INtegrated research on FOrest Resilience and Management in the mEDiterranean

Glossary

Preliminary remarks:

- all these definitions refer to the notion of social-ecological system where the social system and the ecosystem are in complete symmetry not hierarchy (see definition of social-ecological system)

- some words are commonly used with several meanings, we just stress these semantic issues to foster clarification of the discourse, we do not pretend to impose a unique definition.

- some definitions are fully or partially adopted from other sources (in italics, [source] mentioned)

Adaptation

Adaptation has at least three possible meanings, which must be clarified in each case. Adaptation is sometimes used in the sense of "adaptedness" to characterize the state of a society, of an ecosystem, of a population, of a trait, etc. that fulfills the requirements of its current environment. In biology, adaptation is a set of ecological and evolutionary processes that make individuals and populations more or less adapted to their environment. Adaptation is also used to name the set of actions, e.g. management and policies, developed in response to global change, taking benefit from the ecological and evolutionary processes previously mentioned.

Adaptive management (Fig. 1)

Adaptive management should not be confounded with management for adaptation (see above).

Adaptive management is a systematic process for continually adjusting policies and practices by learning from the outcome of previously used policies and practices. Each management action is viewed as a scientific experiment designed to test hypotheses and probe the system as a way of learning about the system. Adaptive management identifies uncertainties, and then establishes methodologies to test hypotheses concerning those uncertainties. It uses management as a tool not only to change the system, but as a tool to learn about the system. [Taken from http://www.resalliance.org/glossary]

Biodiversity

Biodiversity is the variety of life on earth and is classically considered at three hierarchical levels: the genes level (within species), the species level (between species) and the ecosystem level. More generally, biodiversity can follow other grouping of the living: e.g. functional diversity. The biodiversity is not only characterized by its composition but also by its structures (organization in space).

The observed biodiversity is neither fixed nor necessarily optimal to the local conditions. The observed biodiversity is an instant capture resulting from permanent dynamic processes, within and between the levels of organization.

Disturbance

Coming from ecology, the concept can be extended to social-ecological systems. Disturbance is a discrete event in time that disrupts resources, populations, structures or processes in the system and locally creates opportunities for new individuals to become established or structures to emerge.

Disturbance can be considered as part of the system dynamics (e.g. fire-prone ecosystems, riparian forests) or as external to the system.

Disturbance regime describes the regional pattern of disturbances that shape an ecosystem over a long time scale. The main modalities characterizing a disturbance regime include size, frequency (or return interval), intensity (or duration) of disturbances.

Ecosystem functions (EF)

EFs are the biological, geochemical and physical processes within an ecosystem, which depend on the response of biodiversity elements and of their interactions to the environment. In forest systems, management may have an effect on EF through its impacts on ecosystem composition, biodiversity and structure or on the resources.

Ecosystem services (ES) (Fig. 2)

In an anthropogenic point of view, ESs are the direct and indirect contributions of ecosystems to human well-being. In the broader framework of social-ecological systems where human and non-human agents interact, ESs are the benefits that all agents derive from the social-ecological system. ESs are the results of the ecosystem functions. In this project we use the Common International Classification of Ecosystem Services (CICES) in three sections: provisioning, regulation and maintenance, cultural. From the CICES list, we identified 18 ES *a priori* most relevant in the Mediterranean forests.

We distinguish between target ES, which are the direct objectives of management, and non-target ES, that are not currently direct objectives but may be correlated to target ES and might become themselves future targets of management. Positive or negative correlations among ES are rarely, if ever, intrinsic, they are variable and depend both on the local social-ecological context and on the management.

Efficiency, Substitution, Redesign (ESR)

ESR is an analytical grid proposed by Hill (1995) to characterize strategies for adaptation in terms of the modifications they introduce into the system. Efficiency is a strategy that does not change the composition of the system but increases the efficiency of the use of resources that become scarce, e.g. changing tree density. Substitution goes a step forward changing some elements of the system while keeping the same objective, e.g. changing forest reproductive material to maintain timber production. Redesign is a more holistic strategy that reorganizes the system and its orientations, e.g. changing the objective from production forest to nature conservation or even to another ecosystem.

