Cross-sectoral planning decision-making platform to foster climate action

Rethink Action

D 4.5 | LAMS catalogue: design, development and deployment I. Explanatory Note

WP4 – Land use-based Adaptation and Mitigation Solutions (LAMS) catalogue

Version 1.1 | February 2025

H2020-LC-GD-2020-2: LC-GD-9-2-2020. Developing end-user products and services for all stakeholders and citizens supporting climate adaptation and mitigation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Disclaimer

Copyright Message

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Document History

Project Acronym	RethinkAction
Project Title	CRoss-sEcToral planning enHanced by a decisIoN-maKing platform to foster climate Action
Project coordination	CARTIF
Project duration	48 Months [October 2021 – September 2025]
Title	D4.5 - LAMS catalogue: design, development and deployment I
Dissemination Level	Public
Status	Final
Version	1.1
Work Package	WP4 – Land use-based Adaptation and Mitigation Solutions (LAMS) catalogue
Lead Beneficiary	CMCC
Other Beneficiaries	CARTIF
Other authors	INRAE, UNU-EHS, IVL, RINA-C, NOA, GEO, FC.ID
Author(s)	Claudia Dămătîrcă [CMCC], Chiara De Notaris [CMCC], Maria Vincenza Chiriacò [CMCC]

Date	Ver.	Contributers	Comment
12/12/2021	0.1	Iván Ramos Diez (CARTIF)	Template
12/06/2023	0.1	Claudia Dămătîrcă (CMCC), Chiara De Notaris (CMCC)	Table of Content
23/06/2023	0.1	Claudia Dămătîrcă (CMCC), Chiara De Notaris (CMCC)	First Draft
06/07/2023	0.2	Maria Vincenza Chiriacò (CMCC)	Internal review
18/07/2023	0.2	Sara Barilari (CARTIF), Noelia Ferreras Alonso (CARTIF), Gema Hernández Moral (CARTIF)	Internal review
18/07/2023	0.2	Suzie Durand (INRAE)	Internal review

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

19/07/2023	0.2	Océane Espin (CMCC), Chiara Trozzo (CMCC)	Internal review
04/10/2023	0.3	Claudia Dămătîrcă (CMCC), Océane Espin (CMCC), Chiara Trozzo (CMCC)	Final draft for quality review
06/10/2023	0.3	Robert Oakes (UNU-EHS), Sara Barilari (CARTIF)	Quality review
09/10/2023	0.3	Dániel Ganszky (GEO)	Quality review
13/10/2023	0.4	Claudia Dămătîrcă (CMCC), Maria Vincenza Chiriacò (CMCC)	Final consolidated version
13/10/2023	1.0	Iván Ramos (CARTIF)	Final review
14/02/2025	1.1	Encarnação Coelho (FC.ID), Bishwajit Roy (FC.ID), Robert Oakes (UNU-EHS), Kariuki Weru (UNU-EHS), Jane Ihrfors (IVL), Chiara De Notaris (CMCC)	Development of Annex II
17/02/2025	1.1	Chiara De Notaris (CMCC)	Implementation of changes after the second review meeting
19/02/2025	1.1	Iván Ramos (CARTIF)	Final version ready for submission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

List of Organizations

	Participant Name	Short Name	Country	Logo
1	Fundación CARTIF	CARTIF	Spain	
2	University of Valladolid	UVa	Spain	
3	IVL Swedish Environmental Research Institute	IVL	Sweden	
4	RINA Consulting	RINA-C	Italy	
5	Euro-Mediterranean Center of Climate Change	CMCC	Italy	
6	Climate Media Factory	CMF	Germany	
7	National Observatory of Athens	NOA	Greece	
8	GMV Aerospace and Defence SAU	GMV	Spain	
9	FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências	FC.ID	Portugal	
10	ICLEI - Local Governments for Sustainability e.V. (World Secretariat) 10 A | ICLEI European Secretariat GmbH	ICLEI	Germany	
11	United Nations University - Institute for Environment and Human Security	UNU-EHS	Japan	
12	Geonardo Environmental Technologies Ltd.	GEO	Hungary	
13	Institut National de la Recherche pour l'Agriculture, l'Alimentation et l'Environnement	INRAE	France	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Table of Content

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

List of Figures

List of Tables

Abbreviation and Acronyms

Acronym	Description
EU	European Union
IPCC	Intergovernmental Panel on Climate Change
IC	Impact Chain
KPI	Key Performance Indicator
LAMS	Land use-based Adaptation and Mitigation Solutions
LUCAS	Land Use and Coverage Area frame Survey
SDGs	Sustainable Development Goals
WP	Work Package

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Executive summary

Deliverable D4.5 “LAMS catalogue: design, development and deployment I” presents the outcomes of Task 4.4 “LAMS catalogue development, deployment and validation”.

The deliverable 4.5 consists of the first version of the Land use-based Adaptation and Mitigation Solutions (LAMS) catalogue that includes the parameters and variables identified and analyzed under T4.2 “LAMS catalogue requirements definition and specifications” and T4.3 “Analysis of synergies and trade-offs and definition of the KPI-driven evaluation framework of LAMS”, that are deemed to be relevant for the RethinkAction modelling activities and incorporated in the RethinkAction platform. The LAMS catalogue is submitted as an Excel tool (deliverable type: OTHER), while the present Explanatory Note is elaborated to describe the catalogue and the methodologies applied.

The aim of Task 4.4 is to develop, deploy and validate the LAMS catalogue. The first version of the catalogue includes 60 LAMS, consistent across scales (from EU/Global to national/local), that were analyzed in depth, including the identification of synergies and trade-offs and drivers and barriers. D4.5 will be subjected to continuous testing and improvements from its incorporation in activities from WP5 (Modelling framework and policy recommendations) and WP6 (Case studies- local evaluation), including feedback and comments from stakeholders about its usability and potential improvements. The definitive version of the catalogue will be submitted with D4.6 “LAMS catalogue: design, development and deployment II”, and incorporated in the LAMS visualization RethinkAction platform.

This project has received funding from the European Union’s Horizon 2020
research and innovation programme under grant agreement No 101037104.

1 Introduction

1.1 Purpose of the document

The **D4.5 "LAMS catalogue: design, development and deployment I"** is composed of the first version of the Land use-based Adaptation and Mitigation Solutions (LAMS) catalogue (Excel file), that was developed following the structure and requirements defined under Task 4.2 (LAMS catalogue structure and requirements), and an explanatory note (this document) that details the methodologies applied. Starting from the solutions identified and categorized in Tasks 4.1 (Review of Land use-based Adaptation and Mitigation Solutions) and Task 4.2 (LAMS catalogue structure and requirements), the catalogue includes a consolidated list of 62 LAMS. These solutions were analyzed, characterized and systematized under Task 4.3 (Analysis of synergies and trade-offs and definition of the KPI-driven evaluation framework of LAMS), including synergies, trade-offs, drivers and barriers. The LAMS included in the catalogue are relevant at different scales (from local to EU/Global) and across different policy sectors (*e.g.*, agriculture, biodiversity, forestry, buildings, energy, tourism, and more) and address both climate change adaptation and mitigation, as defined by the Intergovernmental Panel on Climate Change (IPCC). Adaptation is "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities", while mitigation is "a human intervention to reduce emissions or enhance the sinks of greenhouse gases".

The aim of the LAMS catalogue is to facilitate the consultation and use of the solutions by the End-Users Community (EUC), consortium members, modelers in WP5 (Modelling framework and policy recommendations) and WP6 (Case studies-local evaluation), and to be integrated in RethinkAction platform in WP7 (RethinkAction Platform: design, development and deployment).

The Excel-based LAMS catalogue consists of 10 sheets, which are detailed in Section 3 (Structure of the catalogue).

1.2 Structure of the document

The document is structured as follows:

- Section 1: introduces the document and explains its main purposes.
- Section 2: provides an overview of the methodology implemented for the LAMS simplification, characterization and analysis.
- Section 3: describes the framework of the catalogue and presents the requirements to align with modelling and platform activities.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

- Section 4: concluding remarks, next steps and links to other WPs.

Additionally, four annexes are provided to complement the information in the main sections, namely:

- Annex I: Simplified LAMS.
- Annex II: LAMS in the Impact Chains.
- Annex III: LAMS Taxonomy.
- Annex IV: Example of LAMS factsheet.

2 Methodology

Task 4.4 integrates the results of Task 4.1, Task 4.2 and Task 4.3, and it was led by CMCC with an active involvement of CARTIF and other RethinkAction project partners. The approach followed for the LAMS catalogue development consisted of the following steps:

1. LAMS simplification
2. LAMS characterization and analysis

The dialogue with the partners in charge of the modelling activities (WP5 and WP6) and platform development (WP7) was crucial for the alignment of the catalogue with their requirements.

2.1 LAMS simplification

Considering the literature data's limitations in providing quantitative and qualitative attribute allocations for each LAMS, a mitigation action was applied and the initiation of a grouping process for the LAMS was prompted. Starting from the initial list of 81 LAMS derived from the desk research conducted in Task 4.1, the input from project partners, and although limited, input from the local stakeholders, the solutions were consolidated with a simplification approach. The simplification took into account several aspects, including the level of detail at which reliable information can be found (e.g., for the adaptation and mitigation potential, the quantification of key parameters, etc.), the similarity of the solutions, the feasibility of simulating them in the model, and more. For example, the LAMS “Composting of agriculture waste and residues and use as fertilizer”, “Reduce tillage intensity: minimum tillage” and “Reduce tillage intensity: zero tillage” were grouped under the new simplified LAMS “Improved cropland management with retention of crop residues”. In addition, the LAMS that could not be modelled were removed from the list (e.g., Regeneration of existing urban areas (old cities and towns, including suburbs)).

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101037104.

From the starting list of 81 LAMS, the number of LAMS was reduced to 58. However, four new LAMS were included in the catalogue, following discussions that highlighted the need of their addition: "Land management of solar photovoltaic systems land", "Precision farming and artificial intelligence", "Freshwater ecosystems restoration and management" and "Coastal zones management". An overview of the former list of LAMS with the corresponding new simplified LAMS, and the LAMS that were added or rejected because of the impossibility of their simulation in the system dynamic model (WP5) is provided in Annex I.

From now on, we will refer to the list of 62 simplified LAMS as the new, definitive list of LAMS.

2.2 LAMS characterization and analysis

LAMS characterization and analysis includes the assessment of each LAMS based on a set of requirements and specifications, that started from general specifications (e.g., LAMS scope, application, actors involved, and more), and continued more-in-depth with the adaptation and mitigation potential, processes involved, the identification of LAMS suitability factors and more. The identification of requirements and specifications for LAMS characterization was conducted under Task 4.2 and the methodology applied is widely described in D4.2 (Requirements and specifications for designing the LAMS catalogue). The analysis of LAMS considering these requirements started under Task 4.2, but most of the activities were conducted under Task 4.3.

Aside from the LAMS characterization based on the requirements identified in Task 4.2, under Task 4.3 the following activities were also conducted:

- the analysis of synergies and trade-offs between LAMS
- the definition of a KPI evaluation framework
- the identification of drivers and barriers for LAMS implementation

The methodology for **synergies and trade-offs**, and **drivers and barriers** identification is extensively detailed in D4.3 (Report on the synergies and trade-offs between the solutions catalogue), while the definition of the **KPI panel** in D4.4 (List of KPIs to measure, analyze and compare solutions).

From the list of specifications and parameters identified in Task 4.2 for LAMS analysis, after active discussions with the other RethinkAction project partners (especially with the leaders of the modelling activities) it was decided that "**Baseline scenarios**" and "**Time needed before the benefits are obtained**" will not be determined as part of the holistic analysis, as they will represent an output of the model simulations, under development in WP5. The identification of "**Actors involved**", defined as having a necessary direct contribution for a successful LAMS implementation, and "**Institutional support**",

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

defined as necessary (in)direct support for the success of LAMS implementation, were determined starting from the factors identified in D2.2 (Review of lifestyle and structural behaviour change affecting land use), section 3.6 of this document, and expert judgement. The adaptation and mitigation potential were extracted from IPCC reports, and the adaptation effect of each LAMS was also addressed in terms of reduction of risks and possible opportunities. The references are listed in "source" columns in the catalogue.

Lastly, the methodology for the identification of LAMS suitability factors is detailed in D5.2 (Methods for impact assessment and land allocation considering LAMS deployment).

