratos BE (eds.), 2020. Gobernanza y Manejo de las Costas y Mares ante la Incertidumbre. Una Guía para Tomadores de Decisiones. Universidad Autónoma de Campeche, Ricomar. 894 p. https://doi.org/10.26359/epomex.0120

Teutli-Hernández C, Herrera-Silveira JA, Cisneros-de la Cruz DJ & Román-Cuesta R. 2020. Mangrove ecological restoration guide: Lessons learned. Mainstreaming Wetlands into the Climate Agenda: A multi-level approach (SWAMP). CIFOR/CINVESTAV-IPN/UNAM-Sisal/PMC, 42p. https://www.cifor.org/publications/pdf_files/Books/2020-Guide-SWAMP.pdf (English and Spanish)

Zaldívar-Jiménez MA, Herrera-Silveira JA, Teutli-Hernández C, Comín FA, Andrade JL, Coronado Molina C & Pérez Ceballos R. 2010. Conceptual framework for mangrove restoration in the Yucatán Peninsula. Ecological Restoration 28(3), September 2010. https://doi.org/10.3368/er.28.3.333

Websites:

Jorge Herrera's website: https://www.mda.cinvestav.mx/Investigaci%C3%B3n/DepartamentodeRecursosdelMar/PersonalAcad%C3%A9mico/Investigadores/jherrera.aspx

Laboratory of Primary Productivity (Blue Carbon activities in Yucatan lead by CINVESTAV): https://www.facebook.com/312963992490646/posts/el-dr-jorge-herrera-silveira-nos-explica-el-panorama-del-carbono-azul-en-manglar/695543647566010/

Presentations:

https://marfund.org/en/wp-content/uploads/2019/11/Anexo-8-Restauracion-de-Manglares-Claudia-Teutli.pdf

123. Manual for the Measurement, Monitoring and Reporting of Carbon and Greenhouse Gases in Mangroves in Restoration

Contact:

Rosa Maria Roman-Cuesta; Claudia Teutli, Jorge Herrera, Diana Cisneros

CRP/Institution: CIFOR

CRP/Flagship (if relevant): 3

Website: https://www.cifor.org/knowledge/publication/8051 (Spanish only)

Short description of the tool:

This manual leverage 10 year of successful mangrove restoration in Yucatán-Mexico led by CINVESTAV-UNAM researchers. With more than 1,000 hectares successfully restored, this valuable tool navigates practitioners on the steps to follow to measure carbon in mangroves at an early successional restoration stage. It complements a CIFOR's previous manual on carbon measurements in mature mangroves (Kauffman and Donato, 2012) and adds a section on methods to estimate and report greenhouse gas emissions from the restored sites.

Category of tool:

Decision-making supporting tool:

Manual or guidelines

Main theme:

Forest landscape restoration

Main focus:

Biophysical and ecological aspects

Scale:

Landscape

Regional

Global

Stage of development:

Effective use on the ground (mature tool)

Example(s) of effective use:

Celestun, Sisal, Progreso, Dzilam Bravo, Rio Lagartos, Cancun, Puerto Morelos, Mahahual, Chetumal

References and further readings:

Kauffman JB & Donato DC. 2012 Protocols for the measurement, monitoring and reporting of structure, biomass and carbon stocks in mangrove forests. Working Paper 86. CIFOR, Bogor, Indonesia**.** https://www.cifor.org/publications/pdf_files/WPapers/WP86CIFOR.pdf

Websites:

Jorge Herrera's website: https://www.mda.cinvestav.mx/Investigaci%C3%B3n/DepartamentodeRecursosdelMar/PersonalAcad%C3%A9mico/Investigadores/jherrera.aspx

Laboratory of Primary Productivity (Blue Carbon activities in Yucatan lead by CINVESTAV): https://www.facebook.com/312963992490646/posts/el-dr-jorge-herrera-silveira-nos-explica-el-panorama-del-carbono-azul-en-manglar/695543647566010/

WORKING PAPER

DOI: 10.17528/cifor/008438

Forests and trees have a major role to play to advance the 2030 Agenda for sustainable development and address major global challenge such as: climate change, deforestation, forest and land degradation, biodiversity erosion, poverty and food insecurity. Over the last ten years, with the Bonn Challenge, the New York Declaration on Forests, the UN Decade on Ecosystem Restoration, and several regional initiatives, forest and landscape restoration has gained increased traction on the political agenda. Successful and sustainable land restoration implies to consider a wide range of interconnected variables and, thus, requires a broad, diverse and transdisciplinary knowledge, as well as a deep understanding of local socio-ecological contexts. Research and development institutions play a central role in generating the needed knowledge and sharing it with the relevant stakeholders. This is why FTA, the CGIAR research program on forests, trees and agroforestry prepared with its partners this compilation of existing restoration tools developed by CGIAR research programs (CRPs), CGIAR centers and partner organizations. This document aims to inform the different stakeholders involved in restoration at different scales (policy makers, forest managers and restoration practitioners, land owners, project managers, conservation organizations, students and researchers) and help them find the tools they need to achieve their specific objectives in a given context.

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

CGIAR RESEARCH PROGRAM ON Policies, Institutions, and Markets Led by IFPRI

CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems

The CGIAR Research Program on Forests, Trees and Agroforestry (FTA) is the world's largest research for development program to enhance the role of forests, trees and agroforestry in sustainable development and food security and to address climate change. CIFOR leads FTA in partnership with ICRAF, the Alliance of Bioversity International and CIAT, CATIE, CIRAD, INBAR and TBI.

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