Innovation (technological and social innovation) (Fig. 3)

Within the EU2020 strategy, social innovation based on mobilizing people's creativity is considered an effective way to develop novel solutions behind technological innovations, to make better use of scarce resources, and to promote an innovative and learning society (BEPA, 2011: 7). In general terms, social innovation can be described as the capacity to create and implement new ideas that are likely to deliver value (thus meeting individual economic interests), contemporarily responding to social demands (thus meeting societal needs), that are traditionally not addressed by markets or existing institutions. In accordance with this definition, SI might include new institutional arrangements (e.g. new formal/informal rules, new administrative procedures), new actors' relationships and interactions (e.g. new forms of collaboration, new networks; new attitudes, values and behaviours) and/or new fields of activity (e.g. social entrepreneurships or enterprises, new social uses of forests) (EC, 2013 and 2015) able to contribute to enhance the quality of life and human well-being. At least two approaches to innovation are used in the forest-related resources management and bio-based economy based on forestry: the traditional, technological approach and the innovative, social one, which main characteristics are synthetized in Fig. 3.

Resilience, Resistance, Recovery

Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks. [Taken from http://www.resalliance.org/glossary]

In this project, we consider specific resilience (resilience of what to what) as the capacity to maintain target ecosystem services above a minimum level while undergoing change. We also consider general resilience as the capacity to maintain the forest ecosystem as such, even if target ecosystem services are radically changed. Resilience can be achieved by changing ecological or social structures in the system.

In a social-ecological system, various ecological and social components of resilience can be measured and resilience thresholds identified. Resilience components reflect three characteristics:

- the amount of change the system can undergo and still retain the same ecosystem services (specific resilience) or still remain a forest (general resilience);
- the degree to which the system is capable of self-organization;
- the ability to build and increase the capacity for learning and adaptation.

Resistance, i.e. the intensity of pressure needed to change the system, and recovery or reversibility, i.e. the ability of the system to return to its original regime after disturbance, are other important related characteristics.

Risk

Risk is the potential of losing something of value. It results from the exposure of a vulnerable asset to a threat. Reducing the risk can be achieved through different strategies that may be combined: reducing the exposure, reducing the vulnerability, reducing the threat or reducing the values or goods at stake.

A risk may be known or unknown, measurable or not. The prevention principle deals with known risks while the precaution principle deals with unknown risks. In the context of change, it is important to understand, and eventually manage, the temporal and the spatial scales of the risks under consideration.

Scales

In this project we consider multiple temporal horizons to assess risks and uncertainties, to develop scenarios and run model simulations, to assess management and social innovations: horizon 2035 (short-term), horizon 2050 (mid-term) and horizon 2100 (long-term). The level of uncertainty increases with the temporal scale, but the constraints to innovation decrease. Each management or social option has an objective specifically defined for one temporal horizon (in general) but it has associated benefits and risks in all of them that have to be considered.

The spatial scales considered in the project are the forest scale, i.e. a single unit of management for forest planning, and the forest massif scale, i.e. a local territory that includes multiple forest plans and eventually other ecosystems. At a smaller scale, the forest compartment is the basic area where interventions are applied to a stand. Larger scales, e.g. global climate or socio-economic scenarios, are considered to contextualize the case studies.

Scenarios (Fig. 4)

A scenario is a coherent, internally consistent and plausible description of a possible future state of the world (IPCC 2013). Scenarios are uncertain, multidimensional (contain information about a wide range of socio-economic and biophysical factors), schematic in that they highlight essential details but no so much distract from large-scale patterns, come in sets of two or more to reflect, as well as possible, the range of uncertainty in projections (Lempert 2013). The goal of working with scenarios is not to predict the future but to better understand uncertainties and alternative futures, in order to consider how robust different decisions or options may be under a wide range of possible futures.

There are different types of scenarios, used for different purposes. The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) proposes a typology in four groups: exploratory scenarios that are used in this project (exploring trajectories more than final states), target-seeking scenarios (exploring pathways towards a target state), ex-ante assessment (exploring final states) and ex-post assessment (retrospective analysis).

Social-ecological system (SES) (Fig. 5)

SES is an integrative framework for a local system where the ecosystem compartment and the social compartment interact. Both compartments are described by their own structures and processes. The dynamics of each compartment has an impact on and is impacted by the other (agency is recognized not only to humans). The management of the ecosystem directly drives the ecosystem structures, which impact the ecological processes, the ecosystem functions and ultimately the ecosystem services.