3 Structure of the catalogue

The LAMS catalogue will, on one side, represents the basis of the RethinkAction platform (under development in WP7), that will allow the consultation and getting key information about the LAMS included in the catalogue by end-users, while on the other side will form the basis for the modelling activities (WP5 and WP6). Therefore, the catalogue contains a brief and clear description of each LAMS, general specifications, as well as requirements that are strictly connected to the setup and functioning of the models, which are in the process of being defined.

As above mentioned, the Excel-based LAMS catalogue consists of ten sheets. The first "Introduction" sheet contains information about the partners involved in the development of the LAMS catalogue and the aim of the catalogue. The "LAMS list" sheet comprises the list of the 62 LAMS, accompanied by the LAMS source (*i.e.,* the policy document where the LAMS was identified), the LAMS definition, other relevant information, such as the benefits derived from the LAMS, and the sources used for the definitions and the relevant information. Further, to emphasize the importance of Nature-based Solutions (NbS), for each LAMS it is indicated whether it can be considered as one. Nature-based Solutions are defined by the European Commission as "solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions". The "General specifications" sheet includes the characterization and systematization of LAMS by:

- Type of solution (*i.e.,* land management, spatial planning, lifestyle/behavioural change);
- Primary policy sector (aligned with the ClimateADAPT categories, *e.g.*, agriculture, biodiversity, energy, forestry, transport, and more);

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

- Secondary policy sector, where relevant;
- Land cover (*e.g.*, cropland, grassland, other_land, forest_managed), needed for the implementation of the LAMS in "Within Limits Integrated Assessment Model" (WILIAM);
- Application (*i.e.,* supply and/or demand);
- Scope (*i.e.,* adaptation and/or mitigation);
- Scale (*i.e.,* Global or local) referred to scale of the model in which the LAMS will implemented (determined in collaboration with partners in charge of modelling activities);
- Actors involved, defined as direct contributors to the LAMS implementation (*e.g.*, policy makers, expert advisors, landowners, and more);
- Institutional support, defined as necessary (in)direct support for the success of LAMS implementation (*e.g.*, National and EU energy policymakers, NGOs, and more).

The "Suitability factors" sheet covers the geographical, regulatory, sustainability and techno-economic suitability factors or applicability conditions of the LAMS. More details can be found in D3.3 (Land use maps and suitability factors for the allocation of land uses) and D5.2 (Methods for impacts assessment and land allocation considering LAMS deployment). The "Processes and parameters" sheet consists of the description of parameters and processes involved for each LAMS, the variables need for model simulation, as well as the feasibility of modeling in the global and local scale models of each LAMS. The "Adaptation and mitigation" sheet includes the LAMS adaptation and mitigation potential and the respective confidence intervals, the potential global mitigation range and the cost of implementation (where possible), derived mainly from the IPCC reports. In addition, the risk addressed by the LAMS and the possible opportunities, with the source, are also included in the "Adaptation and mitigation" sheet. The drivers and barriers to the LAMS implementation are organized into six different categories (institutional, financial, economic, socio-cultural, organizational, technical) and are included in the "Drivers and barriers" sheet. The synergies and trade-offs between the different LAMS are covered in "Synergies and trade-offs" sheet. Following the results described in D4.3 (Report on the synergies and trade-offs between the solutions catalogue), under *Impacts,* "++" refers to a significant positive impact of the LAMS, "+" to slightly positive impact of the LAMS, "-" to slightly negative impact of the LAMS, "--" to a significant negative impact of the LAMS, while under *Resources*, "+" to a small amount of resources for the LAMS implementation, "++" to a moderate need of resource for the LAMS implementation and "+++" to a high need of resource the LAMS implementation (highlighting a high competition for resources between different LAMS). Empty cells refer to a neutral LAMS impact or negligible need of resources. The "KPIs and SDG" sheet consists of the identified list of Key Performance Indicators (KPI)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

and the associated Sustainable Development Goals (SDG). KPI definition, units and sources, as well as SDG target/indicator and sectors influencing the indicators are also included. The last "List of policy documents" sheet includes the acronyms and the complete name of the policy documents consulted at both EU/Global and local/nation scale for the LAMS identification, together with the year of implementation and document link.

3.1 Alignment with impact chains

Two representative Impact Chains (Deliverable 6.1 "Climate change impacts, risks and vulnerabilities in each case study") were used to ensure that the LAMS included in the catalogue are relevant for reducing the risks associated to climate hazards identified within the six RethinkAction case studies (Annex II). Impact chains describing the risk of reduced freshwater availability and the risk of climate change affecting energy production and demand were used for this exercise, due to their relevance across case studies. As described in Annex II, LAMS were associated with sensitivity and capacity factors based on their ability to reduce vulnerability, which is the risk component that can be most affected by LAMS. Both NbS and non-NbS LAMS were identified for this exercise and the important contribution of LAMS with a primary mitigation scope to the delivery of adaptation co-benefits was shown.

3.2 Alignment with modelling activities

The modelling activities will benefit from several variables and parameters included in the LAMS catalogue. However, based on the current level of development of the models in WP5 and WP6 the main requirement that the catalogue should have is a clear description of processes and parameters involved in each LAMS, detailed in the "Processes and parameters" sheet. For example, for the LAMS "Agroforestry: silvoarable (trees in croplands) and silvopastoral systems", the area converted into silvoarable/silvopastoral land, the relative density of woody/crop fractions and the effects related to climate change adaptation and mitigation of this LAMS have to be indicated. The quantification of the variables and parameters will be performed under other tasks related to the modelling activities.

In addition, as already emerged and mentioned in D4.2, it might not be possible to simulate all the LAMS. As the models are still under development (WP5 and WP6), it is not possible to have yet a clear indication of the definitive list of LAMS that will be simulated. This will be performed in a step-wise iterative process with the partners in charge of modeling activities, as the development of the model progresses. The LAMS catalogue will be refined and the updated version will be submitted with Deliverable 4.6 (LAMS catalogue: design, development and deployment II).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

3.3 Alignment with platform requirements

The alignment of the LAMS catalogue with WP7 requirements includes the development of LAMS taxonomy and the preparation of factsheets for each LAMS.

3.3.1 Taxonomy

The LAMS taxonomy represents the LAMS visualization path in the RethinkAction platform. As agreed with the partners involved in the platform development, the first level of discrimination will be based on the LAMS type of solution (*i.e.*, land management, spatial planning, lifestyle/behavioural change), the second is based on the primary policy sector, and lastly, where available, the third is based on the secondary policy sector. By following this specific path, the end-users will be able to select the most relevant LAMS for their needs. For example, by following the path "Land management -> Energy -> Agriculture" the end-users will be able to select between "Renewable energy (biogas) from agricultural residues" and "Renewable energy produced from annual/perennial energy crops" LAMS. An example of LAMS visualization path is provided in Figure 1. The LAMS taxonomy table is provided in Annex III.

Figure 1: Example of LAMS visualization path in the RethinkAction platform.

Once selected a specific LAMS, on the right-side panel of the visualization platform (as relatively visible in Figure 1) some general information about the LAMS will be available such as: the LAMS name, related SDGs, scope (*i.e.*, adaptation and/or mitigation), synergies and trade-offs with other LAMS, scale, a short description, and relevant keywords. In addition, the end-users will be able to download factsheets for the single LAMS that contain detailed information about the selected LAMS.

More information about the integration of the LAMS catalogue in the RethinkAction platform is available in D7.2 (Synthesis of the integration of databases for the RethinkAction data layer).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

3.3.2 Factsheets

The factsheets will be available for download for each single LAMS. All LAMS factsheets follow the same structure, approved by CARTIF and other project partners:

- Catalogue visualization path.
- LAMS name.
- Keywords.
- General description and characterization of the solution.
- Co-benefits and possible negative effects.
- Relevant KPI and association with specific SDGs.
- Drivers and barriers.
- Policy documents and relevance.
- References.

An example of factsheet for the "Agroforestry: silvoarable (trees in croplands) and silvopastoral systems" LAMS is provided in the Annex IV. The definitive and consolidated factsheets for each LAMS will be submitted with D4.6.

4 Conclusions

This report is an Explanatory Note accompanying **D4.5 LAMS catalogue: design, development and deployment I**. It describes the structure and the methodology used for the development of the LAMS catalogue, an excel-based tool that contains 62 land-used based adaptation and mitigation solutions that were comprehensively analyzed and characterized. The holistic analysis of LAMS started from general specifications (e.g., definition, policy sector, application, scope, etc.) and continued with the identification of suitability factors, adaptation and mitigation potential, identification of drivers and barriers and synergies and trade-offs, and more. The collected data was consolidated in the 10 sheets that constitute the LAMS catalogue, and will be needed for the simulations of LAMS in the global and local models and to be integrated in the RethinkAction platform.

The activities under WP4 will continue with the improvement and refinement of the LAMS catalogue, after continuous testing with the end-user community, partners in charge of modelling activities and RethinkAction platform development. The final version of the catalogue will be available in D4.6 "LAMS catalogue: design, development and deployment II". New LAMS could be added or removed from the catalogue, based on the modeling, platform, consortium members or EUC requirements. In addition,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

factsheets will be produced for each LAMS, to provide key information about the solutions included in the catalogue to the EUC, as they will be available for download on the RethinkAction platform. The implementation of the catalogue into a machine-readable file is also under consideration. This will be discussed more in the following months, and will be detailed in D4.6 or in the upcoming deliverables of WP7.

The LAMS catalogue represent the basis of modelling activities, both at global/EU and local scale (WP5 and WP6). Following the simulation and evaluations of the LAMS in the system dynamic models, policy recommendation will be provided at global/EU scale (WP5) and at local scale (WP6). The catalogue will also form the basis of the user-friendly visualization tool, developed in the context of the RethinkAction Project. The RethinkAction platform will allow the EUC to investigate the solutions included in the catalogue, and to access the data collected during the LAMS characterization and analysis, and therefore to have a complete overview about the solutions. These could help empowering on one hand decision-makers (policymakers, landowners, farmers, investors, consultancies, renewable energy companies, etc.) and on the other hand citizens (civil society, NGOs or other associations representing citizens), by improving their knowledge on climate services and adaptation and mitigation solutions and impacts.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Annexes

Annex I: Simplified LAMS

Table 1: List of simplified LAMS and the corresponding former LAMS.

Policy sector	Simplified LAMS	Former LAMS
Agriculture	1. Agroforestry: silvoarable (trees in croplands) and silvopastoral systems	1. Agroforestry: silvoarable (trees in croplands) and silvopastoral systems
Agriculture	2. Establishment (conversion to) of perennial cropping systems	2. Establishment (conversion to) of perennial cropping systems
Agriculture	3. Establishment (conversion to) of permanent grassland	3. Establishment (conversion to) of permanent grassland
Agriculture	4. Land lying fallow (or Set-aside)	4. Increase/decrease of land lying fallow (or Set-aside)
Agriculture	5. Improved cropland management with input of organic amendments	10. Conversion to organic farming
Agriculture	5. Improved cropland management with input of organic amendments	5. Biochar application to soil
Agriculture	6. Improved cropland management with retention of crop residues	15. Composting of agriculture waste and residues and use as fertilizer
Agriculture	6. Improved cropland management with retention of crop residues	6. Reduce tillage intensity: minimum tillage
Agriculture	6. Improved cropland management with retention of crop residues	7. Reduce tillage intensity: zero tillage
Agriculture	7. Crop rotation with leguminous crops	8. Crop rotation with leguminous crops
Agriculture	8. Cover crop	9. Cover crop
Agriculture	9. Improved grazing land management	11. Low intensity grass-based livestock system
Agriculture	10. Improved livestock management	12. Use of bred insects as feed
Agriculture	10. Improved livestock management	13. Increase the share of lipids as feed additives to reduce methane emissions
Agriculture	11. Improved cropland management with precision nutrient management	14. Optimized fertilizer application rate
Agriculture	12. Intercropping	16. Intercropping
Energy	13. Offshore wind and ocean renewable energy plants	17. Increase the production of offshore wind and ocean renewable energy
Energy	14. Spatial planning for the sustainable deployment of energy on land	18. Prioritize construction of photovoltaic plants in areas not suitable for other uses

