Module 2: DPSIR Overview

This Module will provide and overview of the DPSIR framework, and examples from case studies in which it has been used.

Basic DPSIR Concepts

DPSIR Overview - DPSIR Framework

The **Driver-Pressure-State-Impact-Response (DPSIR)** scheme is a flexible framework that can be used to assist decision-makers in many steps of the decision process. DPSIR was initially developed by the Organisation for Economic Co-operation and Development (OECD 1994) and has been used by the United Nations (UNEP 1994; UNEP 2007) and European Environmental Agency (Dutch National Institute for Public Health and the Environment 1995; Pierce 1998; EEA 1999) to relate human activities to the state of the environment.

DPSIR has been widely used for many applications including
•Management of water resources
•River basin management
•Wetlands
•Marine systems
•Agro-environments
•Sustainable development
•Air pollution
•Climate change
•Biodiversity
•Invasive species
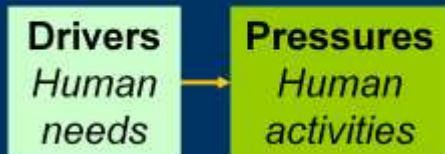
DPSIR Overview - DPSIR Concepts: Drivers

In the DPSIR conceptual framework, **Drivers** are the social, demographic and economic developments in societies and the corresponding changes in life styles, overall levels of consumption and production patterns.

In particular Drivers are often defined as socio-economic sectors that fulfill human needs for
•Food
•Water
•Shelter
•Health
•Security
•Culture

Driving forces can originate and act globally, regionally or locally.

DPSIR Overview - DPSIR Concepts: Pressures

Drivers function through human activities which may intentionally or unintentionally exert **Pressures** on the environment.

Human activities that exert pressure include
•Land use changes
•Resource consumption
•Release of substances
•Physical damage through direct contact uses

Pressures depend on the kind and level of technology involved in source activities, and can vary across geographic regions and spatial scales.

DPSIR Overview - DPSIR Concepts: State

The pressures exerted by society may lead to unintentional or intentional changes in the **State** of the ecosystem.

Usually these changes are unwanted and are seen as negative (damage, degradation, etc.). The pressures exerted by society may directly impact the ecosystem, such as harvesting or dredging, or may be transported and transformed through a variety of natural processes to indirectly cause changes in ecosystem conditions.

The **State** is the condition of the abiotic and biotic components of the ecosystems in a certain area in terms of
•Physical variables - the quantity and quality of physical phenomena such as temperature or light availability
•Chemical variables – the quanity and quality of chemicals such as atmospheric CO_2 concentrations or nitrogen levels
•Biological variables – the condition at the ecosystem, habitat, species, community, or genetic levels, such as fish stocks or biodiversity
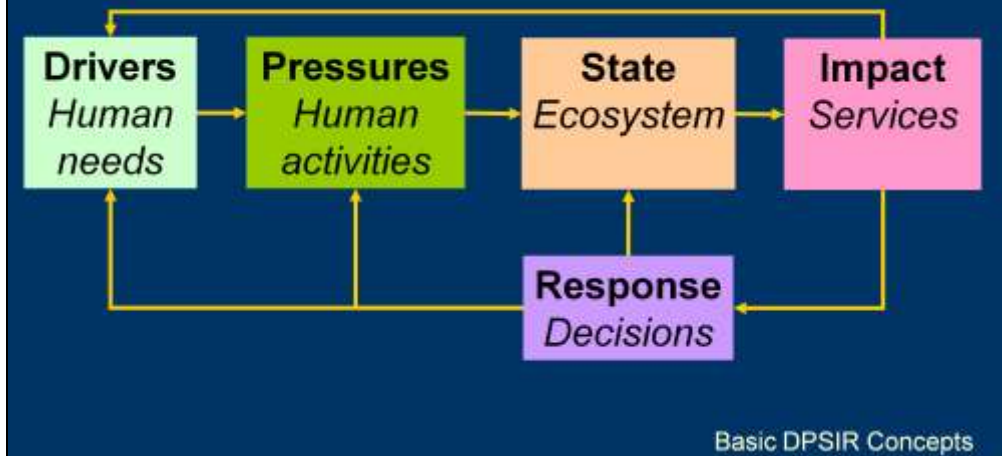
DPSIR Overview - DPSIR Concepts - Impact

Changes in the quality and functioning of the ecosystem have an **Impact** on the welfare or well-being of humans through the provision of ecosystem services.