SES boundaries are defined by the set of agents considered in the framework. External drivers of the system are the global environmental, social, economic, political and institutional contexts, as well as the local interactions with other adjacent ecosystems and other social systems.

Transformability

The capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable. [Taken from http://www.resalliance.org/glossary].

This definition can be extended to the situations where current conditions are still tenable.

Uncertainty (Fig. 6)

The uncertainty is a situation of imperfect and/or unknown information. It may result from (i) stochastic processes (e.g. genetic recombination during meiosis), (ii) incomplete knowledge or incomplete accounting (e.g. uncertainty on parameter values within a model), (iii) representation (e.g. different predictions provided by different models, so-called structural uncertainty), or (iv) ignorance (e.g. uncertainty on input variables of a model, or on complex interactions).

Depending on its nature, the uncertainty can be quantified or not, can be reduced or not. All these uncertainties propagate when a modelling chain is built.

Vulnerability

Vulnerability is the inability of a system to withstand the effects of a hostile environment.

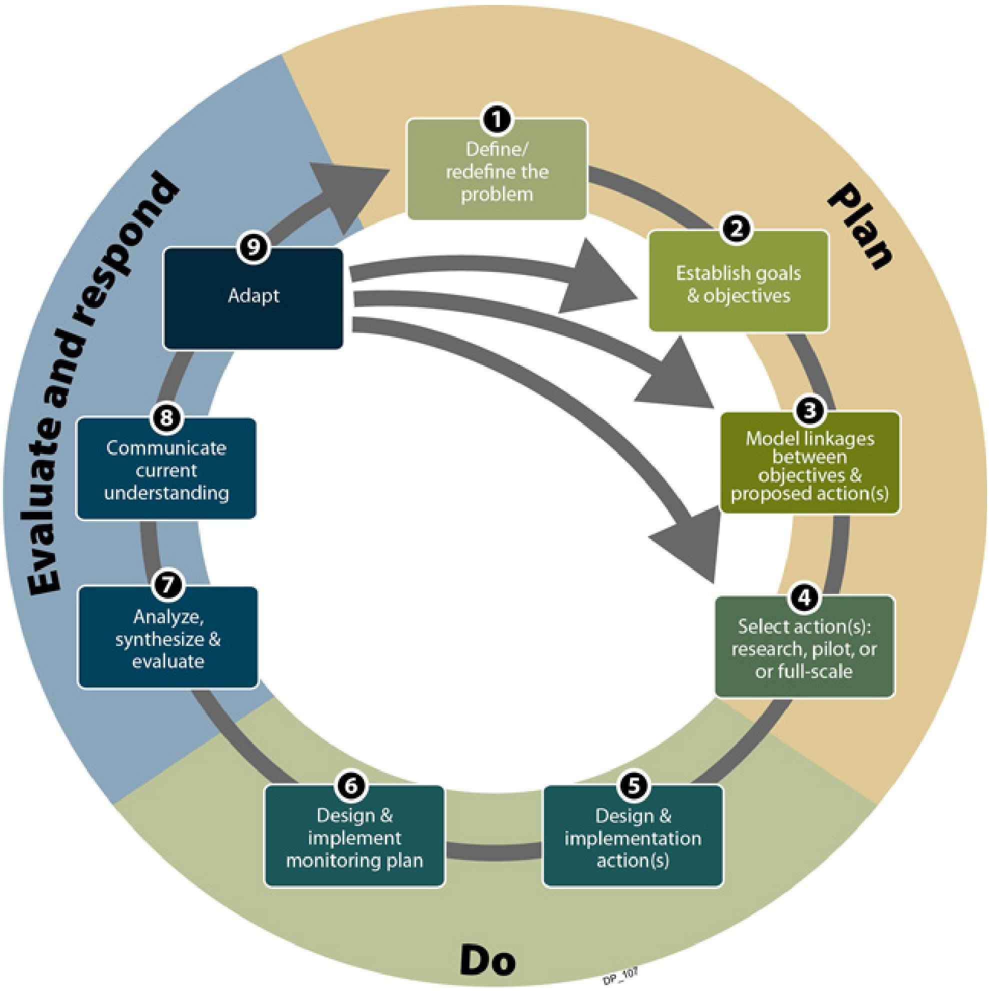

Fig. 1: Adaptive management

Source: California Dpt of Fish and Wildlife [*http://www.dfg.ca.gov/erp/adaptive_management.asp*](http://www.dfg.ca.gov/erp/adaptive_management.asp)

