Trajectories of Social-Ecological Systems in Latin American Watersheds: Facing Complexity and Vulnerability in the context of Climate Change

1st International Team Meeting

Mexico City, 19-20 Febr. 2018

Working package 1. Operationalization of SESs and links with vulnerability framework:

Spatial localization and delineation of social-ecological subsystems in terms of resource (riparian, agricultural, forest etc.) and actor systems;

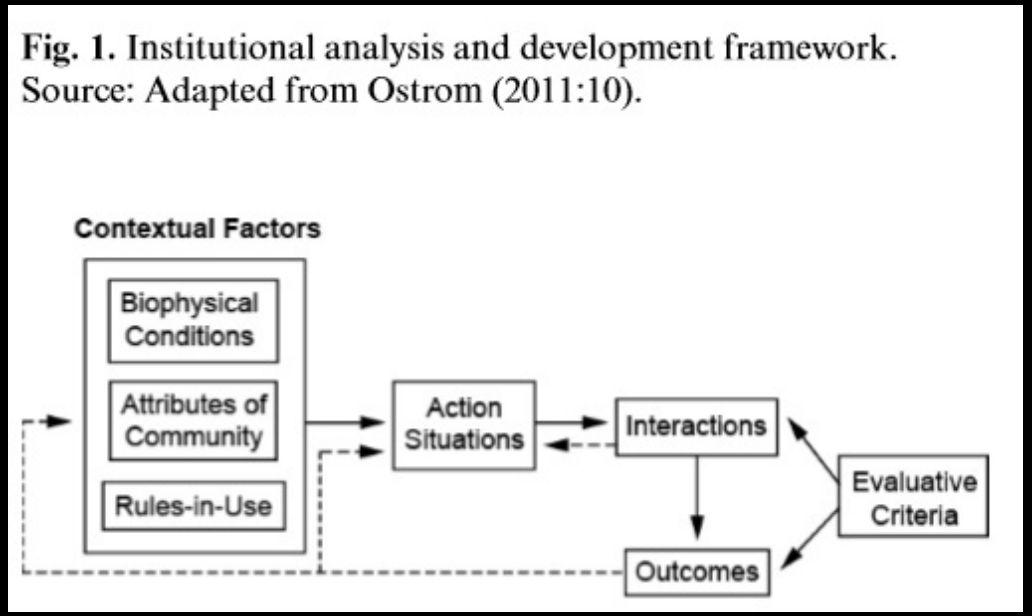
2) Definition of second, third and fourth level SES key variables.

3) Identification of the links between SES key variables and climate change vulnerability (some historical analysis needed)

Marco SES, Ostrom (2009, 2011)

- It is an integrative framework - product of the bibliographic review of different currents and theories to understand the functioning of ecosystems and society
- It is a general framework - adaptable to other theories and different SES
- It is a dynamic framework - that can be changed and adapted to other situations
- It is a framework that can be used to study an SES and for comparison between two or more SES

Marco relacionado: ADI
Marco de Análisis y Desarrollo Institucional



Framework of SES, Ostrom (2009)

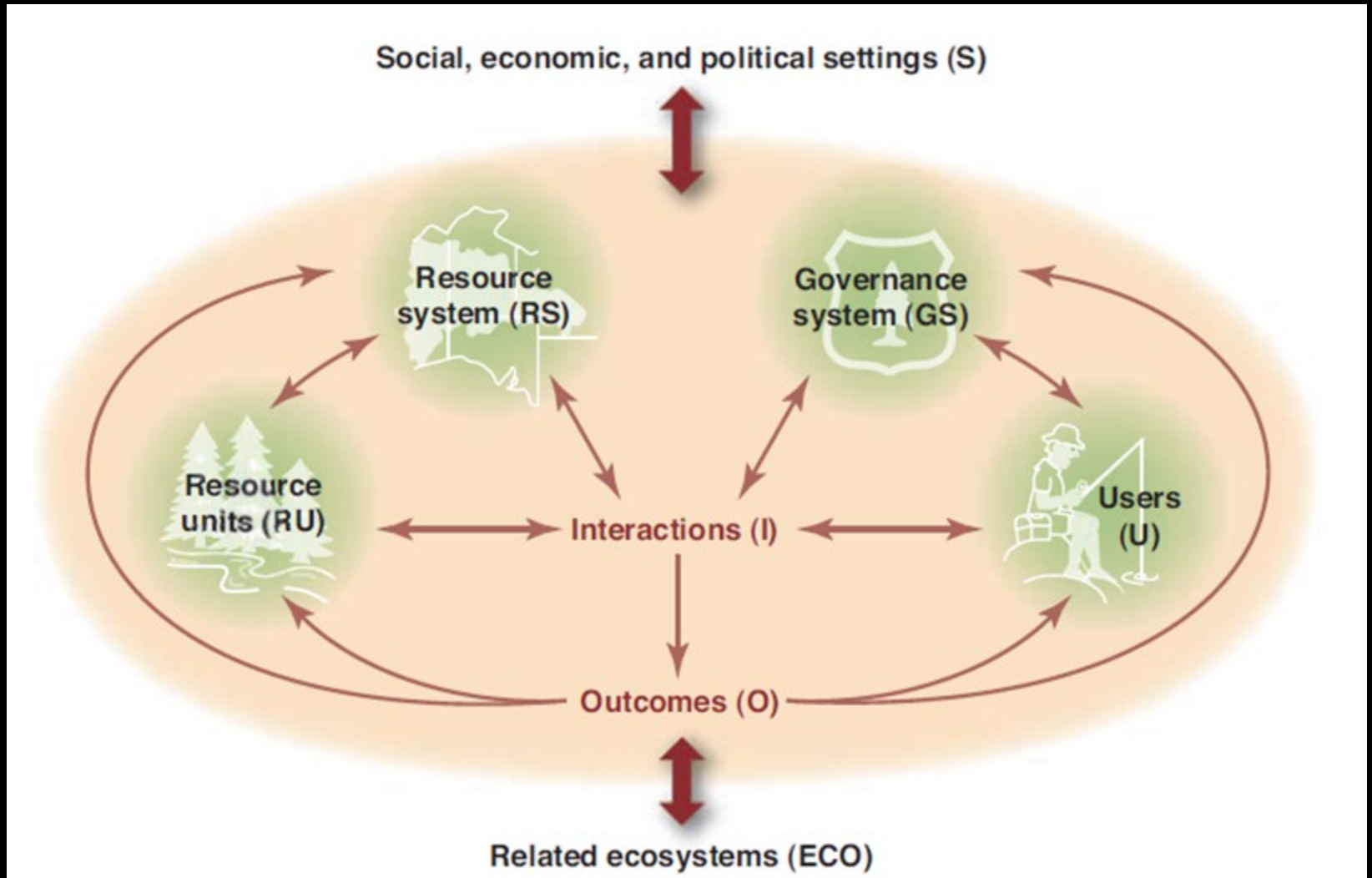


Fig. 1. The core subsystems in a framework for analyzing social-ecological systems.

Variables of SES, Ostrom (2009)

Social, Economic, and Political Settings (S)
S1– Economic development. S2– Demographic trends. S3– Political stability. S4– Other governance systems.
S5– Markets. S6– Media organizations. S7– Technology.