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Policy sector	Simplified LAMS	Former LAMS
Energy	14. Spatial planning for the sustainable deployment of energy on land	C71. Spatial planning for the sustainable deployment of energy on land
Energy	15. Photovoltaic plants	19. Increase the installation of photovoltaic cells.
Energy	16. Wind power plants	20. Wind power plants
Energy	17. Hydroelectric power plants	21. Hydroelectric power plants
Energy	18. Renewable energy (biogas) from agricultural residues	22. Renewable energy (biogas) from agriculture waste and residues
Energy	18. Renewable energy (biogas) from agricultural residues	23. Renewable energy (biogas) from livestock manure
Energy	19. Renewable energy produced from forest biomass	24. Increase the share of renewable energy produced from forest biomass with sustainable harvesting
Energy	20. Renewable energy produced from annual/perennial energy crops	25. Renewable energy (Biofuels, bioliquids, biogas and biomass fuels) produced from annual/perennial energy crops AND/OR short rotation forestry
Energy	21. Agrovoltaic farms	26. Agrovoltaic: Solar-panel farms that provide biodiversity-friendly soil cover, and sustainable bioenergy
Biodiversity	22. Increased portion of forests included under protected areas	27. Increase the portion of forests included under protected areas OR Establishment of protected habitat patches or set aside areas in production forests
Forestry	23. Reforestation/afforestation	28. Reforestation/afforestation
Forestry	24. Protecting and promoting forest natural encroachment	29. Protect and promote forest natural encroachment
Forestry	25. Reduced deforestation	30. Reduce deforestation
Forestry	26. Establishment of firebreaks and fuel load management	31. Establishment of firebreaks and fuel load management
Forestry	27. Reduced forest harvesting (Moderate intensity cutting)	32. Reduce forest harvesting (Moderate intensity cutting)
Forestry	28. Increased forest harvesting	33. Increase forest harvesting for wood products
Forestry	28. Increased forest harvesting	34. Increase forest harvesting for woody biomass for energy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Policy sector	Simplified LAMS	Former LAMS
Buildings	29. Increased share of renewable energy used in buildings	35. Increase the share of renewable energy used in the buildings
Buildings	30. Reduced energy consumption in buildings	36. Reduction in energy consumption in buildings
Urban	31. Limiting urban sprawl	37. Limiting urban sprawl by redeveloping brownfields
Urban	31. Limiting urban sprawl	C77. Limiting urban sprawl by preserving Natural Resources
Urban	31. Limiting urban sprawl	C78. Limiting urban sprawl by promoting more compact ways of development (increase urban density)
Urban	32. Establishment and maintenance of green urban ecosystems	38. Establishment and maintenance of green urban ecosystems
Urban	32. Establishment and maintenance of green urban ecosystems	C76. Counteracting the urban heat island effect by improving the city green infrastructure (e.g. green roofs, trees and other vegetation in public spaces)
Urban	32. Establishment and maintenance of green urban ecosystems	R68. Educational garden plots
Water management	33. Water-use efficiency: improve agricultural irrigation efficiency	41. Water-use efficiency: improve agricultural irrigation efficiency
Water management	34. Water-use efficiency: improve industrial water use efficiency	42. Water-use efficiency: improve industrial water use efficiency
Water management	35. Water-use efficiency: improve domestic water use efficiency	43. Water-use efficiency: reduce per capita domestic water use
Water management	36. Increased use of treated waste water	44. Increase the share of reused treated waste water
Forestry	37. Use of deforestation-free products	45. Ensure use of deforestation-free products
Society (health, wellbeing, education)	38. Shift in people's diet	46. Shift in people's diet - Vegan
Society (health, wellbeing, education)	38. Shift in people's diet	47. Shift in people's diet - Vegetarian
Society (health, wellbeing, education)	38. Shift in people's diet	48. Shift in people's diet - less meat and dairy
Society (health, wellbeing, education)	39. Increased food consumption of local products	50. Increase the share of food consumption of local products
Society (health, wellbeing, education)	40. Increased organic food consumption	51. Increase the share of organic food consumption

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Policy sector	Simplified LAMS	Former LAMS
Society (health, wellbeing, education)	41. Reduced food loss and waste	52. Reduce the rate of food loss and waste
Biodiversity	42. Protecting and restoring wetlands/peatlands (e.g. rewetting)	54. Protecting and restoring wetlands/peatlands (e.g. rewetting)
Agriculture	43. Sustainable agricultural intensification	55. Sustainable agricultural intensification
Agriculture	44. Increase in cultivated area	56. Increase cultivated area
Transport	45. Increased use of electric vehicles	61. Increase the share of electric vehicles
Transport	46. Increased use of renewable energy sources in the transport sector	62. Increase the share of RES in the transport sector
Society (health, wellbeing, education)	47. Reusing and recycling of materials	63. Increase the share of reusing and recycling
Energy	48. Wind and solar repowering	C70. Wind and solar repowering
Energy	49. Floating solar photovoltaic panels in water bodies	C72. Floating solar photovoltaic panels in water bodies
Energy	50. Solar panels in rooftops/buildings	C73. Solar panels in rooftops/buildings
Energy	51. Fostering energy self-consumption	C74. Fostering energy self-consumption
Urban	52. Regulating the use of land in urban areas to provide convenient and efficient access to a diverse mix of land uses (Land use zoning)	C79. Regulating the use of land in urban areas to provide convenient and efficient access to a diverse mix of land uses (Land use zoning)
Financial	53. Reduced Property Tax on zero-emission buildings	C80. Promotion of zero-emission buildings by reducing the Property Tax
Financial	54. Reduced taxation (value-added tax, VAT) for the use of local, recycled and sustainable materials	C81. Promoting the use of local, recycled (circular economy), sustainable materials in the construction sector by reducing the value-added tax (VAT)
Water management	55. Water harvesting: collect and store rain water in reservoirs	R65. Water harvesting: collect and store rain water in reservoirs
Water management	56. Protection of "maximum infiltration zones"	R66. Protect "maximum infiltration zones"
Energy	57. Improved energy storage capacity	R67. Improve energy storage
Tourism	58. Tourist awareness campaigns for land protection, waste reduction and energy consumption	R69. Tourist awareness campaigns for land protection, waste reduction and energy consumption

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Policy sector	Simplified LAMS	Former LAMS
Energy	59. Land management of solar photovoltaic systems land	Added based on expert judgment
Agriculture	60. Artificial Intelligence and Precision Farming	Added based on expert judgment
Water management	61 Freshwater ecosystems restoration and management	Added based on expert judgment
Coastal areas	62 Coastal zones management	Added based on expert judgment
Business and industry	DELETED	39. Use of recycled cotton or other fibres instead of virgin cotton in the textile sector
Business and industry	DELETED	40. Use of organic virgin cotton instead of synthetic fibres in the textile sector
Society (health, wellbeing, education)	DELETED	49. Shift in people's diet - Include products from sustainable acquaculture
Business and industry	DELETED	53. Increase the use of wood products in architecture in substitution of cement and other fossil fuel-based materials
Business and industry	DELETED	57. Increase the share of agro-based bioplastic from 1st generation feedstock instead of fossil-based plastic
Business and industry	DELETED	58. Increase the share of bioplastic from agricultural residues of cellulose instead of fossil-based plastic
Business and industry	DELETED	59. Bio-based materials from agricultural residues
Business and industry	DELETED	60. Bio-based materials from ocean farming of aquatic biomass (algae and other marine resources)
Coastal areas	DELETED	64. Change/point out areas possible for aquaculture
Urban	DELETED	C75. Regeneration of existing urban areas (old cities and towns, including suburbs)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Annex II: LAMS in the Impact Chains

Definitions and approach

How to identify LAMS relevant to address climate risks based on impact chains

The local analysis conducted within Taks 6.1 "Analysis of climate change impacts, risks and vulnerabilities at local scale" deals with climate risks and its components in terms of hazard, exposure, and vulnerability (adaptive capacity and sensitivity). For each case study, Deliverable 6.1 "Climate change impacts, risks and vulnerabilities in each case study" presents Impact Chains (ICs) for the most relevant/vulnerable sectors, which were developed following the methodology described by Hagenlocher et al. (2018). According to their guidebook, "ICs not only provide an understanding of the key components and underlying factors contributing to potential climate impacts and risks, but also support the brainstorming on potential adaptation options or 'packages'. The vulnerability factors can serve as starting points for such a brainstorming exercise. If the IC, for example, shows a sequence of causes and effects, leading from deforestation to reduced erosion prevention (loss of a regulating service) and increased flooding in downstream areas, then it is evident that afforestation or reforestation programmes can be suitable adaptation measures for tackling the flooding problem".

The IPCC defines adaptation as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities". Thus, **adaptation actions** cannot reduce the occurrence of hazards directly but can **moderate harm by increasing the adaptive capacity and reducing sensitivity** of the system, or by reducing its exposure.

Nature-based solutions (NbS) is an umbrella concept currently in focus that promotes nature and provides ecological and socioeconomic benefits. In the revised LAMS catalogue it has been indicated whether a LAMS can be considered as one. Nature-based Solutions are defined by the European Commission as "solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions".

Two representative ICs selected by case study leaders were used to verify the coherence between LAMS and the main risks identified by RethinkAction case studies. To do so, LAMS from the catalogue were included in the ICs in correspondence to sensitivity, capacity, and exposure items. To emphasize the importance of NbS, different colors were used to distinguish them from "conventional" LAMS (i.e., not NbS).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Overall outcome

Impact chains describing the risk of reduced freshwater availability (IC11 - Gotland) and the risk of climate change affecting energy production and demand (IC63 - Azores) were used for this exercise, due to their relevance across case studies. The selected ICs address several natural hazards related to climate change, including sea level rise, intensity and frequency of extreme precipitation, temperature extremes and storms (Fig. 2 and 3). Although adaptation to climate change cannot reduce the occurrence of hazards, it can moderate harm by reducing vulnerability. Thus, LAMS were associated with sensitivity and capacity factors based on their ability to reduce vulnerability. As described in section 2.2 "LAMS characterization and analysis", each LAMS was characterized in terms of reduction of risks and possible opportunities. Further, the "LAMS list" sheet of the catalogue contains information on the benefits derived from the LAMS, including adaptation co-benefits for LAMS with a primary mitigation scope. Sensitivity and capacity factors were associated with 15 LAMS both in IC11 and IC63, showing the important contribution of LAMS with a primary mitigation scope to the delivery of adaptation co-benefits.

Inclusion of LAMS in the Impact Chains

IC11 Risk of reduced fresh water availability in Gotland

The IC evaluating water scarcity was chosen because it was central to all the other ICs that were created for Gotland. Availability of water resources is central for human well-being, both in households as well as in several sectors such as agriculture and business and industry. The IC (Figure 2) was created specifically for Gotland but is applicable to other contexts, as it addresses a widespread climate change associated risk. The LAMS included in the IC are described below.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