Section	Division	Group	Class	Class type	Examples
Provisioning	Nutrition	Biomass	Wild plants, algae and their outputs	*Plants by amount, type*	Wild berries, fruits, mushrooms, for food
			Wild animals and their outputs	*Animals by amount, type*	Game, as well as honey harvested from wild populations; Includes commercial and subsistence hunting for food
	Materials	Biomass	Fibres and other materials from plants, algae and animals for direct use or processing	*Material by amount, type, use, media (land, soil, freshwater, marine)*	Fibres, wood, timber, cork, which are not further processed; industrial products such as cellulose for paper; chemicals extracted or synthesised from plants such as resin; Includes consumptive ornamental uses.
			Genetic materials from all biota		Genetic material (DNA) from wild plants bio-prospecting activities e.g. wild species used in breeding programmes etc.
	Energy	Biomass-based energy sources	Plant-based resources	*By amount, type, source*	Wood fuel for burning and energy production
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by ecosystems	Filtration/sequestration/storage/accumulation by ecosystems	*By amount, type, use, media (land, soil, freshwater, marine)*	Bio-physicochemical filtration/sequestration/storage/accumulation of pollutants in land/soil, including sediments
			Mediation of smell/noise/visual impacts		Visual screening of transport corridors e.g. by trees; Green infrastructure to reduce noise and smells
	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates	*By reduction in risk, area protected*	Erosion / landslide / gravity flow protection; vegetation cover protecting/stabilising terrestrial ecosystems, dunes; vegetation on slopes also preventing avalanches (snow, rock), erosion, etc.
		Liquid flows	Hydrological cycle and water flow maintenance	*By depth/volumes*	Capacity of maintaining baseline flows for water supply and discharge; e.g. fostering groundwater; recharge by appropriate land coverage that captures effective rainfall; includes drought and water scarcity aspects.
			Flood protection	*By reduction in risk, area protected*	Flood protection by appropriate land coverage
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Maintaining nursery populations and habitats	*By amount and source*	Habitats for plant and animal nursery and reproduction
		Soil formation and composition	Weathering processes	*By amount/concentration and source*	Maintenance of bio-geochemical conditions of soils including fertility, nutrient storage, or soil structure; includes biological, chemical, physical weathering and pedogenesis
		Water conditions	Chemical condition of freshwaters	*By amount/concentration and source*	Maintenance / buffering of chemical composition of freshwater column and sediment to ensure favourable living conditions for biota e.g. by denitrification, re-mobilisation/re-mineralisation of phosphorous, etc.
		Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations	*By amount, concentration or climatic parameter*	Global climate regulation by greenhouse gas/carbon sequestration by terrestrial ecosystems
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Physical and experiential interactions	Experiential use of plants, animals and land-/seascapes in different environmental settings	*By visits/use data, plants, animals, ecosystem type*	In-situ bird watching, etc.
		Intellectual and representative interactions	Heritage, cultural		Historic records, cultural heritage
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Spiritual and/or emblematic	Symbolic	*By use, plants, animals, ecosystem type*	Emblematic plants and animals e.g. national symbols such as American eagle, British rose, Welsh daffodil
		Other cultural outputs	Bequest		Willingness to preserve plants, animals, ecoystems, land-/seascapes for the experience and use of future generations; moral/ethical perspective or belief

Fig. 2: Ecosystem services most relevant in the Mediterranean forests (CICES)

Source: INFORMED Stakeholder Panel meeting Lisbon 2015

	Technological approach	**Social approach**
Focus on	- Technological innovations - Large scale investments - Value chain perspective - Sectoral development - Vertical integration	- Social innovations - Small scale - High added value P&S - Network economy - Inter-sectoral development - Horizontal integration
Outputs and inputs diversification	- Wood as the unique raw material - Diversification in outputs	- Diversification inputs (industrial wood, biomass, NTFPs, ESs, etc.)
Market power	- Increased market power of the industrial companies controlling the advanced technologies (high risks connected to the companies consolidation trends)	- Balanced market power among the various diversified operators (reduced risks due to the diversification)
Measure of performance	- Eco-Innovation Scoreboard (national level), by the Eco-Innovation Observatory	- Spot, site-specific (e.g. Local Action Groups within the EU LEADER program)
Model regions	- UK - Scandinavian countries	- Mediterranean countries - mountain regions