Resource Systems (RS)

RS1– Sector (e.g., water, forests, pasture, fish)
RS2– Clarity of system boundaries
RS3– Size of resource system
RS4– Human-constructed facilities
RS5– Productivity of system
RS6– Equilibrium properties
RS7– Predictability of system dynamics
RS8– Storage characteristics
RS9– Location

Governance Systems (GS)

GS1– Government organizations
GS2– Nongovernment organizations
GS3– Network structure
GS4– Property-rights systems
GS5– Operational-choice rules
GS6– Collective-choice rules
GS7– Constitutional-choice rules
GS8– Monitoring and sanctioning rules

Resource Units (RU)

RU1– Resource unit mobility
RU2– Growth or replacement rate
RU3– Interaction among resource units
RU4– Economic value
RU5– Number of units
RU6– Distinctive characteristics
RU7– Spatial and temporal distribution

Actors (A)

A1– Number of relevant actors
A2– Socioeconomic attributes
A3– History or past experiences
A4– Location
A5– Leadership/entrepreneurship
A6– Norms (trust-reciprocity)/social capital
A7– Knowledge of SES/mental models
A8– Importance of resource (dependence)
A9– Technologies available

Action Situations: Interactions (I) → Outcomes (O)

Activities and Processes:

I1– Harvesting
I2– Information sharing
I3– Deliberation processes
I4– Conflicts
I5– Investment activities
I6– Lobbying activities
I7– Self-organizing activities
I8– Networking activities
I9– Monitoring activities
I10– Evaluative activities

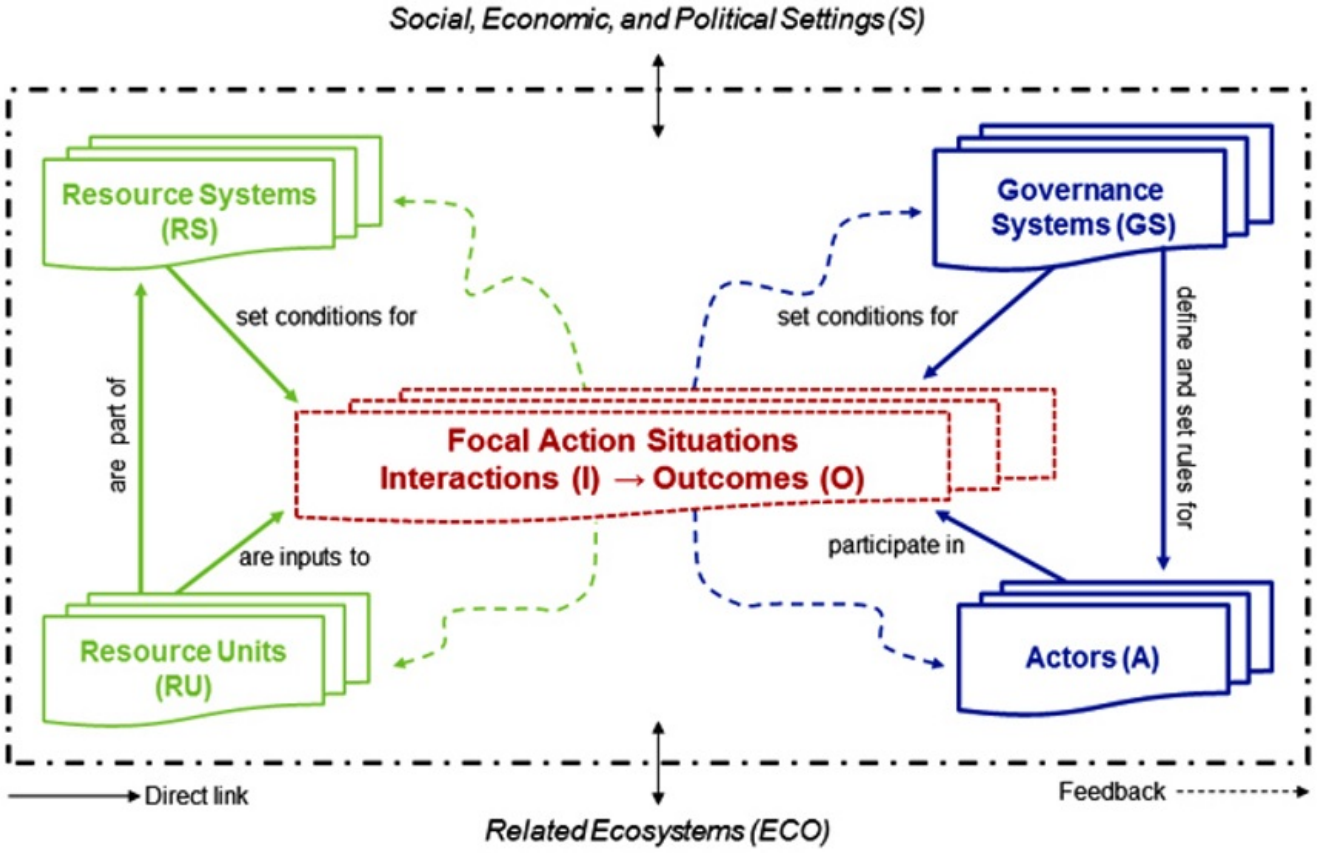
Outcome Criteria:

O1– Social performance measures
(e.g., efficiency, equity, accountability, sustainability)
O2– Ecological performance measures
(e.g., overharvested, resilience, biodiversity, sustainability)
O3– Externalities to other SESs

Related Ecosystems (ECO)
ECO1– Climate patterns. ECO2– Pollution patterns. ECO3– Flows into and out of focal SES.

SES adjusted frame, McGinnis & Ostrom (2014)

Fig. 2. Revised social-ecological system (SES) framework with multiple first-tier components. Solid boxes denote first-tier categories. Resource Systems, Resource Units, Governance Systems, and Actors are the highest-tier variables that contain multiple variables at the second tier as well as lower tiers (see Table 1 for an updated list of second-tier variables within each of the top-tier categories). Action Situations are where all the action takes place as inputs are transformed by the actions of multiple actors into outcomes. Dashed arrows denote feedback from action situations to each of the top-tier categories. The dotted-and-dashed line that surrounds the interior elements of the figure indicates that the focal SES can be considered as a logical whole, but that exogenous influences from related ecological systems or social-economic-political settings can affect any component of the SES. These exogenous influences might emerge from the dynamic operation of processes at larger or smaller scales than that of the focal SES.



Unit is part of the Resource System

Action situation in I-O

In place of users - actors

Variables of SES, McGinnis & Ostrom (2014)

Table 1. Second-tier variables of a social-ecological system. Source: Adapted from Ostrom (2009:421).