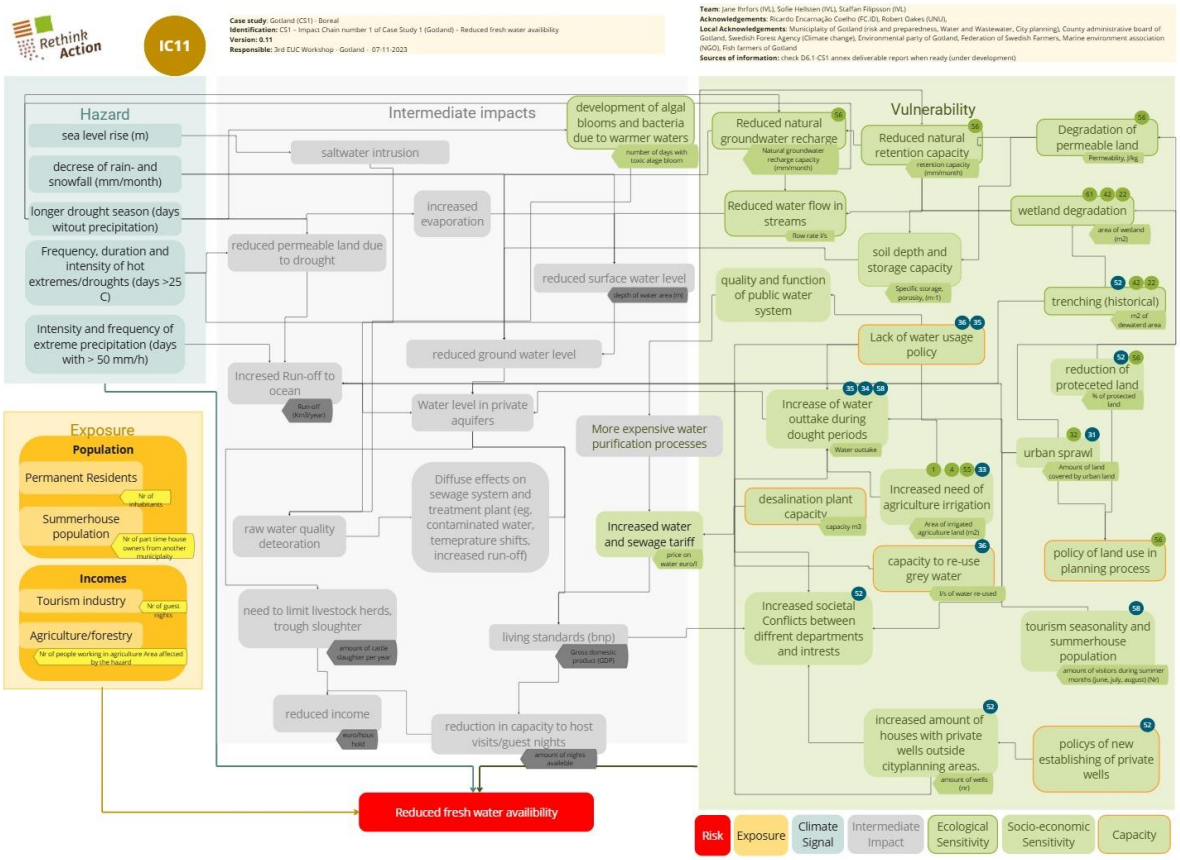

Figure 2. IC11| Risk of reduced fresh water availability (Water management sector, Gotland – CS1). Green dots are Nature-based LAMS and blue dots are conventional LAMS that can reduce this risk. LAMS numbers refer to LAMS ID in the catalogue.

LAMS 1 - Agroforestry: silvoarable (trees in croplands) and silvopastoral systems

General specifications: Nature-based Solution, supply side, adaptation scope with mitigation co-benefits

Definition: Land management system that combines woody biomass (e.g. trees or shrubs) with crops and/or livestock. It is obtained either by planting trees on agricultural land or by cropping (for example after thinning) on forested land. Plots that combine arable intercrops with forestry trees are silvoarable plots, while wooded plots with pasture under the tree canopy are known as silvopastoral plots.

Benefits: Agroforestry can substantially reduce erosion and nutrient leaching, increase carbon sequestration in soils and biomass, improve water and nutrient use efficiency and create favourable micro-climate for crop production. Agroforestry systems can also contribute to improving food productivity while enhancing biodiversity conservation, ecological balance and restoration under changing climate conditions.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
  - increased need of agriculture irrigation.

LAMS 4 - Land lying fallow (or Set-aside)

General specifications: Nature-based Solution, supply side, adaptation scope with mitigation co-benefits

Definition: Establishment and maintenance of permanent grassland (herbaceous fodder, forage or energy crops) for five or more years, through cultivation (sown) or naturally (self-seeded).

Benefits: In addition to the provision of feed, permanent grasslands sustain a broad range of additional ecosystem services, including climate regulation through carbon sequestration, cultural values, protection against erosion and flooding, and pollination of food crops.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
  - Increased need of agriculture irrigation.

LAMS 22 - Increased portion of forests included under protected areas

General specifications: Nature-based Solution, supply side, adaptation scope with mitigation co-benefits

Definition: Increase of forested areas dedicated and managed to achieve the long-term conservation of nature with associated ecosystem services and cultural values. E.g. promotion of forest management practices that reduce harvested timberland from production.

Benefits: Conversion of exploitable forests to protected areas, maintaining primary and old-growth forests offers many co-benefits in terms of climate change mitigation, adaptation, biodiversity conservation, microclimatic regulation, soil erosion protection, and water and flood regulation.

Risk components addressed:

- Vulnerability, ecological sensitivity:
  - Trenching (historical).
  - Wetland degradation.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS 32 - Establishment and maintenance of green urban ecosystems

General specifications: Nature-based Solution, supply side, adaptation scope

Definition: Green urban ecosystems include trees, green roofs, gardens, parks and urban forests. Urban vegetation can help reduce urban heat island effects by shading building surfaces, deflecting radiation from the sun, and releasing moisture into the atmosphere, as well as provide physiological, social, economic, and aesthetic benefits.

Benefits: Green urban ecosystems can mitigate climate change directly through sequestering and storing carbon, and indirectly by inducing a cooling effect thus reducing energy demand and energy use for water treatment. Co-benefits of green urban ecosystems include: reduced urban heat island effect and heat stress, reduced storm water runoff, improving air quality and mental/physical health of citizens.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Urban Sprawl.

LAMS 33 - Water-use efficiency: improve agricultural irrigation efficiency

General specifications: supply side, adaptation scope

Definition: Measures to increase water use efficiency in agricultural fields (e.g. better management of crop water demand, switching to less water intensive crops, changing planting dates, optimized irrigation schedules).

Benefits: Improved agricultural irrigation efficiency can reduce aquifer and surface water depletion, and prevent over-extraction, and the management of climate risks. Many technical innovations, e.g. precision water management, can have benefits for both adaptation and mitigation, although trade-offs are possible. Maintaining the same level of yield through use of site-specific water management-based approach could have benefits for both food security and mitigation.

Risk components addressed:

- Vulnerability, ecological sensitivity:
    - Increase of water outtake during drought periods

LAMS 34 - Water-use efficiency: improve industrial water use efficiency

General specifications: supply side, adaptation scope

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Definition: Measures to increase water use efficiency in industries (e.g. reducing lossess and improving flows, encouraging the circular economy, water recycling, and the reduction and recovery at source of pollutants).

Benefits: Improved water use efficiency can reduce energy requirements for water treatment, thus minimizing carbon footprint and costs, reduce pressures on freshwater ecosystems, reduce polluted wastewater discharge into local freshwater ecosystems.

Risk components addressed:

- Vulnerability, ecological sensitivity:
    - Increase of water outtake during dought periods

LAMS 35 - Water-use efficiency: improve domestic water use efficiency

General specifications: supply side, adaptation scope

Definition: Measures to increase water use efficiency in households (e.g. reducing lossess and improving flows, save drinking water and reduce peak consumption in order to limit infrastructure growth, reduce micro-leaks in private networks, store and reuse rainwater for individual or collective gardens).

Benefits: Improved water use efficiency can reduce energy requirements for water treatment, thus minimizing carbon footprint and costs, reduce pressures on freshwater ecosystems, reduce polluted wastewater discharge into local freshwater ecosystems.

Risk components addressed:

- Vulnerability, ecological sensitivity:
    - Increase of water outtake during drought periods.
- Capacity:
    - Lack of water usage policy.

LAMS 36 - Increased use of treated waste water

General specifications: supply side, adaptation scope

Definition: Measures to increase the use of reclaimed water, defined as urban waste water that has been treated in compliance with the requirements set out in Directive 91/271/EEC and which results from further treatment in a reclamation plant.

Benefits: Wastewater treatment enables sustainable resource management by improving the supply of clean water, and minimizing pressure on natural resources, energy recovery, and agricultural support.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Wastewater treatment provides one of the most sustainable approaches to water conservation, energy production, and agricultural productivity.

Risk components addressed:

- Vulnerability, ecological sensitivity:
    - Increase of water outtake during drought periods.
- Capacity:
    - Capacity to re-use grey water.
    - Lack of water usage policy.

LAMS 42 - Protecting and restoring wetlands/peatlands (e.g. rewetting)

General specifications: Nature-based Solution, supply side, adaptation scope with mitigation co-benefits

Definition: Restoring degraded/damaged wetlands and peatlands and protecting existing ones.

Benefits: Protecting and restoring wetlands/peatlands can lead to an increase carbon sinks, avoid and reduce greenhouse gases emissions, and can provide benefits by regulating water flow and preventing downstream flooding.

Risk components addressed:

- Vulnerability, ecological sensitivity:
    - Trenching (historical).
    - Wetland degradation.

LAMS 52 - Regulating the use of land in urban areas to provide convenient and efficient access to a diverse mix of land uses (Land use zoning)

General specifications: supply and demand side, mitigation scope

Definition: Mixed-use development combining residential areas with places of employment and commerce instead of isolating individual areas, allowing for more pedestrians and public transit as opposed to traffic and pollution. Urban planning (Land use zoning) can promote it by regulating the use of land in urban areas.

Benefits: Protection of natural capital by preventing/limiting vegetation clearing, avoids land degradation and rehabilitation of degraded land/contaminated sites, promotes conservation and enhancement of ecosystems and ecological corridors, encourages higher density development, local food production, transportation alternatives, preserves a sense of place, increased housing diversity and

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

affordability, protects biodiversity, maintains intact natural landscapes, restores ecological connectivity, identifies and manages areas for future climate space for species expected to be displaced by climate change, and identify and protect climate refugia.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
  - Increased societal Conflicts between different departments and interests.
  - Increased number of houses with private wells outside city planning areas.
  - Policies of new establishing of private wells.
- Vulnerability, ecological sensitivity:
  - Trenching (historical).
  - Reduction of protected land.

LAMS 55 - Water harvesting: collect and store rain water in reservoirs

General specifications: Nature-based Solution, supply side, adaptation scope

Definition: Building of water storage reservoirs for agricultural and other purposes, as a part of Natural Water Retention Measures.

Benefits: Natural Water Retention Measures: multi-functional measures that aim to protect and manage water resources using natural means and processes, e.g., building up Green Infrastructure, restoring ecosystems and changing land use. Rainwater storage reservoirs provide multiple benefits, including flood risk reduction, water quality improvement, groundwater recharge and habitat improvement.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
  - Increased need of agriculture irrigation.
- Intermediate impact:
  - Reduced surface water level.

LAMS 56 - Protection of "maximum infiltration zones"

General specifications: Nature-based Solution, supply side, adaptation scope

Definition: The areas of maximum infiltration present the most favourable conditions to recharge aquifer systems.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Benefits: Maximum infiltration zones are important locations of potential areas of groundwater recharge, contributing to decrease the unorganised runoff and erosive processes, to increase freshwater reserves supplies and water availability and to maintain the balance of the landscape geomorphological dynamics.

Risk components addressed:

- Vulnerability, ecological sensitivity:
    - Reduction of protected land.
    - Degradation of permeable land.
    - Reduced natural retention capacity.
    - Reduced natural groundwater recharge.
- Capacity:
    - Policy of land use in planning process.

LAMS 58 - Tourist awareness campaigns for land protection, waste reduction and energy consumption

General specifications: demand side, adaptation scope with mitigation co-benefits.

Definition: Information campaigns to promote sustainable tourism.

Benefits: Tools and strategies such as awards, eco-labels and certification schemes, communication, awareness and educational campaigns can be designed to steer tourists' behavior towards responsible tourism, to improve resource consumption, waste management and transport optimization.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Increase of water outtake during drought periods.
    - Tourism seasonality and summerhouse population.

LAMS 61 - Freshwater ecosystems restoration and management

General specifications: Nature-based Solution, supply side, adaptation scope.

Definition: The restoration and management of freshwater ecosystems should include efforts to restore the natural longitudinal and lateral connectivity of rivers as well as their riparian areas and floodplains, including through the removal of barriers with a view to supporting the achievement of favorable conservation status for rivers, lakes and alluvial habitats and species living in those habitats.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Benefits: Freshwater ecosystems management and restoration through Nature-based Solutions can deliver multiple benefits in terms of hydro-meteorological risks reduction (e.g., riverine flood) and biodiversity. These include microclimate creation, flood and drought mitigation, as well as improved local water quality.

Risk components addressed:

- Vulnerability, ecological sensitivity:
    - Wetland degradation.

LAMS 62 - Coastal zones management

General specifications: Nature-based Solution, supply side, adaptation

Definition: Establishment and implementation of maritime spatial plans and integrated coastal management strategies, including Nature-based Solutions to address aspects related to climate change (e.g. risks, adaptation needs) and environmental issues (e.g. reduce pollution and waste disposal in marine waters), as to conserve marine ecosystems.

Benefits: Coastal zone management can help protect and restore coastal ecosystems and reduce risks derived from natural hazards such as coastal erosion and coastal flooding.