Fig. 3: Technological and social approach to innovation in bio-based economy in forestry

Source: Pettenella, Secco and Masiero - forthcoming

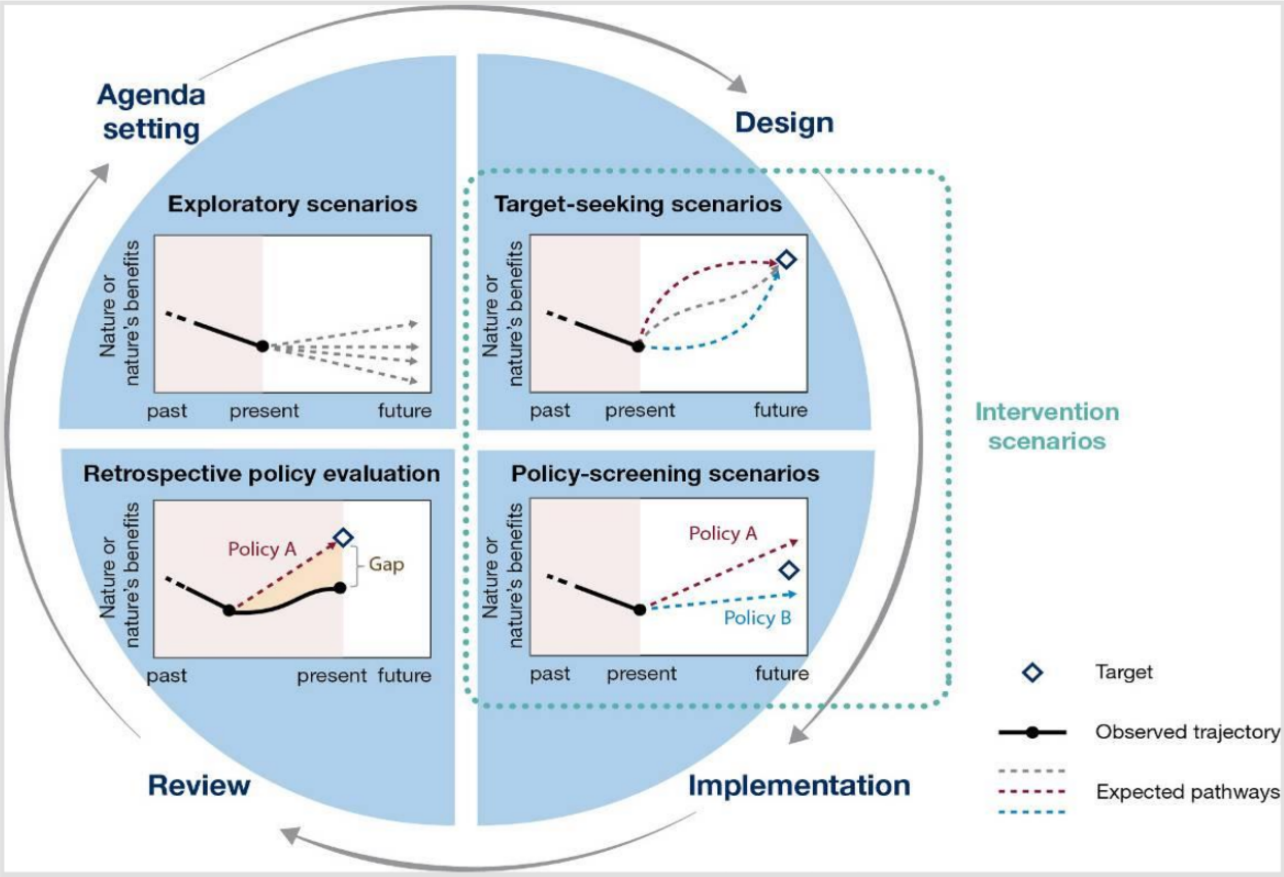

Fig. 4: Roles played by different types of scenarios corresponding to the major phases of the policy cycle