First-tier variable	Second-tier variables
Social, economic, and political settings (S)	S1 – Economic development
	S2 – Demographic trends
	S3 – Political stability
	S4 – Other governance systems
	S5 – Markets
	S6 – Media organizations
	S7 – Technology
Resource systems (RS)	RS1 – Sector (e.g., water, forests, pasture, fish)
	RS2 – Clarity of system boundaries
	RS3 – Size of resource system
	RS4 – Human-constructed facilities
	RS5 – Productivity of system
	RS6 – Equilibrium properties
	RS7 – Predictability of system dynamics
	RS8 – Storage characteristics
	RS9 – Location
Governance systems (GS)	GS1 – Government organizations
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	GS3 – Network structure
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	GS5 – Operational-choice rules
	GS6 – Collective-choice rules
	GS7 – Constitutional-choice rules
	GS8 – Monitoring and sanctioning rules
Resource units (RU)	RU1 – Resource unit mobility
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	RU6 – Distinctive characteristics
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Actors (A)	A1 – Number of relevant actors
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	A5 – Leadership/entrepreneurship
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	A7 – Knowledge of SES/mental models
	A8 – Importance of resource (dependence)
	A9 – Technologies available
Action situations: Interactions (I) → Outcomes (O)	I1 – Harvesting
	I2 – Information sharing
	I3 – Deliberation processes
	I4 – Conflicts
	I5 – Investment activities
	I6 – Lobbying activities
	I7 – Self-organizing activities
	I8 – Networking activities
	I9 – Monitoring activities
	I10 – Evaluative activities
	O1 – Social performance measures (e.g., efficiency, equity, accountability, sustainability)
	O2 – Ecological performance measures (e.g., overharvested, resilience, biodiversity, sustainability)
	O3 – Externalities to other SESs
Related ecosystems (ECO)	ECO1 – Climate patterns
	ECO2 – Pollution patterns
	ECO3 – Flows into and out of focal SES

Variables of 1st and 2nd level:
S - conditions (S1-7)
RS - resource system (RS1-9)
RU - resource unit (RU1-7)
GS - governance system (GS1-8)
A - actors (A1-9)
I - interactions (I1-10)
O - results (O1-3)
ECO - ecosystems (ECO1-3)

Alternative proposal of variables of a 3rd level, McGinnis & Ostrom (2014)

Table 2. Alternative list of second-tier properties for governance systems (GS*).†

Second-tier variable	Third-tier variables
GS1* – Policy area	
GS2* – Geographic scale of governance system	
GS3* – Population	
GS4* – Regime type	
GS5* – Rule-making organizations	Public sector organizations (government agencies, etc.) Private sector organizations (for-profit) Nongovernmental, nonprofit organizations Community-based organizations Hybrid organizations
GS6* – Rules-in-use	Operational-choice rules Collective-choice rules Constitutional-choice rules
GS7* – Property-rights systems	
GS8* – Repertoire of norms and strategies	
GS9* – Network structure	
GS10* – Historical continuity	

†Asterisks denote the tentative nature of these suggestions.

Modified frame: Hinkel, Bots, Schlüter (2014)

Suitability for forestry and fishing SES, Hinkel, Bots, Schlüter (2014)

Fig. 2. A simple forestry example of a social-ecological system (SES) framework. Boxes denote concepts, black arrows pointing down denote attribution relationships, black open arrowheads pointing up denote subsumption relationships, brown links denote aggregation relationships. A 1 indicates a one-to-one attribution relationship; an asterisk indicates a one-to-many attribution relationship. Concept names are indicated in boldface in the top part of the boxes; attributed variables are listed in the bottom part of the boxes. Process relationships and outcome metrics are not shown.

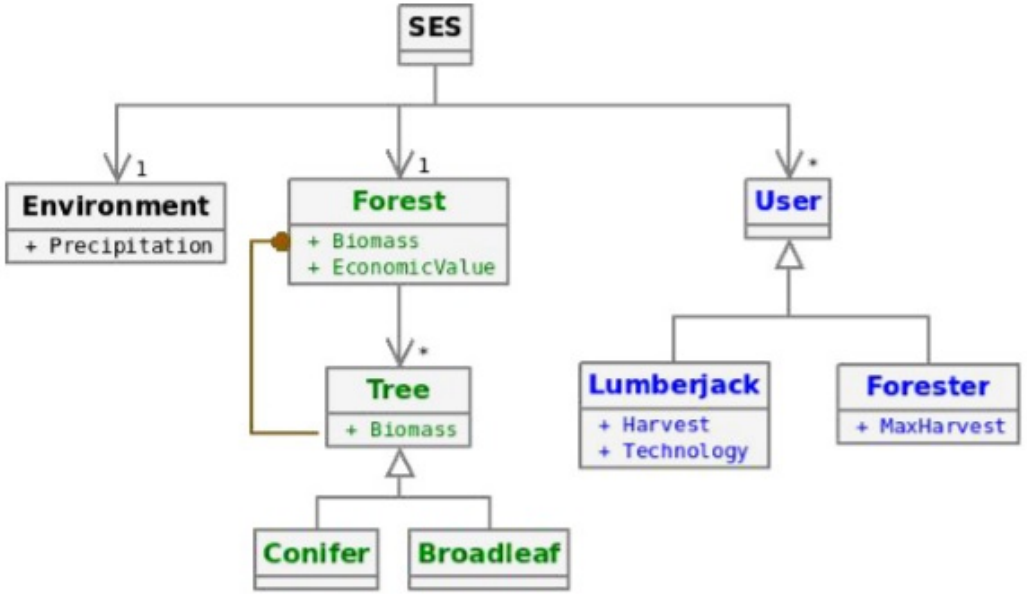
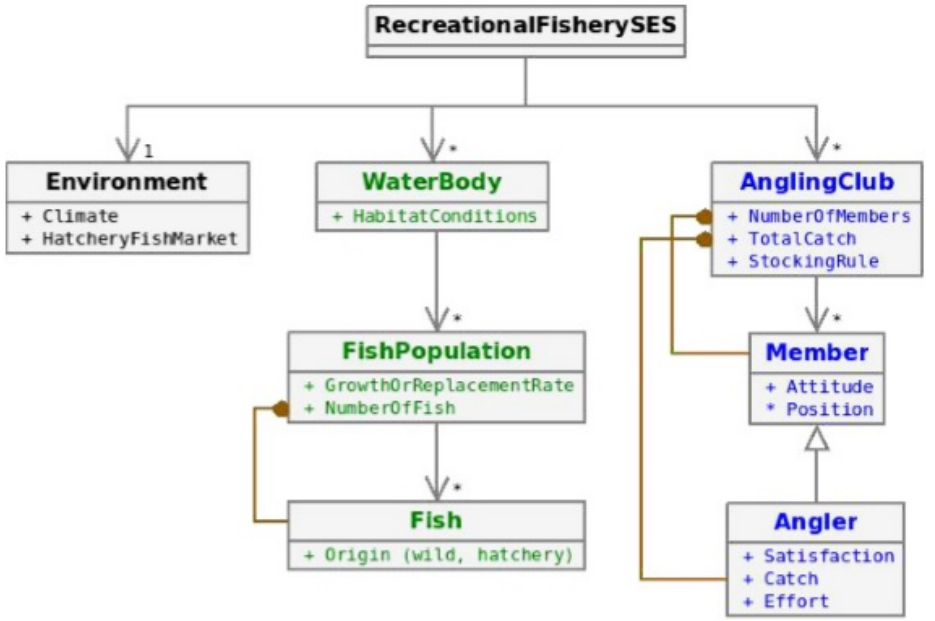
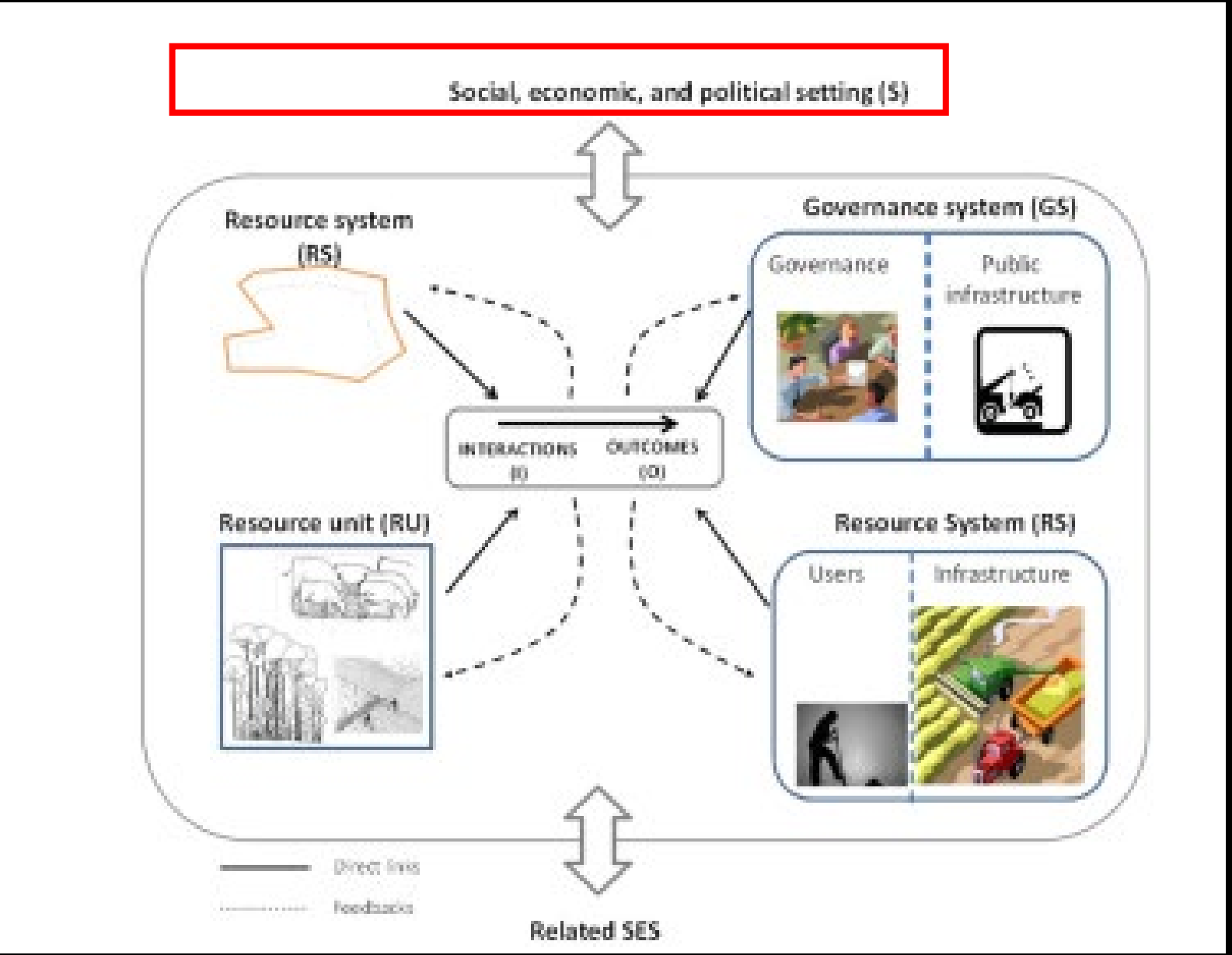