Ecosystem goods and services are ecosystem functions or processes that directly or indirectly benefit human social or economic drivers, or have the potential to do so in the future. Ecosystem processes benefit humans through

•Provisioning of food, timber, water

•Regulation of air quality, water quality, or disease

•Cultural benefits including aesthetic or recreational value

•Indirect supporting processes that maintain the ecosystem

The value of ecosystem services depends on human need and use (e.g., market value).

DPSIR Overview - DPSIR Concepts - Response

Humans make decisions in **Response** to the impacts on ecosystem services or their perceived value.

Responses are actions taken by groups or individuals in society and government to prevent, compensate, ameliorate or adapt to changes in the state of the environment by seeking to

•Control drivers or pressures through regulation, prevention, or mitigation

•Directly maintain or restore the state of the environment

•Deliberately "do nothing"

Decision making processes occur at a variety of scales, from individuals to local management to federal government.

Basic DPSIR Concepts

DPSIR Overview - Benefits of DPSIR

The DPSIR framework has several features which have contributed to its wide use:

•Transparency and simplicity, with five concepts that are readily obvious to both scientists and stakeholders.

•Enhances communication between scientists and stakeholders by simplifying the complex connections between humans and the environment

•Allows particular linkages or interactions to be isolated while retaining conceptual relevance to the larger system

•Inherently human-centric, it is appealing to the public and decision-makers.

•Appealing to policy actors because it links political objectives to environmental problems and implies causal relationships among factors (Smeets and Weterings, 1999; Giupponi, 2007)

•The elements of DPSIR can be mapped onto other frameworks, including those of the Millennium Ecosystem Assessment (Hassan et al. 2005) and Long Term Ecological Research Program

In some applications of DPSIR, Drivers or Pressures are considered to include natural physical drivers, such as climate change or hurricane events. However, because there is value in the human-centric nature of DPSIR, we focus Drivers and Pressures as specifically human-derived and instead include natural processes within State. This is helpful when identifying where to target Responses, such that they can be specifically linked to socio-economic sectors or human activities.

The DPSIR framework does not capture every situation perfectly, but is a reasonable means to organize the many social, economic and ecological interactions.

DPSIR Overview - DPSIR Applications

The DPSIR framework has been used for a variety of applications including…

•Deriving indicators of sustainability which can be used in monitoring programs, or mapped to quantify and track current and future levels of key metrics

•Summarizing and categorizing information from a variety of sources

•Providing a framework for developing models or decision support tools which can be used to evaluate and compare decision outcomes

We will present a few real-world examples of such applications.

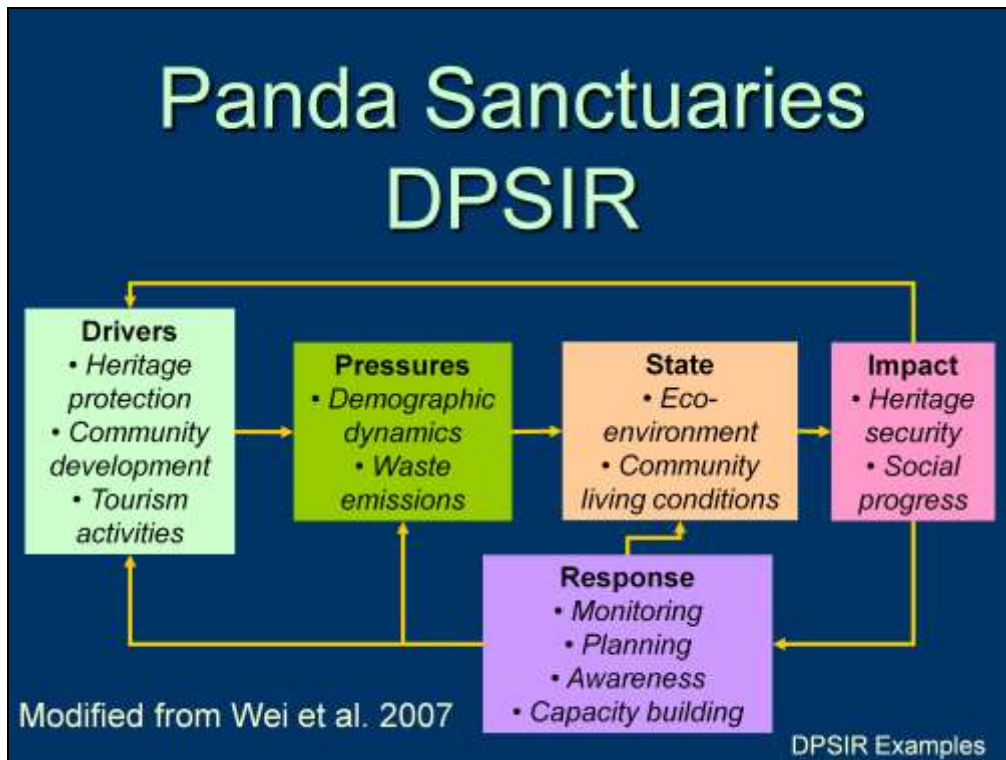**DPSIR Overview - DPSIR Example: Panda Sanctuaries**