Risk components addressed:

- Intermediate impact:
    - Saltwater intrusion.

IC63 Risk of climate change affecting energy production and demand in Azores

This impact chain was chosen because it represents aspects related to urban areas with broad applicability and transferability of the solutions identified. The IC (Figure 3) showcases the challenges associated with the ongoing energy transition but in specific in the Azorean archipelago. In short, from the production side, the inclusion of non-dispatchable renewable energy sources can create instabilities that the current fossil fuel-based energy system needs to deal with. This is linked with the intermittency of some energy sources like wind and solar. Geothermal energy sits at a mid-point due to reliability concerns. All energy sources are affected by temperature, but the demand side is also affected. The consumption behaviour and the fact that housing has a general low efficiency can contribute to peak demand events that can further destabilize the energy system. The LAMS included in the IC are described below.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

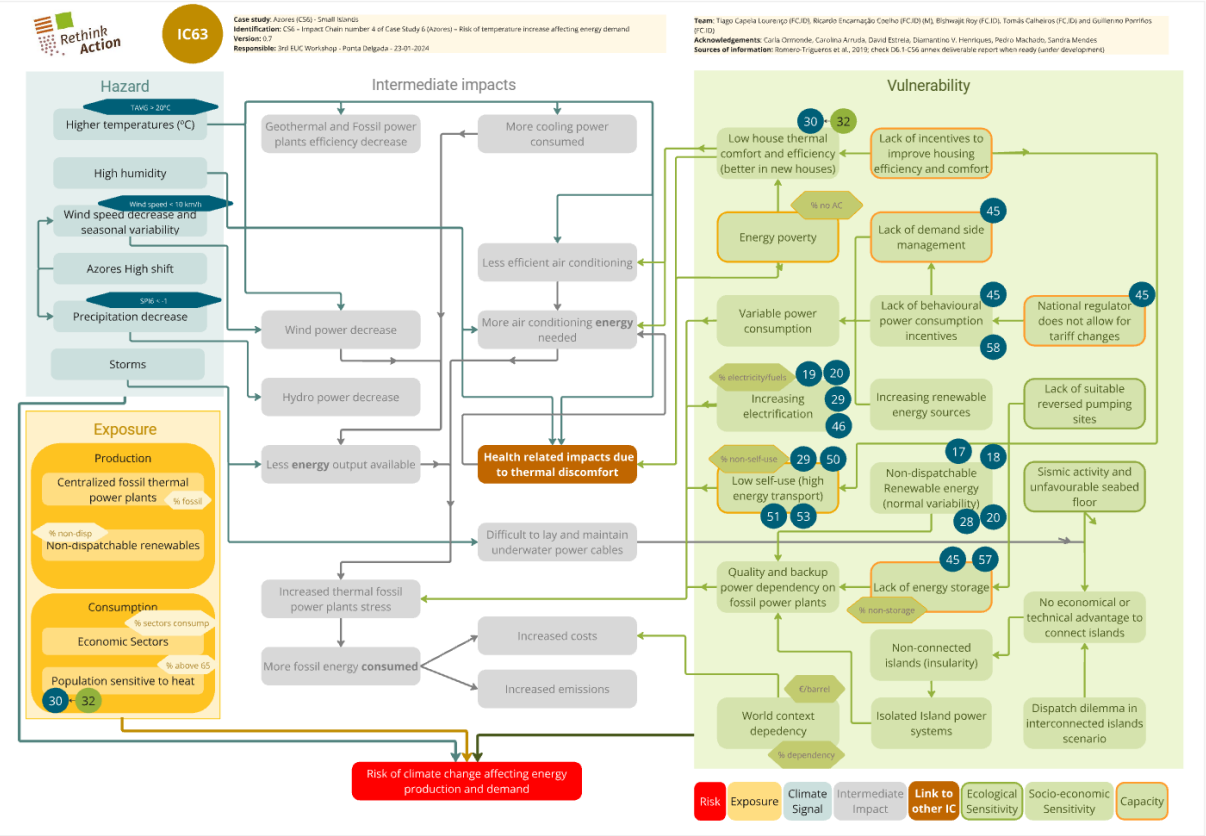

Figure 3. IC63| Risk of climate change affecting energy production and demand (Energy sector, Azores - CS6). Green dots are Nature-based LAMS and blue dots are conventional LAMS that can reduce this risk. LAMS numbers refer to LAMS ID in the catalogue.

LAMS 17 - Hydroelectric power plants

General specifications: Conventional, production-side, mitigation scope with adaptation co-benefits

Definition: Generation of electricity from the hydraulic energy of a river, either natural or artificial

Benefits: Hydroelectric power plants are the most mature renewable energy sources out of all. It can provide power at a cheaper rate while having the highest power generating capacity. However, its impact on nature far outweighs the advantages it offers.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Non-dispatchable Renewable energy (normal variability).

Effect on Impact Chain: Hydroelectric dams have essentially two types of working water basis: impoundment, which are dispatchable in good hydrological years, and off-the-river which depend more on the short-term precipitation. In the Azores the off-the-river type is prevalent and based in smaller

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

water lines called "Ribeiras". They are affected by precipitation but still retain relevant characteristics of impoundment dams due to the presence of lagoon systems. These feeds the water lines making the dams more dispatchable, which contribute to adapting to this risk. An energy source is dispatchable when the electrical grid can dispatch the production at will. This does not happen with solar PV and wind which can have a variable and unpredictable output. Dispatchability helps to stabilize the grid thus reducing the risk of the climate affecting the energy system. In dry years the availability of this energy source is limited but still in way which is predictable enough to control energy production and dispatch energy sources.

LAMS 18 - Renewable energy (biogas) from agricultural residues

General specifications: Conventional, both demand- and production-side, mitigation scope with adaptation co-benefits.

Definition: Anaerobic digestion of liquid or solid residues (e.g., livestock manure, straw, harvest residues, green manure, cover crops) for the production of biogas. Nutrient rich digestate can be used as fertilizer.

Benefits: Anaerobic digestion is versatile and flexible. It can use different agricultural residues as input substrate at the same time or isolated. The produced biogas can be used to generate electricity, heat, combined heat and power (CHP), cold (CCHP), or upgraded into biomethane. The output digestate can have different uses, namely as a biofertilizer, allowing for a closed loop of nutrient restoration in soil and consequently, maintaining feedstock productivity sustainably.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Non-dispatchable Renewable energy (normal variability).

LAMS 19 - Renewable energy produced from forest biomass

General specifications: Conventional, demand-side, mitigation scope with adaptation co-benefits

Definition: Measures carried out considering maintenance of soil quality and biodiversity with the aim of minimizing negative impacts, that increase share of renewable energy produced from forest biomass, i.e. all kind and type of organic materials derived from forest and woodlands.

Benefits: Renewable energy production from forest biomass could reduce carbon dioxide (CO_2) emissions compared to the conventional energy production systems. However, forest biomass has a low energy conversion rate and soot emissions and residues. In addition, lack of continuous access to biomass is a severe concern in the long-term sustainability of direct renewable energy production from forest biomass.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Increasing electrification.

LAMS 20 - Renewable energy produced from annual/perennial energy crops

General specifications: Conventional, both demand- and production-side, mitigation scope with adaptation co-benefits.

Definition: Energy produced from crop biomass produced on agricultural land as a main crop (i.e. energy crops) and short rotation forest plantations (excludes forests planted for protection or ecosystem restoration).

Benefits: Planting bioenergy crops, like perennial grasses, on degraded land can increase soil carbon and ecosystem quality (including biodiversity), thereby helping to preserve soil quality, reverse land degradation, prevent desertification processes, and reduce food insecurity. However, large-scale production of bioenergy crops can require significant amounts of land, increasing potential pressures for land conversion and land degradation.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Non-dispatchable Renewable energy (normal variability).
    - Increasing electrification.

LAMS 28 - Increased forest harvesting

General specifications: Conventional, production-side, mitigation scope with adaptation co-benefits

Definition: Increase harvesting of EU forests to produce wood (i.e. utilized as a material) and biomass for energy production.

Benefits: Harvesting should be carried out considering the maintenance of soil quality and biodiversity, while minimizing negative impacts. It should avoid stump and root cutting, degradation of primary forests or their conversion to plantation forests, and logging on vulnerable land. Minimizing large-scale clearing and ensuring locally appropriate thresholds for deadwood extraction and the requirement to use clear-cutting systems to reduce impacts on soil quality, including soil compaction, and features and habitats of biodiversity.

Risk components addressed:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

- Vulnerability, Socioeconomic sensitivity:
    - Non-dispatchable Renewable energy (normal variability).

LAMS 29 - Increased share of renewable energy used in buildings

General specifications: Conventional, demand-side, mitigation scope with adaptation co-benefits

Definition: Solutions that allow to increase the share of renewable energy used in buildings (e.g. installation of solar panels). (24)

Benefits: Renewable energy is generated from non-fossil sources, namely wind, solar (both solar thermal and solar photovoltaic) and geothermal energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Low self-use (high energy transport).
    - Increasing electrification.

LAMS 30 - Reduced energy consumption in buildings

General specifications: Conventional, demand-side, mitigation scope with adaptation co-benefits

Definition: Solutions that allow a reduction in energy consumption (e.g. increasing the energy efficiency of the building).

Benefits: Minimizing energy consumption in buildings can lead to greenhouse gas emissions mitigation, provide adaptive capacity and resilience to the building stock, reduce costs for maintaining comfort, minimize the vulnerability of occupants to extreme weather conditions, and reduce risks of disruption to energy supply and address fuel poverty.

Risk components addressed:

- Exposure
    - Population sensitive to heat.
- Vulnerability, Socioeconomic sensitivity:
    - Low house thermal comfort and efficiency (better in new houses).

LAMS 32 - Establishment and maintenance of green urban ecosystems

General specifications: Nature-based Solution, demand-side, adaptation scope with mitigation co-benefits

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Definition: Green urban ecosystems include trees, green roofs, gardens, parks and urban forests. Urban vegetation can help reduce urban heat island effects by shading building surfaces, deflecting radiation from the sun, and releasing moisture into the atmosphere, as well as provide physiological, social, economic, and aesthetic benefits.

Benefits: Green urban ecosystems can mitigate climate change directly through sequestering and storing carbon, and indirectly by inducing a cooling effect thus reducing energy demand and energy use for water treatment. Co-benefits of green urban ecosystems include reduced urban heat island effect and heat stress, reduced storm water runoff, improving air quality and mental/physical health of citizens.

Risk components addressed:

- Exposure
    - Population sensitive to heat.
- Vulnerability, Socioeconomic sensitivity:
    - Low house thermal comfort and efficiency (better in new houses).

LAMS 45 - Increased use of electric vehicles

General specifications: Conventional, demand-side, mitigation scope with adaptation co-benefits

Definition: Incentivize the use of fully electric vehicles, i.e. drawing their energy solely from an electric battery or another energy storage or supply device.

Benefits: Switching to electric vehicles has the potential to reduce carbon dioxide (CO2) emissions, increase air-quality and public health.

Risk components addressed:

- Vulnerability, Adaptive capacity:
    - Lack of energy storage.
    - Lack of demand side management.
    - National regulator does not allow for tariff changes.
- Vulnerability, Socioeconomic sensitivity:
    - Lack of behavioral power consumption incentives.

LAMS 46 - Increased use of renewable energy sources in the transport sector

General specifications: Conventional, demand-side, mitigation scope with adaptation co-benefits.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Definition: Solutions to increase the share of renewable fuels derived from biomass or of non-biological origin.

Benefits: Increased use of renewable energy sources in the transport sector reduces the emissions of both greenhouse gases and local pollutants. The most important biofuels today are bioethanol (made from sugar and cereal crops) used to replace petrol, and biodiesel (made mainly from vegetable oils) used to replace diesel. Bioliquids are liquid fuels made from biomass to produce electricity, heating or cooling. However, the production of biofuels can cause indirect land use change, and there is a limit to how much can derive from feedstock with high risk of indirect land use change.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Increasing electrification.

LAMS 50 - Solar panels in rooftops/buildings

General specifications: Conventional, demand-side, mitigation scope with adaptation co-benefits

Definition: Generation of electricity from solar energy by installing photovoltaic panels on rooftops, to meet land-competing food-energy demands in the urban context.