Fig. 4. The social-ecological system (SES) framework applied to the case of a recreational fishery. Boxes denote concepts, black arrows pointing down denote attribution relationships, black open arrowheads pointing up denote subsumption relationships, brown links denote aggregation relationships. A 1 indicates a one-to-one attribution relationship; an asterisk indicates a one-to-many attribution relationship. Concept names are indicated in boldface in the top part of the boxes; attributed variables are listed in the bottom part of the boxes. Process relationships and outcome metrics are not shown.



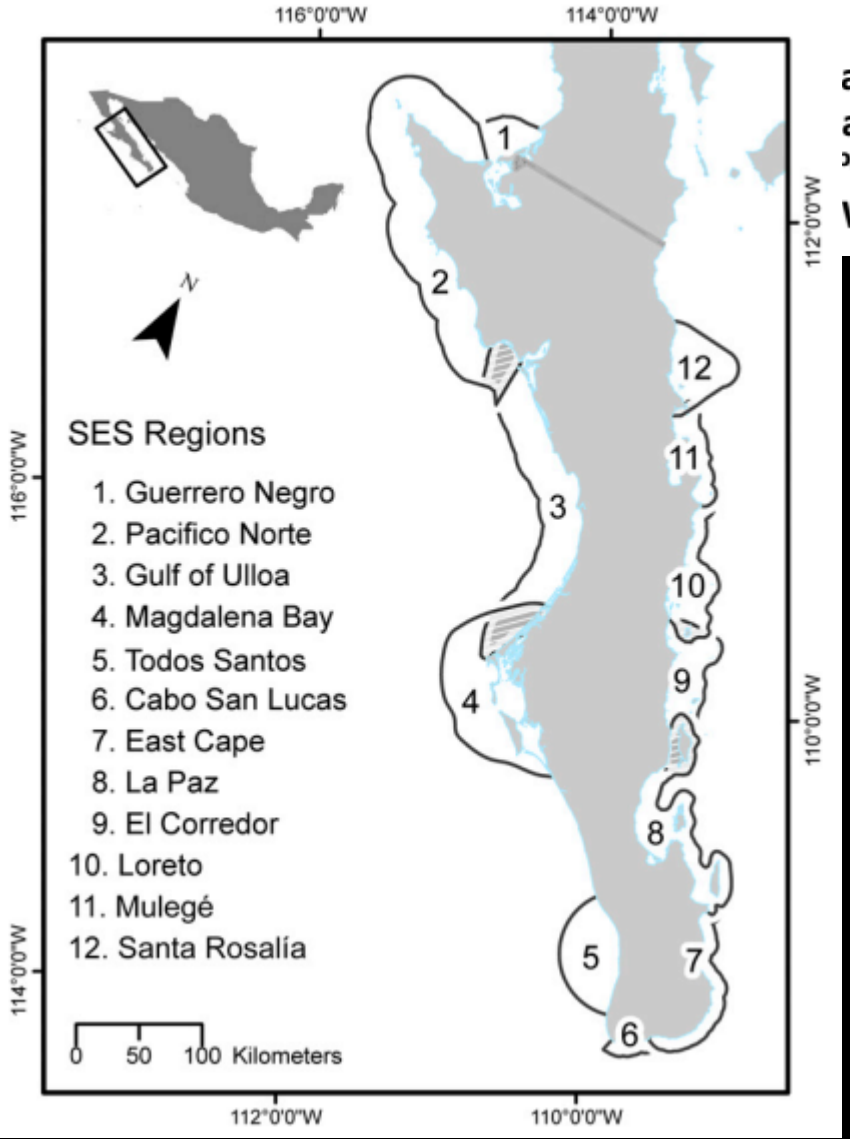
Other interpretation of SES framework

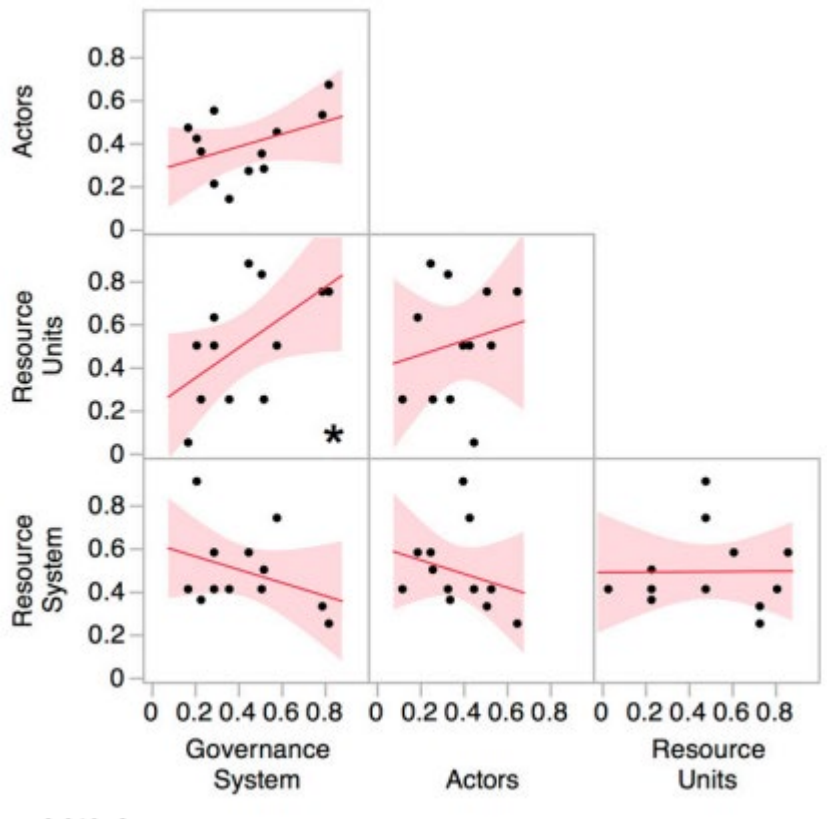


Adapted from Leslie et al. 2015

Operationalizing the social-ecological systems framework to assess sustainability

PNAS, 2015





#	Variable	Code	Tier[1]	Weight[2]	Definition
					The set of institutions (i.e. rules and norms) which shape the behavior of the actors (i.e. fishers) (10).[3]
					Implementation of practical decisions by individuals authorized or allowed to take these actions and the creation of institutions and policy decisions by those actors authorized to participate in the collective decision (11).
					Area-based permanent or limited property rights granted to a formally or informally organized group of fishers (10).
					Policy instrument designed to control inputs into a fishery such the limit of boats, fishing gear, and length of use.
					The characteristics of an individual or group user of the resource units (i.e., fish) (10).
					Type of actors that are present within a particular social-ecological system and participate in or interfere with the harvest of the

Social–ecological traps and transformations in dryland agro-ecosystems: Using water system innovations to change the trajectory of development