Wei and colleagues used the DPSIR framework to identify key issues and a set of indicators for evaluating sustainability of Giant Panda Sanctuaries in Sichuan, China.

The Sichuan Giant Panda Sanctuaries are large areas of protected habitat in Southwestern China, covering almost 1 million hectares. Local farmers account for approximately 86% of the total population within the area.

Local authorities have been making efforts to protect World Heritage sites. A set of indicators for assessing sustainable development will facilitate monitoring and determine whether sites are being properly managed.

The DPSIR Framework was used to generate policy relevant indicators for evaluating sustainability of Giant Panda Sanctuaries.

Wei, J., Z. Yountao, X. Houqin, and Y. Hui. 2007. A framework for selecting indicators to assess the sustainable development of the natural heritage site. Journal of Mountain Science 4:321-330.

DPSIR Overview - Panda Sanctuaries DPSIR

The authors used the DPSIR framework to identify key factors which could be monitored to indicate sustainable development of Giant Panda Sanctuaries.

In addition to natural physical drivers, including climate change, key socio-economic Drivers and their corresponding indicators, included:

•Heritage protection & conservation   •Community development   •Tourism Activities

These Socio-economic drivers create Pressures, and their corresponding indicators, on the state of the ecosystem through

•Demographic dynamics   •Waste emissions

Changes in the State that can be monitored include

•Eco-environment   •Community living conditions

Changes in the ecological and environmental state can have Impacts on indicators of

•Heritage security   •Social progress

Long-range management actions, or Response, may be quantified by

•Monitoring   •Thematic planning   •Awareness, training, and education   •Capacity building

Wei, J., Z. Yountao, X. Houqin, and Y. Hui. 2007. A framework for selecting indicators to assess the sustainable development of the natural heritage site. Journal of Mountain Science 4:321-330.

DPSIR Indicators

Item	Factor	Indicators
Driver	Heritage protection & conservation	Type and value of protection incentives, area under conservation
Driver	Community development	Urbanization level, population growth rate
Driver	Tourism Activities	% employment in tourism, contribution of tourism income to local GDP
Pressure	Demographic dynamics	Net migration rate
Pressure	Waste emissions	Rates of greenhouse gas emissions, rates of sulphur dioxide emissions
State	Eco-environment	Soil degradation index
State	Community living conditions	Access to safe drinking water, life expectancy
Impact	Heritage security	Landscape fragmentation, bamboo coverage, distribution of panda sanctuaries
Impact	Social progress	Public perception of condition
Response	Monitoring	Construction of a monitoring network, investment in monitoring
Response	Thematic planning	Quantity & quality of plans, implementation of plans
Response	Awareness, training, and education	Sales promotion, percent of population trained
Response	Capacity building	Share of protection investment in GDP; funding of programs launched

Modified from Wei et al. 2007

DPSIR Examples

DPSIR Overview – DPSIR Indicators

The authors used the DPSIR framework to generate a tentative list of sustainable development indicators which could be used to monitor management activities.

In addition to natural physical drivers, including climate change, key socio-economic Drivers and their corresponding indicators, included:

Heritage protection & conservation: type and value of protection incentives, area under conservation

Community development: urbanization level, population growth rate

Tourism Activities: % employment in tourism, contribution of tourism income to local GDP

These Socio-economic drivers create Pressures, and their corresponding indicators, on the state of the ecosystem through

Demographic dynamics: net migration rate

Waste emissions: rates of greenhouse gas emissions, rates of sulphur dioxide emissions

Changes in the State that can be monitored include

Eco-environment: Soil degredation index

Community living conditions: Access to safe drinking water, life expectancy

Changes in the ecological and environmental state can have Impacts on indicators of