Benefits: Installing photovoltaic (PV) panels on rooftops it would lead to less consumption of land. The installation of PV panels can generate power and change the role of buildings from energy consumers to prosumers. In the meantime, such distributed power generation could enhance the energy security and increase public awareness of climate change. A synergetic integration of rooftop agriculture and PV offers a solution to couple land-competing food energy with other ecosystem services (e.g. carbon and water recycling) into urban landscape decision-making by optimizing multi-functional land-use.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Low self-use (high energy transport).

LAMS 51 - Fostering energy self-consumption

General specifications: Conventional, demand-side, mitigation scope with adaptation co-benefits

Definition: Consuming one's own electricity through renewable energy facilities (solar-powered, wind, geothermal or biomass). The owner of the facilities can then choose whether or not to connect them to the national grid.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Benefits: There are many benefits from using self-generated energy, including less needs of energy infrastructure to transport electricity, shift from energy consumer to producer, cheaper energy bills, energy autonomy and reduced carbon emissions.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Low self-use (high energy transport).

LAMS 53 - Reduced Property Tax on zero-emission buildings

General specifications: Conventional, demand-side, mitigation scope with adaptation co-benefits

Definition: A zero-emission building is defined as a building with a very high energy performance. The very low amount of energy still required should be fully covered by energy from renewable sources and without on-site carbon emissions from fossil fuels.

Benefits: Zero-emission buildings increase energy efficiency, energy savings and reduce greenhouse gas emissions.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Low self-use (high energy transport).

LAMS 57 - Improved energy storage capacity

General specifications: Conventional, production-side, mitigation scope with adaptation co-benefits

Definition: Improved energy storage capacity technologies (e.g. reversed pumping, batteries).

Benefits: Long-duration energy storage can significantly enhance the utilization of renewable energy sources and reduce the need for firm low-carbon generation.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Lack of energy storage.

LAMS 58 - Tourist awareness campaigns for land protection, waste reduction and energy consumption

General specifications: Conventional, demand-side, mitigation scope with adaptation co-benefits

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Definition: Information campaigns to promote sustainable tourism.

Benefits: Tools and strategies such as awards, eco-labels and certification schemes, communication, awareness and educational campaigns can be designed to steer tourists' behaviour towards responsible tourism, to improve resource consumption, waste management and transport optimization.

Risk components addressed:

- Vulnerability, Socioeconomic sensitivity:
    - Lack of behavioral power consumption incentives.

References

Chiriacò, M. V., Dămătîrcă, C., Abd Alla, S., Barilari, S., Biancardi Aleu, R., Brazzini, T., Capela Lourenço, T., de Carolis Villars, C. A., Durand, S., di Lallo, G., Encarnação Coelho, R., Espin, O., Ferreras-Alonso, N., Galluccio, G., Ganszky, D., Hellsten, S., Hernández-Moral, G., Ihrfors, J., Keramitsoglou, I., … De Notaris, C., 2025. A catalogue of land-based adaptation and mitigation solutions to tackle climate change. Scientific Data, 12(1), 166. https://doi.org/10.1038/s41597-025-04484-0

Hagenlocher, M., Schneiderbauer, S., Sebesvari, Z., Bertram, M., Renner, K., Renaud, F., Wiley, H. and Zebisch, M., 2018. Climate Risk Assessment for Ecosystem-based Adaptation–A guidebook for planners and practitioners. https://www.adaptationcommunity.net/wp-content/uploads/2018/06/giz-eurac-unu-2018-en-guidebook-climate-risk-asessment-eba.pdf

RethinkAction Consortium, 2023. D3.3 - Land use maps and suitability factors for the allocation of land uses / WP - Data processing for climate and land use modelling.

Saretto, F., 2024. Assessment of Climate Change Impact on Rainfed Barley Production in the Mediterranean Basin. The Almeria province case study (Master's dissertation, Politecnico di Torino).

Saretto, F.; Roy, B.; Encarnação Coelho, R.; Reder, A.; Fedele, G.; Oakes, R.; Brandimarte, L.; Capela Lourenço, T, 2024. Impacts of Climate Change and Adaptation Strategies for Rainfed Barley Production in the Almería Province, Spain. Atmosphere, 15, 606. https://doi.org/10.3390/atmos15050606

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Annex III: LAMS Taxonomy

Table 2. LAMS taxonomy for the inclusion in the RethinkAction visualization platform.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
1	Agroforestry: silvoarable (trees in croplands) and silvopastoral systems	Land management system that combines woody biomass (e.g., trees or shrubs) with crops and/or livestock	Land management	Agriculture	Forestry	Supply	Mitigation/Adaptation	Global/EU/Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 8: Decent work and economic growth GOAL 15: Life on land	Trees, crops, livestock
2	Establishment (conversion to) of perennial cropping systems	Establishment and maintenance of perennial woody crops (e.g. orchards)	Spatial planning	Agriculture		Supply	Mitigation/Adaptation	Global/EU/Local scale	GOAL 15: Life on land	Trees, woody crops, perennial crops
3	Establishment (conversion to) of permanent grassland	Establishment and maintenance of permanent grassland (herbaceous fodder, forage or energy crops, for 5 or more years) through cultivation (sown) or naturally (self-seeded).	Spatial planning	Agriculture		Supply	Mitigation/Adaptation	Global/EU/Local scale	GOAL 15: Life on land	Perennial crops, grass, forage
4	Land lying fallow (or Set-aside)	Arable land which is not harvested for the duration of (at least) a crop year.	Spatial planning	Agriculture	Biodiversity	Supply	Mitigation/Adaptation	Global/EU/Local scale	GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Fallow crop rotation, non-productive area, sustainable agriculture
5	Improved cropland management with input of	Improved cropland management includes practices such as improved crop	Land management	Agriculture	Water management	Supply	Mitigation/Adaptation	Global/EU/Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 6: Clean water and sanitation	Organic farming practices, manure,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
	organic amendments	varieties, crop rotation, optimised fertiliser application rate and timing, reduced tillage intensity, residue retention and improved water management. The regular use of organic amendments (such as animal manure, biochar, etc.) leads to an increased input of carbon to the soil							GOAL 13: Climate action GOAL 15: Life on land	compost, biochar
6	Improved cropland management with retention of crop residues	Improved cropland management includes practices such as improved crop varieties, crop rotation, optimised fertiliser application rate and timing, reduced tillage intensity, residue retention and improved water management.	Land management	Agriculture	Water management	Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Organic farming practices, crop residues incorporation, organic inputs
7	Crop rotation with leguminous crops	Successive cultivation of different crops, including legumes and non-legumes.	Land management	Agriculture		Supply	Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good Health and Well-being	Legume-based crop rotation, crop rotation with legumes, legumes and non-legumes succession
8	Cover crop	Crops that provide temporary vegetative cover between successive	Land management	Agriculture		Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good Health and Well-being	Winter cover crops, cover crop rotation,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
		agricultural crops, or between rows of tree or vine crops.								mixture of cover crops
9	Improved grazing land management	Switch from intensive to extensive grazing systems, using an appropriate animal stocking density that fits the carrying capacity and optimize forage performance, while maintaining animal performance. It includes management of vegetation with improved grass varieties/sward composition, deep rooting grasses, increased productivity, and nutrient management	Land management	Agriculture		Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Pasture, grazing management, livestock
10	Improved livestock management	Improved livestock management includes practices aimed at reducing emissions while increasing productivity, such as improved feed, use of dietary additives (e.g., bioactive compounds, fats), breeding, herd management and improved manure management.	Land management	Agriculture		Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Livestock nutrition optimization, livestock breeding and genetics, herd management
11	Improved cropland management	Improved cropland management includes practices such as	Land management	Agriculture		Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 6: Clean water	Precision nutrient management,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
	with precision nutrient management	improved crop varieties, crop rotation, optimized fertilizer application rate and timing, reduced tillage intensity, residue retention and improved water management. The implementation of precision nutrient management plans (rate, timing, application, additives) increases nutrient use efficiency and reduce losses							and sanitation GOAL 13: Climate action GOAL 15: Life on land	nutrient optimization, nutrient use efficiency
12	Intercropping	Crop diversification in space obtained by having multiple crop species cultivated in the same field	Land management	Agriculture		Supply	Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good Health and Well-being	Crop diversification, crop combinations, mixed cropping
13	Offshore wind and ocean renewable energy plants	Generation of electricity from ocean-based resources, such as wind turbines located offshore and marine based energy sources including waves, tides, and salinity and thermal properties.	Spatial planning	Energy	Coastal areas	Supply	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 9: Industry, innovation and infrastructure GOAL 13: Climate action GOAL 14: Life below water	Renewable energy, offshore wind energy, ocean renewable energy
14	Spatial planning for the sustainable deployment of energy on land	Spatial planning system that addresses the spatial dimensions of energy demand and energy	Spatial planning	Energy	Urban	Supply	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 9: Industry, innovation and	Sustainable energy deployment, land allocation for energy,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
		supply in a holistic way. It involves regulations/taxes/subsidies to: produce renewable energy near to the places of consumption (to avoid the deployment of more energy infrastructure to transport electricity), avoid cropland areas, especially those with high productivity (no competition for resources), avoid biodiversity protected areas, avoid areas of biodiversity richness							infrastructure GOAL 15: Life on land	renewable energy land suitability
15	Photovoltaic plants	Generation of electricity from solar energy	Spatial planning	Energy		Supply	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 9: Industry, innovation and infrastructure GOAL 13: Climate action GOAL 15: Life on land	Renewable energy, solar energy, photovoltaic panels
16	Wind power plants	Generation of electricity from wind, through the use of wind turbines	Spatial planning	Energy		Supply	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 9: Industry, innovation and infrastructure GOAL 13: Climate action GOAL 15: Life on land	Renewable energy, wind energy, photovoltaic panels
17	Hydroelectric power plants	Generation of electricity from the hydraulic energy of a	Spatial planning	Energy	Water management	Supply	Mitigation	Global/EU/ Local scale	GOAL 6: Clean water and sanitation GOAL 7: Affordable and clean energy	Renewable energy, water energy,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
		river, either natural or artificial							GOAL 9: Industry, innovation and infrastructure GOAL 13: Climate action GOAL 15: Life on land	hydroelectric power
18	Renewable energy (biogas) from agricultural residues	Anaerobic digestion of liquid or solid residues (plant biomass and/or livestock manure) for the production of biogas. Nutrient rich digestate can be used as fertilizer.	Land management	Energy	Agriculture	Supply	Mitigation	Global/EU/ Local scale	GOAL 2: Zero hunger GOAL 7: Affordable and clean energy GOAL 13: Climate action GOAL 15: Life on land	Renewable energy, crop residues, livestock manure
19	Renewable energy produced from forest biomass	Measures carried out considering maintenance of soil quality and biodiversity with the aim of minimizing negative impacts, that increase share of renewable energy produced from forest biomass , i.e. all kind and type of organic materials derived from forest and woodlands.	Land management	Energy	Forestry	Supply	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 13: Climate action GOAL 15: Life on land	Renewable energy, wood energy, forest bioenergy
20	Renewable energy produced from annual/perennial energy crops	Energy produced from crop biomass produced on agricultural land as a main crop (i.e., energy crops) and short rotation forest plantations (excludes forests planted for	Land management	Energy	Agriculture	Supply	Mitigation	Global/EU/ Local scale	GOAL 2: Zero hunger GOAL 7: Affordable and clean energy GOAL 13: Climate action GOAL 15: Life on land	Renewable energy, energy crop, high biomass crop