GEC, 2013

Elin Enfors *

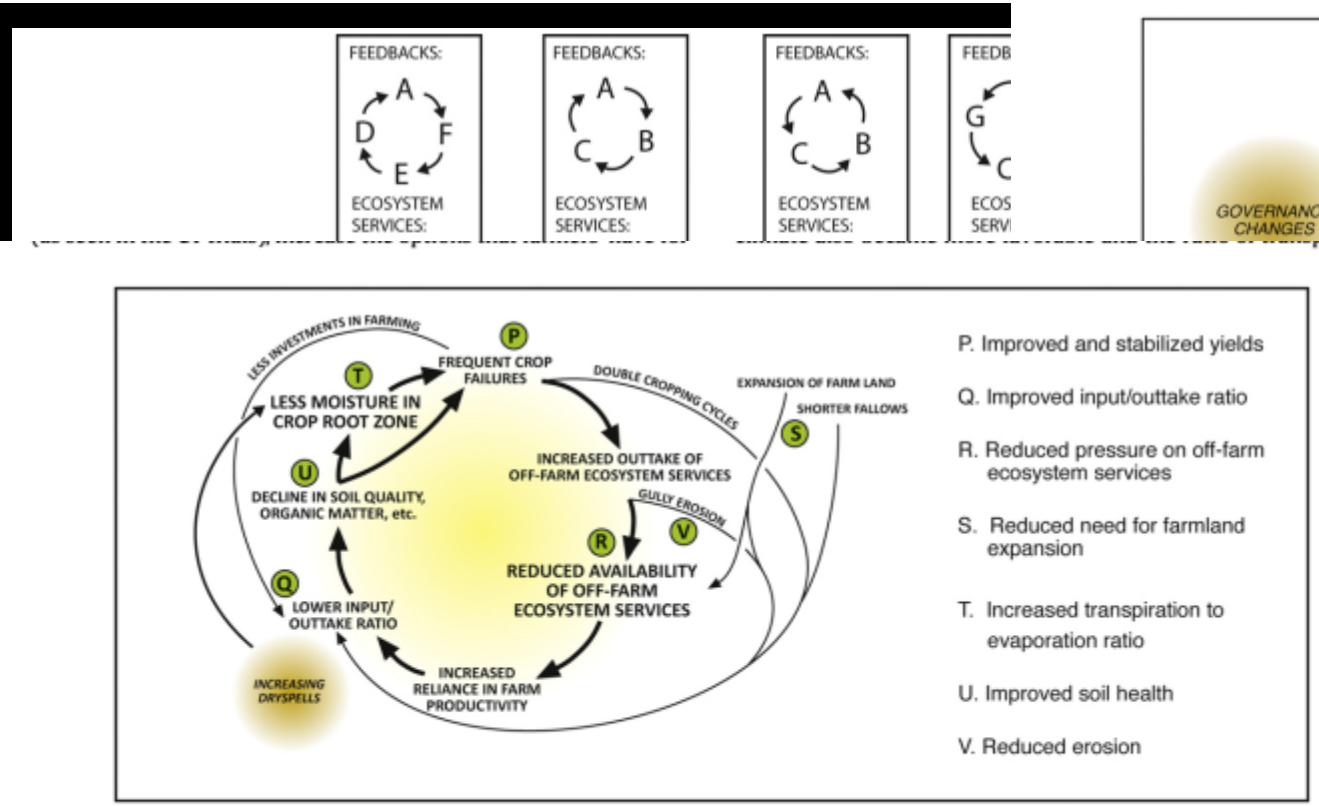
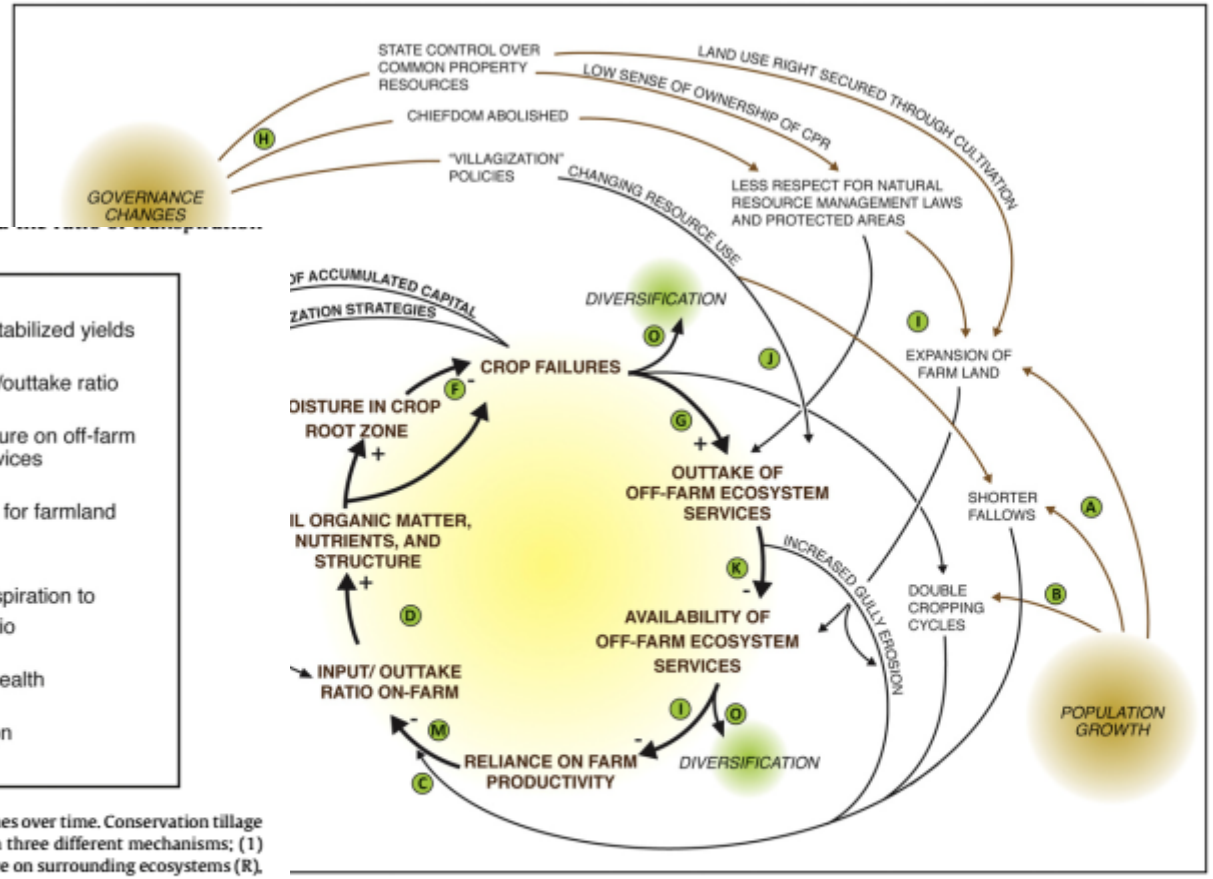