Heritage security: landscape fragmentation, bamboo coverage, distribution of panda sanctuaries

Social progress: public perception of condition

Long-range management actions, or Response, may be quantified by

Monitoring: construction of a monitoring network, investment in monitoring

Thematic planning: quantity & quality of plans, implementation of plans

Awareness, training, and education: Sales promotion, Percent of population trained

Capacity building: share of protection and pollution treatment investment in GDP; funding of programs launched

Wei, J., Z. Yountao, X. Houqin, and Y. Hui. 2007. A framework for selecting indicators to assess the sustainable development of the natural heritage site. Journal of Mountain Science 4:321-330.
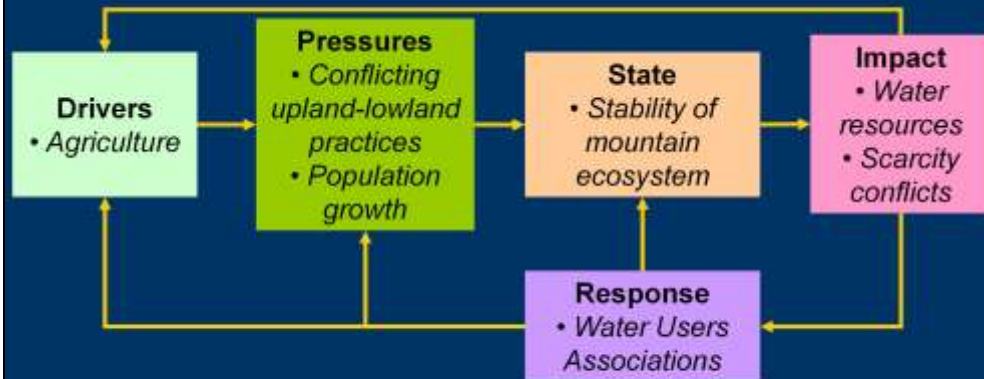
DPSIR Overview - DPSIR Example: Mountain Development

Mountains are globally important ecosystems, providing rich biological diversity, recreational opportunities, and hubs of culture and heritage. However, they are susceptible to accelerating rates of soil erosion, landslides, and loss of habitat, in addition to widespread poverty among mountain inhabitants.

Odermatt used the DPSIR framework in a comparative study of 40 case studies to demonstrate possible approaches to Sustainable Mountain Development (SMD) that could be applied globally.

Odermatt, S. 2004. Evaluation of mountain case studies by means of sustainability variables: A DPSIR model as an evaluation tool in the context of the North-South discussion. Mountain Research and Development 24:336-341.

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DPSIR Overview - Mountain DPSIR

For most case studies, Odermatt was able to draw a DPSIR diagram to illustrate the key drivers, pressures, state variables, impacts, and responses evaluated in the given study. The example here is modified from a Mount Kenya case study.

Odermatt, S. 2004. Evaluation of mountain case studies by means of sustainability variables: A DPSIR model as an evaluation tool in the context of the North-South discussion. Mountain Research and Development 24:336-341.

DPSIR Overview – Review of Responses

Odermatt compared the case studies by identifying key elements within the DPSIR framework.

The major Driving forces and Pressures in developing countries included

•Unsustainable agriculture and landuse   •Weak national economy

•Erosion   •Deforestation   •Shifting cultivation

The review of the 40 case studies led to a total of 22 responses which could be used for sustainable mountain development, including:

•Involvement of stakeholders

•Empowerment of mountain communities in decision making processes

•Creation of new livelihood opportunities

•Improvement of transportation services

•Water Users Associations

•Hydropower generation

•Sustainable forestry and agriculture

•Reforestation

•Documenting and communicating local knowledge

Through comparison of existing case studies, the author concluded that "involvement of stakeholders" and "gathering of baseline information" were of utmost importance for achieving sustainable mountain development.