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
		protection or ecosystem restoration)								
21	Agrovoltaic farms	Solar-panel farms that provide biodiversity-friendly soil cover and sustainable bioenergy	Spatial planning	Energy	Agriculture	Supply	Mitigation	Global/EU/ Local scale	GOAL 2: Zero hunger GOAL 7: Affordable and clean energy GOAL 9: Industry, innovation and infrastructure GOAL 13: Climate action GOAL 15: Life on land	Solar farming, agriculture and solar integration, dual land use systems, renewable energy
22	Increased portion of forests included under protected areas	Increase of forested areas dedicated and managed to achieve the long-term conservation of nature with associated ecosystem services and cultural values. E.g. promotion of forest management practices that reduce harvested timberland from production.	Land management	Biodiversity	Forestry	Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Forest protection, forest conservation, forest preservation
23	Reforestation/afforestation	Reforestation: Establishment of forest plantations on temporarily unstocked lands that are considered as forest; Afforestation: Establishment of forest plantations on land that, until then, was not classified as forest. Implies a	Spatial planning	Forestry	Biodiversity	Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Forest restoration, tree planting, forest plantation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
		transformation from non-forest to forest.								
24	Protecting and promoting forest natural encroachment	Promote the increase in density, cover and biomass of indigenous woody or shrubby plants	Land management	Forestry	Biodiversity	Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Encroachment, woody plant encroachment, woody plant invasion
25	Reduced deforestation	Conservation of existing carbon pools in forest vegetation and soil by controlling the drivers of deforestation (i.e., commercial and subsistence agriculture, mining, urban expansion), which is defined as the permanent destruction of forests and woodlands and conversion to non-forest uses.	Land management	Forestry	Biodiversity	Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Forest management, forest conservation, forest protection
26	Establishment of firebreaks and fuel load management	A firebreak is a barrier, natural or otherwise, or one prepared after a fire occurs, from which all or most of the inflammable materials have been removed. Fuel load management: Keep the fuel load per hectare under a certain threshold, in order to reduce fire intensity.	Land management	Forestry		Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 3: Good Health and Well-being GOAL 13: Climate action GOAL 15: Life on land	Forest fire, fire prevention, fire mitigation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
27	Reduced forest harvesting (Moderate intensity cutting)	Measure that gradually reach the maximum stock of standing timber compatible with continuous harvesting and regeneration.	Land management	Forestry		Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Forest management, sustainable logging, sustainable timber harvesting
28	Increased forest harvesting	Increase harvesting of EU forests to produce wood (i.e. utilized as a material) and biomass for energy production	Land management	Forestry	Business and industry; Energy	Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 2: Zero hunger GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 7: Affordable and clean energy GOAL 9: Industry, innovation and infrastructure GOAL 11: Sustainable cities and communities GOAL 12: Responsible consumption and production GOAL 13: Climate action GOAL 15: Life on land	Forest management, increased timber harvesting, increased wood production
29	Increased share of renewable energy used in buildings	Measures that allow increasing the share of renewable energy used in buildings, e.g. installation of solar panels	Lifestyle/behavioral change	Buildings	Energy	Demand	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 9: Industry, innovation and infrastructure	Green buildings, low-energy buildings, energy self-sufficiency
30	Reduced energy consumption in buildings	Measures that allow a reduction in energy consumption, e.g. increasing the energy efficiency of the building	Lifestyle/behavioral change	Buildings	Energy	Demand	Mitigation	Global/EU/ Local scale	GOAL 12: Responsible consumption and production	Energy efficiency, low-energy buildings, responsible energy consumption

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
31	Limiting urban sprawl	Planning policies and techniques that help concentrate growth within targeted areas, restrain development from sprawling uncontrollably into rural settings, and protect or restore a region's natural resource base. Land development prescriptions, such as subdivision regulations, zoning provisions, building permit limits, and urban growth boundaries can prohibit or direct growth away from undesirable locations.	Spatial planning	Urban	Biodiversity	Supply	Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation for all GOAL 7: Affordable and clean energy GOAL 9: Industry, innovation and infrastructure GOAL 10: Reduced inequalities GOAL 11: Sustainable cities and communities GOAL 12: Responsible consumption and production GOAL 13: Climate action GOAL 15: Life on land	Urban planning, smart growth, controlled urban expansion
32	Establishment and maintenance of green urban ecosystems	Green urban ecosystems include trees, green roofs, gardens, parks and urban forests. Urban vegetation can help reduce urban heat island effects by shading building surfaces, deflecting radiation from the sun, and releasing moisture into the atmosphere, as well as provide physiological, social, economic, and aesthetic benefits.	Spatial planning	Urban	Biodiversity	Supply	Adaptation	Global/EU/ Local scale	GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 11: Sustainable cities and communities GOAL 13: Climate action GOAL 15: Life on land	Urban vegetation, urban green space, green cities

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
33	Water-use efficiency: improve agricultural irrigation efficiency	Measures to increase water use efficiency in agricultural fields, e.g. better management of crop water demand, switching to less water intensive crops, changing planting dates, optimized irrigation schedules	Lifestyle/behavioral change	Water management	Agriculture	Demand	Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 8: Decent work and economic growth GOAL 11: Sustainable cities and communities GOAL 13: Climate action GOAL 15: Life on land	Water conservation, precision water management, optimized irrigation
34	Water-use efficiency: improve industrial water use efficiency	Measures to increase water use efficiency in industries, i.e. reducing losses and improving flows	Lifestyle/behavioral change	Water management	Business and industry	Demand	Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 8: Decent work and economic growth GOAL 11: Sustainable cities and communities GOAL 13: Climate action GOAL 15: Life on land	Water conservation, industrial water management, industrial water recycling
35	Water-use efficiency: improve domestic water use efficiency	Measures to increase water use efficiency in households, i.e. reducing losses and improving flows	Lifestyle/behavioral change	Water management	Society (health, wellbeing, education)	Demand	Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 8: Decent work and economic growth GOAL 11: Sustainable cities and communities GOAL 13: Climate	Water conservation, domestic water management, water saving

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
									action GOAL 15: Life on land	
36	Increased use of treated waste water	Measures to increase the use of reclaimed water, defined as urban waste water that has been treated in compliance with the requirements set out in Directive 91/271/EEC and which results from further treatment in a reclamation plant	Lifestyle/behavioral change	Water management	Business and industry	Demand	Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 8: Decent work and economic growth GOAL 11: Sustainable cities and communities GOAL 13: Climate action GOAL 15: Life on land	Water conservation, wastewater recycling, water reuse
37	Use of deforestation-free products	Any tools/approaches (e.g. Information System/product traceability system) that ensure that products, whether sourced in the EU or from third countries, sold on the EU market do not come from supply chains associated with deforestation or forest degradation and, in general, do not contribute to global deforestation.	Lifestyle/behavioral change	Forestry	Society (health, wellbeing, education)	Demand	Mitigation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 8: Decent work and economic growth GOAL 9: Industry, innovation and infrastructure GOAL 15: Life on land	Forest conservation, sustainable sourcing, zero-deforestation products
38	Shift in people's diet	"Sustainable healthy diets represent a range of dietary changes to improve human diets, to make them healthy in terms	Lifestyle/behavioural change	Society (health, wellbeing, education)	Agriculture	Demand	Mitigation	Global/EU/ Local scale	GOAL 2: Zero hunger GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 8: Decent work	Dietary change, healthy diets, sustainable diets

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
		of the nutrition delivered, and also (economically, environmentally and socially) sustainable." A shift towards reduced consumption of animal products can reduce GHG emissions, reduce cropland and pasture requirements, enhance biodiversity protection, and reduce mitigation costs. By freeing land, dietary change can facilitate other land-based solutions for climate change adaptation and mitigation.							and economic growth GOAL 10: Reduced inequalities GOAL 12: Responsible consumption and production GOAL 13: Climate action GOAL 15: Life on land	
39	Increased food consumption of local products	Measures that incentivizes consumption of local products, e.g. front-of-pack labelling of origin or provenance	Lifestyle/behavioural change	Society (health, wellbeing, education)	Agriculture	Demand	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 3: Good Health and Well-being GOAL 8: Decent work and economic growth GOAL 12: Responsible consumption and production GOAL 15: Life on land	Sustainable food, local food, responsible consumption
40	Increased organic food consumption	Measures that incentivize the consumption of organic food, meant as a holistic production management system which promotes and enhances agro-	Lifestyle/behavioural change	Society (health, wellbeing, education)	Agriculture	Demand	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 2: Zero hunger GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 8: Decent work and economic growth GOAL 10: Reduced inequalities	Sustainable food, organic food, responsible consumption

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
		ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems.							GOAL 12: Responsible consumption and production GOAL 13: Climate action GOAL 15: Life on land	
41	Reduced food loss and waste	Improve food packaging and storage and clarify labeling (i.e., best before dates) to reduce food loss and waste. Since approximately 9–30% of all food is wasted, reducing food waste can reduce pressure on land	Lifestyle/behavioural change	**Society (health, wellbeing, education)**	Agriculture	Demand	Mitigation	Global/EU/ Local scale	GOAL 6: Clean water and sanitation GOAL 7: Affordable and clean energy GOAL 8: Decent work and economic growth GOAL 11: Sustainable cities and communities GOAL 12: Responsible consumption and production GOAL 13: Climate action GOAL 15: Life on land	Food waste reduction, food loss prevention, sustainable food systems
42	Protecting and restoring wetlands/peatlands (e.g. rewetting)	Restoring degraded/damaged wetlands and peatlands and protecting existing ones. This leads to an increase carbon sinks and avoids CO2 emissions from degraded peatlands.	Land management	**Biodiversity**		Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 14: Life below water GOAL 15: Life on land	Rewetting, peatland conservation, wetland conservation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
43	Sustainable agricultural intensification	Increasing yields from the same area of land while decreasing negative environmental impacts of agricultural production and increasing the provision of environmental services.	Land management	Agriculture		Supply	Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good health and well-being GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Food security, increased production, sustainable agriculture
44	Increase in cultivated area	Land use change to croplands	Spatial planning	Agriculture		Supply	Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good health and well-being GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Food security, increased production, increased cropland area
45	Increased use of electric vehicles	Incentivize the use of fully electric vehicles, i.e drawing their energy solely from an electric battery, a fuel cell, or another energy storage or supply device	Lifestyle/behavioural change	Transport	Energy	Demand	Mitigation	Global/EU/ Local scale	GOAL 9: Industry, innovation and infrastructure GOAL 11: Sustainable cities and communities	Sustainable transportation, green transportation, zero-emission vehicles
46	Increased use of renewable energy sources in the transport sector	Measures to increase the share of renewable fuels derived from biomass or of non-biological origin	Lifestyle/behavioural change	Transport	Energy	Demand	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 11: Sustainable cities and communities	Sustainable transportation, renewable transport fuels, renewable energy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
47	Reusing and recycling of materials	Measures to incentivize reusing and recycling of materials and products	Lifestyle/behavioural change	Society (health, wellbeing, education)	Business and industry	Demand	Mitigation	Global/EU/ Local scale	GOAL 12. Responsible consumption and production	Waste reduction, waste recovery, recycling
48	Wind and solar repowering	Upgrading or retrofitting renewable energy sources components. It exploits existing land sites, in which renewables are operating for years.	Spatial planning	Energy		Supply	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 15: Life on land	Plant upgrading, plant retrofitting, plant improvement
49	Floating solar photovoltaic panels in water bodies	Conventional solar modules mounted on floaters, which provide buoyancy to the whole arrangement while anchored to the bottom of the water body	Spatial planning	Energy	Coastal areas	Supply	Mitigation	Global/EU/ Local scale	GOAL 6: Clean water and sanitation GOAL 7: Affordable and clean energy GOAL 9: Industry, innovation and infrastructure GOAL 13: Climate action	Floating solar panels, solar energy on water, renewable energy
50	Solar panels in rooftops/buildings	Generation of electricity from solar energy by installing photovoltaic panels on rooftops, to meet land-competing food-energy demands in the urban context	Spatial planning	Energy	Buildings	Supply	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 11: Sustainable cities and communities GOAL 13: Climate action	Renewable energy, low-energy buildings, energy self-sufficiency
51	Fostering energy self-consumption	Consuming one's own electricity through renewable energy facilities (solar-powered, wind, geothermal or biomass). The owner of the facilities can	Lifestyle/behavioural change	Energy	Society (health, wellbeing, education)	Demand	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 15: Life on land	Energy efficiency, responsible energy consumption, renewable energy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
		then choose whether or not to connect them to the national grid.								
52	Regulating the use of land in urban areas to provide convenient and efficient access to a diverse mix of land uses (Land use zoning)	Mixed-use development combines residential areas with places of employment and commerce instead of isolating individual areas, allowing for more pedestrians and public transit as opposed to traffic and pollution. Urban planning (Land use zoning) can promote it by regulating the use of land in urban areas	Spatial planning	Urban	Society (health, wellbeing, education)	Supply/Demand	Mitigation	Global/EU/ Local scale	GOAL 9: Industry, innovation and infrastructure GOAL 11: Sustainable cities and communities	Urban planning, smart growth, urban zoning
53	Reduced Property Tax on zero-emission buildings	A zero-emission building is defined as a building with a very high energy performance, with the very low amount of energy still required fully covered by energy from renewable sources and without on-site carbon emissions from fossil fuels.	Lifestyle/behavioural change	Financial	Buildings; Energy	Supply/Demand	Mitigation	Global/EU/ Local scale	GOAL 11: Sustainable cities and communities	Reduced taxation, low energy buildings, green building incentives
54	Reduced taxation (value-added tax, VAT) for the use of local, recycled	Promote the use of local materials to reduce the energy needed for materials transportation.	Lifestyle/behavioural change	Financial	Business and industry	Supply/Demand	Mitigation	Global/EU/ Local scale	GOAL 11: Sustainable cities and communities GOAL 12: Responsible	Reduced taxation, sustainable materials, tax incentives