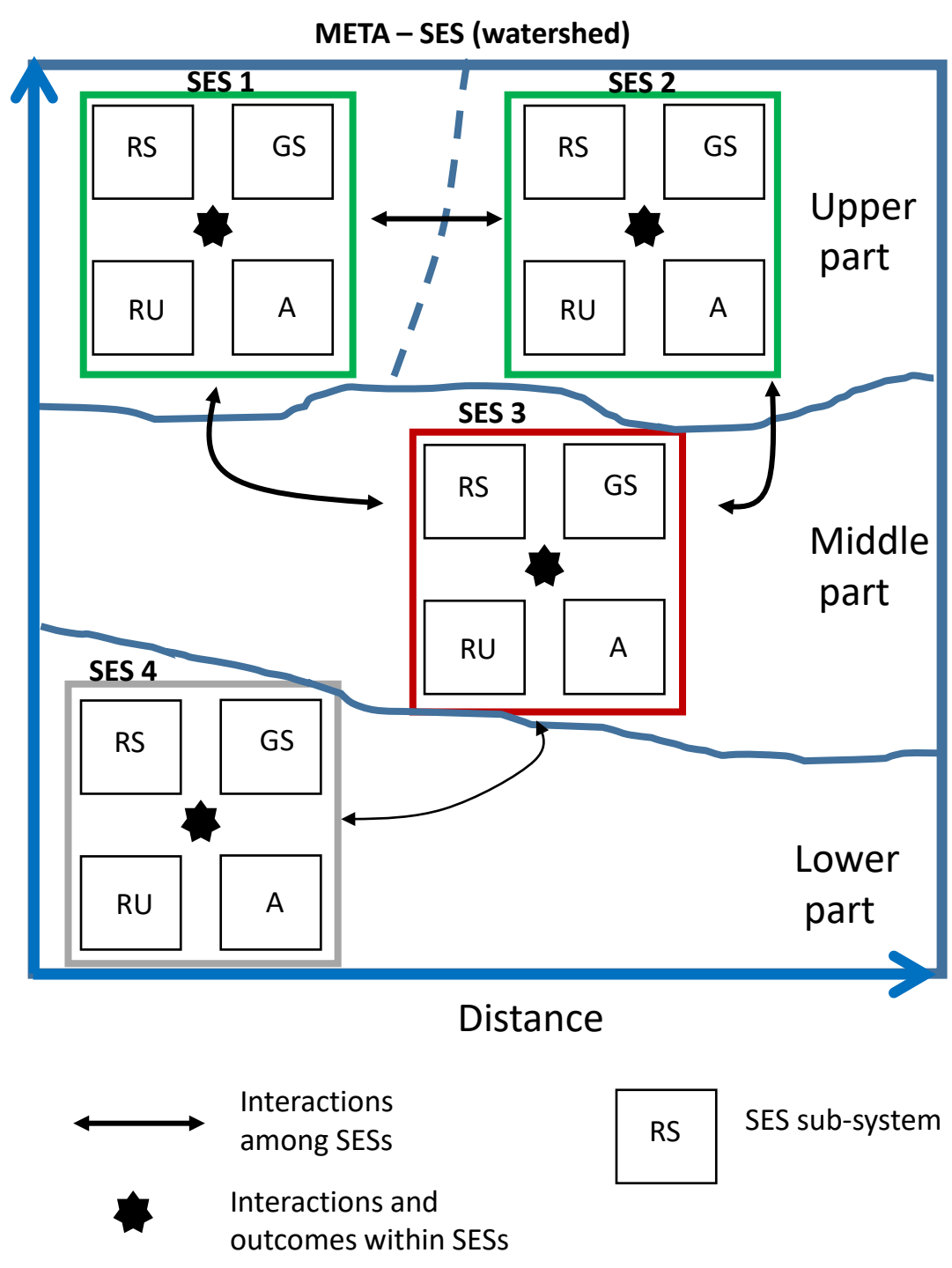
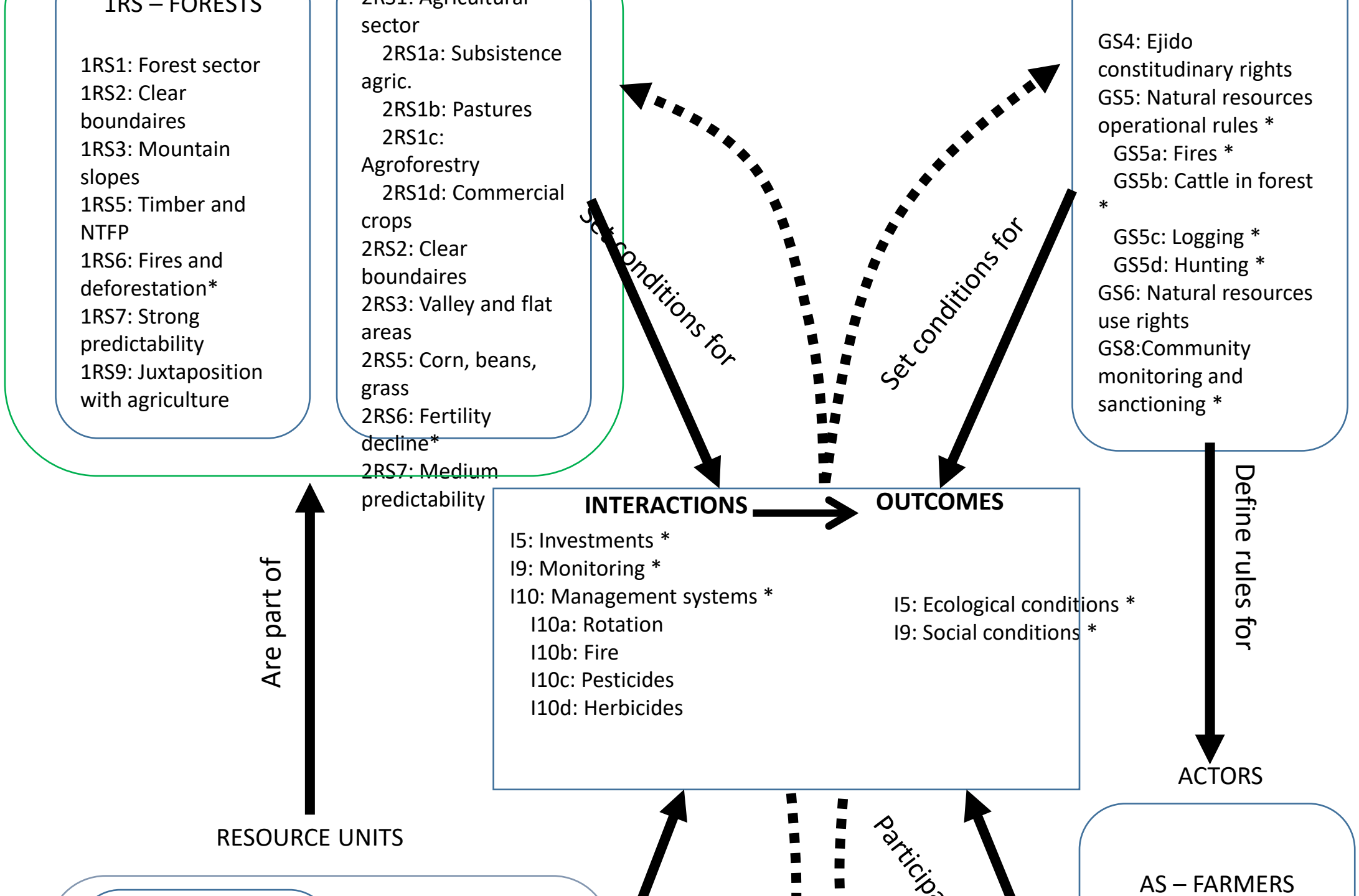