Source: IPBES Summary for policymakers of the methodological assessment of scenarios and models of biodiversity and ecosystem services http://www.ipbes.net/publication/summary-policymakers-methodological-assessment-scenarios-and-models-biodiversity-and

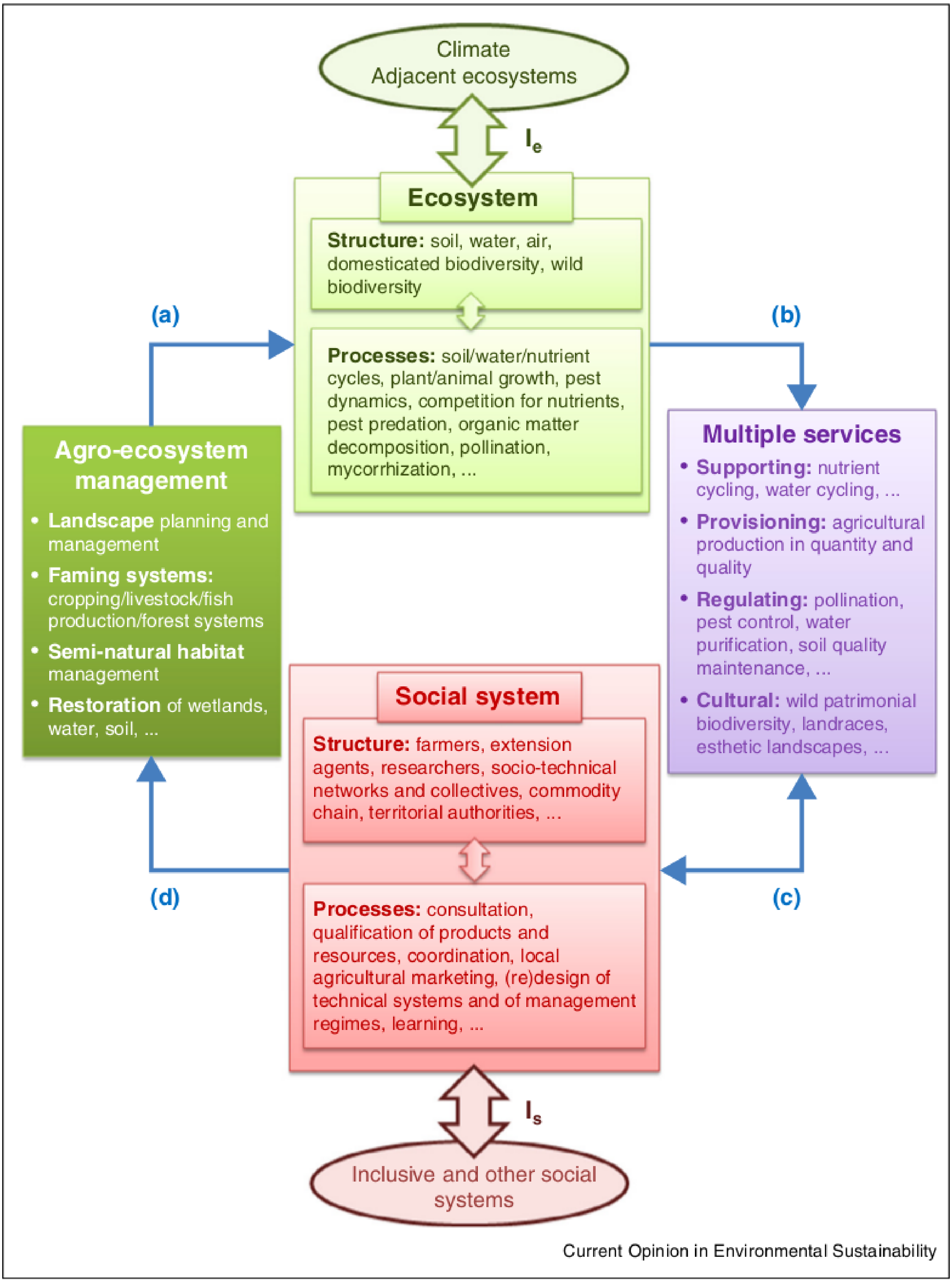

Fig. 5: Social-ecological system

Source: Lescourret et al (2015) A social-ecological approach to managing multiple agro-ecosystem services. Current Opinion in Environmental Sustainability 14:68-75