Odermatt, S. 2004. Evaluation of mountain case studies by means of sustainability variables: A DPSIR model as an evaluation tool in the context of the North-South discussion. Mountain Research and Development 24:336-341.
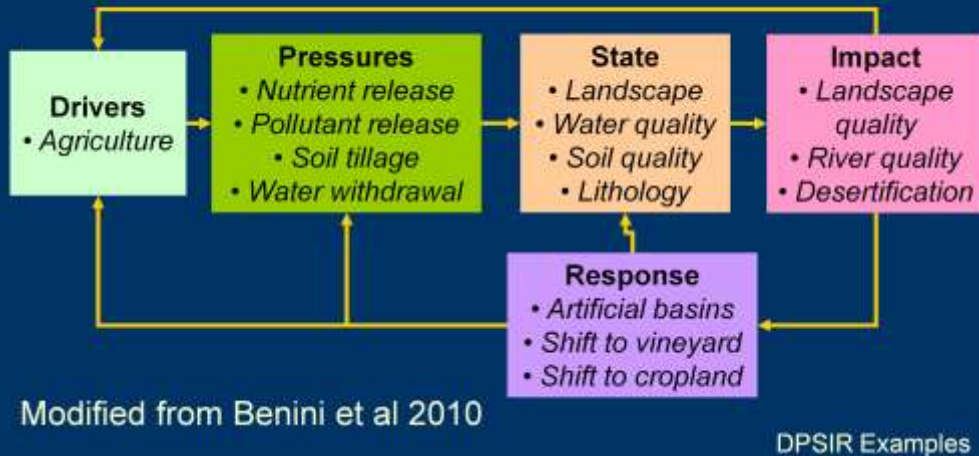
DPSIR Overview - DPSIR Example: Water Management

Benini and colleagues used the DPSIR framework to evaluate indicators associated with shortage of water in the river and the modification of the landscape structure in the Lamone River basin of Northern Italy.

The effect of different management scenarios on the indicators was evaluated using an approach called Multi-Criteria Decision Analysis. This allows decision-makers to examine situations where different stakeholders have different concepts of what is important and what outcomes they desire. A software program, called MULINO-Decision Support System, was used by the authors; it adopts DPSIR as a reference framework to integrate socio-economic and ecological modeling techniques.

Benini, L., V. Bandini, D. Marazza, and A. Contin. 2010. Assessment of land use changes through an indicator-based approach: A case study from the Lamone river basin in Northern Italy. Ecological Indicators 10:4-14
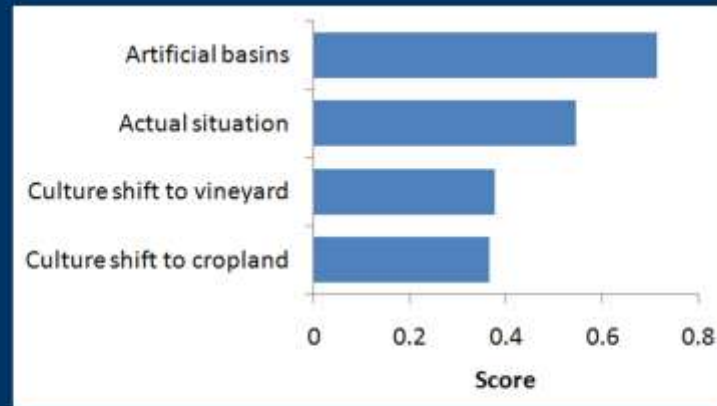
DPSIR Overview -Water Management DPSIR

Benini and colleagues used the DPSIR framework to derive the conceptual model for management of the river basin.

This process defined the key elements to be included in the model evaluation of management scenarios.

Benini, L., V. Bandini, D. Marazza, and A. Contin. 2010. Assessment of land use changes through an indicator-based approach: A case study from the Lamone river basin in Northern Italy. Ecological Indicators 10:4-14

DPSIR Overview – Comparing Responses

The selected indicators were evaluated under a variety of management scenarios using MULINO-DSS, with equal weight given to social, environmental, and economic concerns. The decision indicators included loss of agricultural income, loss

of agricultural surfaces, number of artificial basins, hydrological balance, and presence of a riparian buffer. The various indicators are combined using additive weighting to give a score for each possible management action.

The creation of artificial basins was determined to be the best scenario because it solved the water balance issue but produced only a small loss in agricultural income. The current management scenario ranked 8th out of the 13 evaluated scenarios.

The authors emphasize that their analysis is not the solution, but only one piece to be entered into the public debate on river basin management strategies.

Benini, L., V. Bandini, D. Marazza, and A. Contin. 2010. Assessment of land use changes through an indicator-based approach: A case study from the Lamone river basin in Northern Italy. Ecological Indicators 10:4-14

DPSIR Overview - Need for Tools

Although DPSIR has been widely used, tools are generally lacking which can aid decision-makers in building a DPSIR framework for their own problem.

DPSIR frameworks are typically developed to address a specific management problem.

In the next module, we present a suite of tools to facilitate development of DPSIR frameworks.