Fig. 4. Influence of SWSIs on the system dynamics. Current feedbacks push Makanya along a trajectory where the productive potential declines over time. Conservation tillage and rainwater harvesting based supplemental irrigation, the SWSIs evaluated here, destabilize the current dynamics in Makanya through three different mechanisms; (1) through improved yields (P), which allow farmers to build up buffers and invest in their farming systems (Q), and which reduce the pressure on surrounding ecosystems (R), as well as the need for farmland expansion (S), (2) through changes in the field water balance, which enable a positive water-productivity feedback (T) and reduce erosion (V), and (3) through improved the soil health (U), which enables a better plant response to water availability. Introducing this type of water management technology therefore has the potential to open up for transformation towards development trajectories with higher agro-ecological productivity.



strates how three external drivers for change have interacted with a set of key system variables in a feedback process that over the agro-ecosystem. Plus and minus signs represent the relations between the variables in the main feedback loop. When the ers reduced their fallows and shifted from single to double annual copping cycles. This had negative impact on soil fertility. At gly common. The combined effect was lower availability of moisture in the crop root zone and more frequent crop failures. The farmers' dependency on the surrounding ecosystem subsequently increased. This coincided with a series of institutional changes, which more or less caused an open access situation to common property resources. The availability of crop complementing income sources declined and farmers were forced to increasingly extractive farming methods, which affects farm productivity negatively. Today, low yields and frequent crop failures force farmers to deplete the capital they have accumulated every other year. This lowers the capacity for farming system investments, reinforcing the feedback.