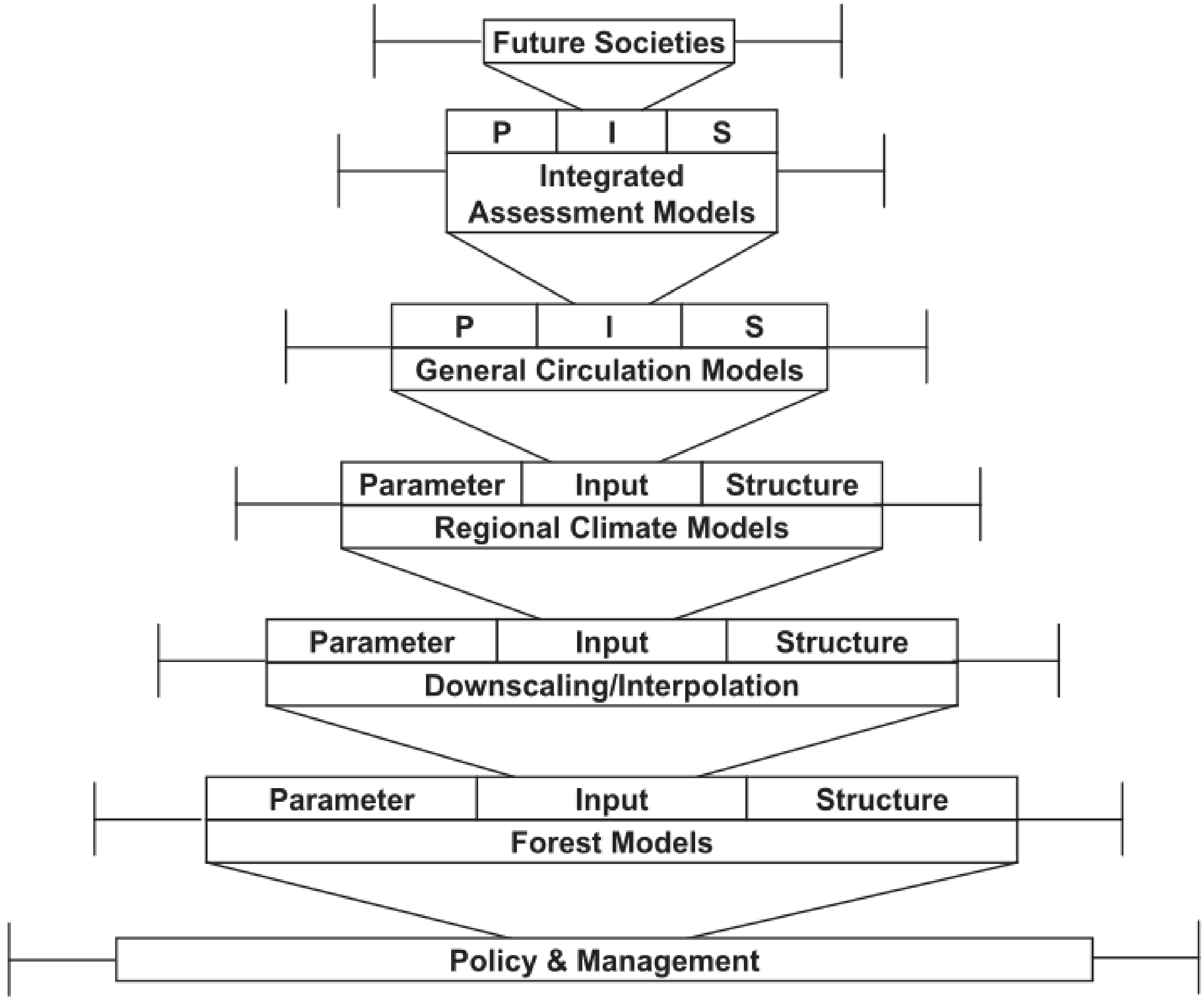

Fig. 6: The cascade of uncertainty

Source: Lindner et al (2014) Climate change and European forests: What do we know, what are the uncertainties, and what are the implications for forest management? J Environ Manage, 146:69–83