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
	and sustainable materials	Promote the use of recovered, reused and recycled materials, by applying the principles of the circular economy to the way we design buildings, infrastructure and other elements of the built environment, so as to reduce greenhouse gas emissions, while creating urban areas that are more liveable, productive and convenient.							consumption and production	
55	Water harvesting: collect and store rain water in reservoirs	Building of water storage reservoirs for agricultural and other purposes, as a part of Natural Water Retention Measures.	Land management	Water management		Supply	Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 8: Decent work and economic growth GOAL 11: Sustainable cities and communities GOAL 13: Climate action GOAL 15: Life on land	Rainwater collection, rainwater storage, sustainable water management
56	Protection of "maximum infiltration zones"	The areas of maximum infiltration present the most favorable conditions to recharge aquifer systems	Land management	Water management	Biodiversity	Supply	Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 3: Good Health and Well-being GOAL 6: Clean water and sanitation GOAL 8: Decent work and economic growth	Aquifers, groundwater, water recharge

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
									GOAL 11: Sustainable cities and communities GOAL 13: Climate action GOAL 15: Life on land	
57	Improved energy storage capacity	Improved energy storage capacity technologies. Long-duration energy storage can significantly enhance the utilization of renewable energy sources and reduce the need for firm low-carbon generation	Spatial planning	**Energy**		Supply	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 9: Industry, innovation and infrastructure GOAL 15: Life on land	Energy storage, storage capacity, renewable energy
58	Tourist awareness campaigns for land protection, waste reduction and energy consumption	Information campaigns to promote sustainable tourism	Lifestyle/behavioural change	**Tourism**	Society (health, wellbeing, education)	Demand	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 12: Responsible consumption and production	Sustainable tourism, information campaigns, public awareness
59	Land management of solar photovoltaic systems	The land management of the area below and around the PV panels	Land management	**Energy**	Agriculture	Supply	Mitigation	Global/EU/ Local scale	GOAL 7: Affordable and clean energy GOAL 15: Life on land	Solar land management, renewable energy, solar energy
60	Precision farming and artificial intelligence	Highly controlled, accurate, and optimized agricultural production based on information and high technology sensor and analysis tools	Land management	**Agriculture**	Technology	Supply	Mitigation/Adaptation	Global/EU/ Local scale	GOAL 1: No poverty GOAL 2: Zero hunger GOAL 6: Clean water and sanitation GOAL 13: Climate action GOAL 15: Life on land	Precision agriculture, digitalization, precision farm management

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

LAMS ID	LAMS	Definition	Type of solution	Primary policy sector	Secondary policy sector	Application	Scope	Scale	Contribution to UN SDG	Keywords
61	Freshwater ecosystems restoration and management	The restoration and management of freshwater ecosystems should include efforts to restore the natural longitudinal and lateral connectivity of rivers as well as their riparian areas and floodplains, including through the removal of barriers with a view to supporting the achievement of favorable conservation status for rivers, lakes and alluvial habitats and species living in those habitats.	Land management	Water management	Biodiversity	Supply	Adaptation	Global/local	GOAL 6: Clean water and sanitation GOAL 11: Sustainable cities and communities GOAL 13: Climate action GOAL 14: Life below water GOAL 15: Life on land	Nature-based, river, lakes, riverbank
62	Coastal zones management	Establishment and implementation of maritime spatial plans and integrated coastal management strategies, including Nature-based Solutions to address aspects related to climate change (e.g. risks, adaptation needs) and environmental issues (e.g. reduce pollution and waste disposal in marine waters), as to conserve marine ecosystems.	Land management	Coastal areas	Biodiversity	Supply	Adaptation	Global/local	GOAL 6: Clean water and sanitation GOAL 11: Sustainable cities and communities GOAL 13: Climate action GOAL 14: Life below water GOAL 15: Life on land	Nature-based, dunes, erosion

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Annex IV: Example of LAMS factsheet

Agroforestry: silvoarable (trees in croplands) and silvopastoral systems

Catalogue visualization path

Land management -> Agriculture-> Forestry

LAMS name

Agroforestry: silvoarable (trees in croplands) and silvopastoral systems

Keywords

Trees, crops, livestock

General description and characterization of the solution

Table 3. List of general characteristics of Agroforestry LAMS.

Type of solution	Land management
Land use	Agriculture & livestock
Policy sector(s)	Agriculture; Forestry
Definition	Land management system that combines woody biomass (e.g., trees or shrubs) with crops and/or livestock. It is obtained either by planting trees on agricultural land or by cropping (for example after thinning) on forested land. Plots that combine arable intercrops with forestry trees are silvoarable plots, while wooded plots with pasture under the tree canopy are known as silvopastoral plots.[1] Agroforestry practices help reduce soil erosion, nutrient leaching and increase carbon sequestration. It is also used for preventing wind erosion (wind breaks) as it helps stabilize and reduce dust storms. In addition, it mitigates negative impacts from management of adjacent lands and enhances aesthetic values.[1,2]
Processes, effects, and relevant factors	Reduction of agricultural area for cash crops/grassland; change in biomass C and in soil organic carbon content (20 years); reduced input of N fertilizer[1]
Scope and potential	Large Adaptation Potential and Large Mitigation Potential[1]
Application	Supply
Actors involved	Farmers, scientists, agricultural policy-makers, environmental scientists, environmental organizations

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Co-benefits and possible negative effects

Table 4. List of co-benefits and possible negative effects of Agroforestry LAMS implementation.

Co-benefits	Negative effects
1. Climate issues 1.1. Greenhouse gases emissions 1.2. Carbon storage/sequestration 3. Air quality 4. Soil quality 5. Biodiversity 6. Public health and well-being 6.1. Landscape aesthetic 6.2. Noises, lights, dusts and smells 6.3. Health 6.4. Human well being 6.5. Recreational activities 6.6. Income 7. Financial and economy 7.1. Cost avoiding 7.2. Job creation 7.3. Circular economy contribution 8. Low need for resources 8.1. Animals, products and sub-products from animal's alive and carcasses (including manure) 8.5 Minerals and metals 8.6 Energy (including fossil fuel energies)	8. High need for resources 8.2. Plants, products and sub-products from plants 8.3. Water 8.4. Land 9. High need for social resources 9.1. Length of time to implement the solutions (short term solutions, medium term, long term) 9.2. Labour quantity/labour use 9.3. Skills of labour required and technologies 9.4. Public / Community engagement 9.5. Level of organization 10. High need for financial resources

Relevant KPI and contribution to specific SDGs

Table 5. Relevant KPIs and contribution to specific SDGs for Agroforestry LAMS.

Relevant performance indicators (KPIs)*	Contribution to specific SDGs
Soil organic carbon (SOC) content Agricultural areas as a proportion of total land area Agricultural production	15. Life on land 15.3.1. Proportion of land that is degraded over total land area 2. Zero hunger 2.4.1 Proportion of agricultural area under productive and sustainable agriculture 2.3.1 Volume of production per labour unit by classes of farming/pastoral/forestry enterprise size

Drivers and barriers

Table 6. List of drivers and barriers for Agroforestry LAMS implementation.

Category	Drivers	Barriers
Institutional and legal factors	Supporting policies[4]	Greater administrative burden, CAP measures are complex and extensive[4,5,6]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

		Constrained policies[4]
Financial and investment factors	CAP subventions[4]	Lack of reliable financial support[3] Possible need of a high financial investment for farmers at the initial stage[4]
Economic and market factors	Livelihood diversification through the diversification of production[3,4,5,6] Development of local rural economy including creating jobs and eco-tourism[4,5] Decrease in charges of fertilizers or pesticides[4,5] Increase in income through the increase in production, yield and number of production (if the system is well designed and conducted) [4,5] Enhance the circular economy through the use of biomass coming from trees[6] Low cost of implementation compared to other solutions[3]	Uncertainty in long-term returns from the tree plantations (market fluctuations, weather conditions, and unforeseen challenges) which can impact the profitability of the investment over time [4] Benefits not fully perceived by markets[6]
Socio-cultural factors	Increasing food insecurity[3] Support recreational activities (hunting, fishing, horse-riding, mountain biking, wildlife watching, etc.)[4,5] Pleasant looking landscape[4,5,6] Conservation of landscape as cultural heritage[2] Contribution to animal welfare (shelter from wind, cold and rain, shade from the sun, protection from predators and encourage natural behaviour such as foraging and scratching)[4] Support ecosystem services[3,4,5,6] Healthier food production[5] Facilitation of well-being[5,6] Safety benefits: reduction of risk fires[5,6]	Request for additional work[4]
Organizational and governance factors		
Technical factors	Development of technical advisory (agroforestry systems require careful design and a high level of initial planning and monitoring)[4,6] Development of professional training[4,6] Integrating agroforestry into agricultural training[4,6] Development of research and innovation (e.g. shade adapted varieties)[4] Increase resilience of livestock systems because it can improve fodder production and provide additional food sources (e.g. acorns, tree fodder) during periods of drought, hence leading to a reduced need for external inputs[6]	Technical complexity of running an agroforestry system that requires skills in several areas of work[4,6] Technical blockage through machinery dimensions that may not be adapted to the width of intercrops[4] Lack of available technical information[4,6] The five agroforestry practices are not well-known[6] Lack of knowledge among farmers[6]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Policy documents and relevance

Table 7. List of policy documents where Agroforestry LAMS was identified at local and global scale.

Policy documents where LAMS was mentioned	Relevant scale
Local/National ProRural agri-farming program of Azores (PT) Italian National Forest strategy (IT) Plan Andaluz de Accion Clima (ES) EU/Global European Union Common agricultural policy (CAP) 2019 IPCC Special report on climate change and land	Local, National European Union/Global

References

Table 8. List of scientific sources utilized for the Agroforestry LAMS.

Scientific references
[1]IPCC, 2019: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.
[2]Torralba, M., Fagerholm, N., Burgess, P.J., Moreno, G. and Plieninger, T., 2016. Do European agroforestry systems enhance biodiversity and ecosystem services? A meta-analysis. Agriculture, ecosystems & environment, 230, pp.150-161. https://doi.org/10.1016/j.agee.2016.06.002
[3]Smith, P., J. Nkem, K. Calvin, D. Campbell, F. Cherubini, G. Grassi, V. Korotkov, A.L. Hoang, S. Lwasa, P. McElwee, E. Nkonya, N. Saigusa, J.-F. Soussana, M.A. Taboada, 2019: Interlinkages Between Desertification, Land Degradation, Food Security and Greenhouse Gas Fluxes: Synergies, Trade-offs and Integrated Response Options. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.- O. Portner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. https://doi.org/10.1017/9781009157988.008
[4]Augere-Granier, M.L. (2020). "Agroforestry in the European Union", European Parliamentary Research Service, 11p. https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/651982/EPRS_BRI(2020)651982_EN.pdf
[5]Mosquera-Losada, M.R., Santiago-Freijanes, J.J., Rois-Díaz, M., Moreno, G., den Herder, M., Aldrey, JA., Ferreiro-Domínguez, N., Pantera, A., Pisanelli, A. and Rigueiro Rodríguez, A. (2018). Agroforestry in Europe: a land management policy tool to combat climate change. Land Use Policy 78, p603-613. https://doi.org/10.1016/j.landusepol.2018.06.052
[6]AGFORWARD project (2017). How can policy support the uptake of agroforestry in Europe?, WP8: Agroforestry Policy Development, Deliverable 8.24, 21p.

Notes:

*KPI: Key performance indicator (measures that are used to assess essential factors related to a given objective).

*SDGs: Sustainable development goals.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.

Contact

Fundación CARTIF

E-Mail: rethinkaction@cartif.es

Phone: + 34 983 546 504

Fax. + 34 983 546 521

Parque Tecnológico de Boecillo, parcela 205

CP: 47151, Boecillo (Valladolid), Spain

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037104.