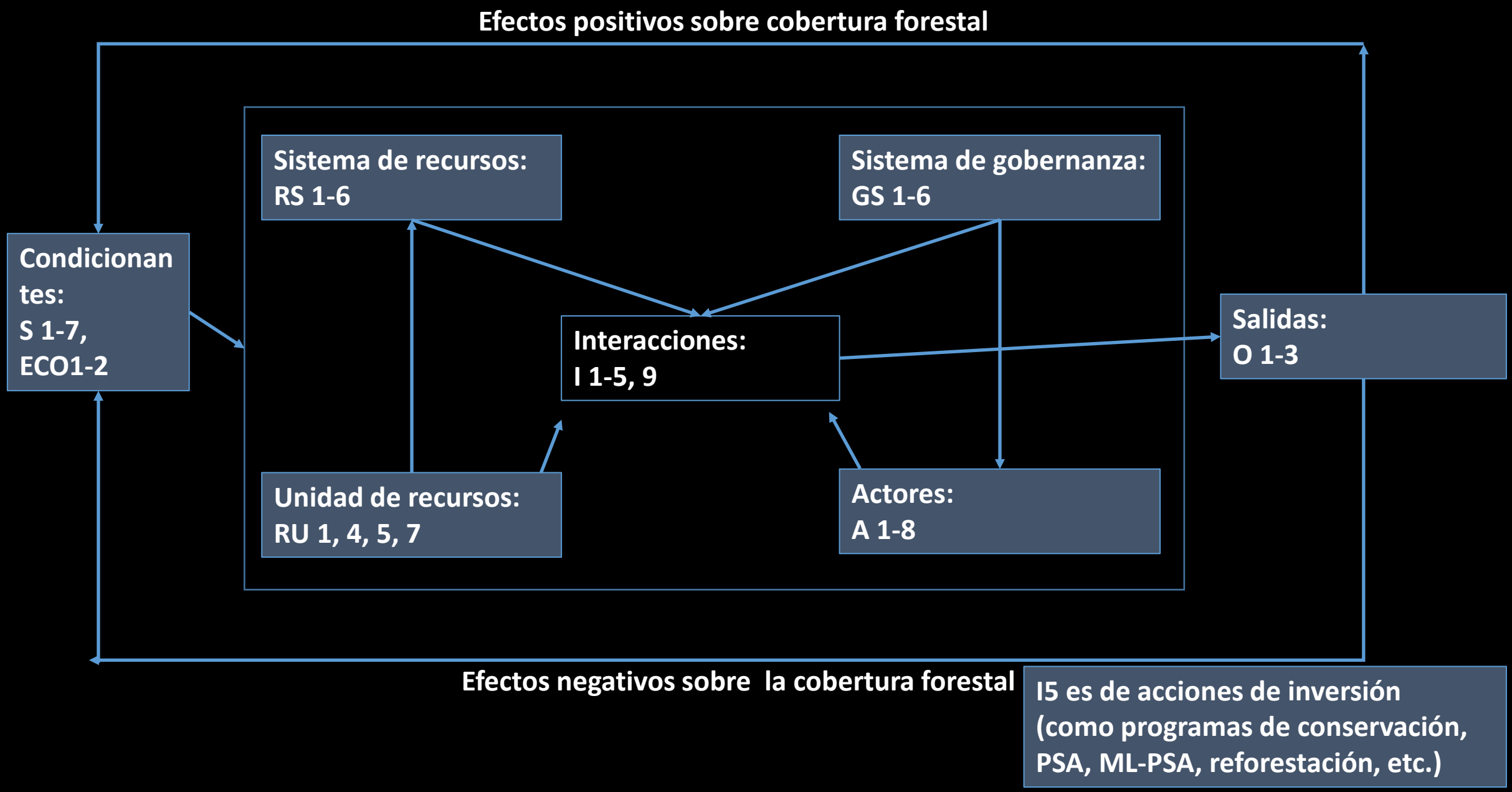

META – SES (watershed)
SES 1
RS
GS
RU
A
SES 2
RS
GS
RU
A
Upper part
SES 3
RS
GS
RU
A
Middle part
SES 4
RS
GS
RU
A
Lower part
Distance
Interactions among SESs
Interactions and outcomes within SESs
RS
SES sub-system


1RS – FORESTS
1RS1: Forest sector
1RS2: Clear boundaires
1RS3: Mountain slopes
1RS5: Timber and NTFP
1RS6: Fires and deforestation*
1RS7: Strong predictability
1RS9: Juxtaposition with agriculture
2RS1: Agricultural sector
2RS1a: Subsistence agric.
2RS1b: Pastures
2RS1c: Agroforestry
2RS1d: Commercial crops
2RS2: Clear boundaires
2RS3: Valley and flat areas
2RS5: Corn, beans, grass
2RS6: Fertility decline*
2RS7: Medium predictability
GS4: Ejido constitudinary rights
GS5: Natural resources operational rules *
GS5a: Fires *
GS5b: Cattle in forest *
GS5c: Logging *
GS5d: Hunting *
GS6: Natural resources use rights
GS8:Community monitoring and sanctioning *
Set conditions for
Set conditions for
Define rules for
INTERACTIONS
OUTCOMES
I5: Investments *
I9: Monitoring *
I10: Management systems *
I10a: Rotation
I10b: Fire
I10c: Pesticides
I10d: Herbicides
I5: Ecological conditions *
I9: Social conditions *
Are part of
ACTORS
RESOURCE UNITS
AS – FARMERS

« PROBLEMAS NACIONALES Project»: Mexican part of experience

- Project 246947 CONACYT "Socio-ecological analysis of the consequences of the implementation of forest conservation programs in the peri-urban and rural context", PDC PN-2014-01
- Inter-disciplinary, inter-sectoral and inter-institutional team
- Two case studies: Ajusco, Mexico City and San Antonio Del Barrio, Oaxaca
- Formalization and Operationalization Exercise of SES (Ostrom)
- Result: several publications, conferences, workshops, and a comparative book in process

Model and variables for formalization of SES



Example of operationalization

Segundo nivel	Tercer nivel	Fuente de información	Disponibilidad
RS2 Claridad de límites del sistema	Natural: bosque y agua dentro de la comunidad (mención)	INEGI, CONABIO	Red hidragráfica, INEGI, escala 1:50,000 en formato shape http://www.inegi.org.mx/geo/contenidos/recnat/hidrologia/regiones_hidrograficas.aspx VER RU1
RS3 Tamaño del sistema	Superficie en hectáreas. Social comunidad (mención)	RAN, INEGI	SIG del RAN https://sig.ran.gob.mx/acceso.php SOLO CONSULTA, es necesario crear un usuario Datos abiertos gobierno federal: http://datos.gob.mx/busca/organization/ran se pueden descargar los archivos shape de los polígonos del RAN Infraestructura y características de las localidades con menos 5 mil habitantes http://www.inegi.org.mx/sistemas/consulta_resultados/m5mh.aspx?c=28004&s=est
RS4 Infraestructura	Forestal académica (equipo medición científica)	INEGI, CONABIO, datos abiertos gobierno federal, CONAFOR	VER RU1 Sistema Nacional de Información Forestal: http://www.cnf.gob.mx:8090/snif/portal/
	Hídrica académica (equipo medición científica)	SMN	Sistema Meteorológico Nacional, información climatológica por estado, datos por estaciones http://smn.cna.gob.mx/es/climatologia/informacion-climatologica
RS5 Productividad del sistema	Forestal: productividad (cálculo)	CONABIO, NASA	CONABIO, imágenes MODIS http://speck.conabio.gob.mx/modis/ NASA https://modis.gsfc.nasa.gov/data/dataprod/mod01.php
	Hídrico: balance (cálculo)	SMN, CONAGUA	VER RS2 y RS4
RS6 Propiedades de equilibrio	Forestal: fragmentación (cálculo)	INEGI, CONABIO	Imágenes Landsat, descargables GRATIS, es necesario generar una cuenta http://earthexplorer.usgs.gov/ VER RU1
	Hídrico: línea base y cambio	SMN, CONAGUA	VER RS2 y RS4

Almost 50% of variables in relation to Institutions, Governance, Actors, Homes, Inspects, etc. were obtained from field work and the application of semi-structured interviews and surveys

DISCUSSION

- Experience of SES framework aplication?
- SES variables in 4 studies cases
- Comparision of the variabilities?
- SES framework and compatibility of OCELET variables

February 20th mini-workshop

- Manuscript about development of SES framework (in LA?)

Discusion now: brainstorming?

Experiences of formalization and operationalization of the analytical framework of Socio-Ecological Systems (SES) in Latin America ??

- Latin American Socio-ecological systems (forestry, agricultural, desert, coastal)
- Diversity of analytical frameworks for the study and management of socio-ecosystems
- Analytical framework of Ostrom Socio-ecological systems
- Problems of the formalization and operationalization of the SES analytical framework (Background: Elinor Ostrom, 2009, New bibliography, with special issue of Ecology end Society 2014, among other recent publications of years 2015-2017)
- Some formalization works, with very little progress in the operationalization of SES
- Mapping of the spatial distribution and timeline of the works on the formalization and operationalization of SES in Latin America
- Protocols for the analysis of second, third and fourth level variables
- Problems with applying of SES framework