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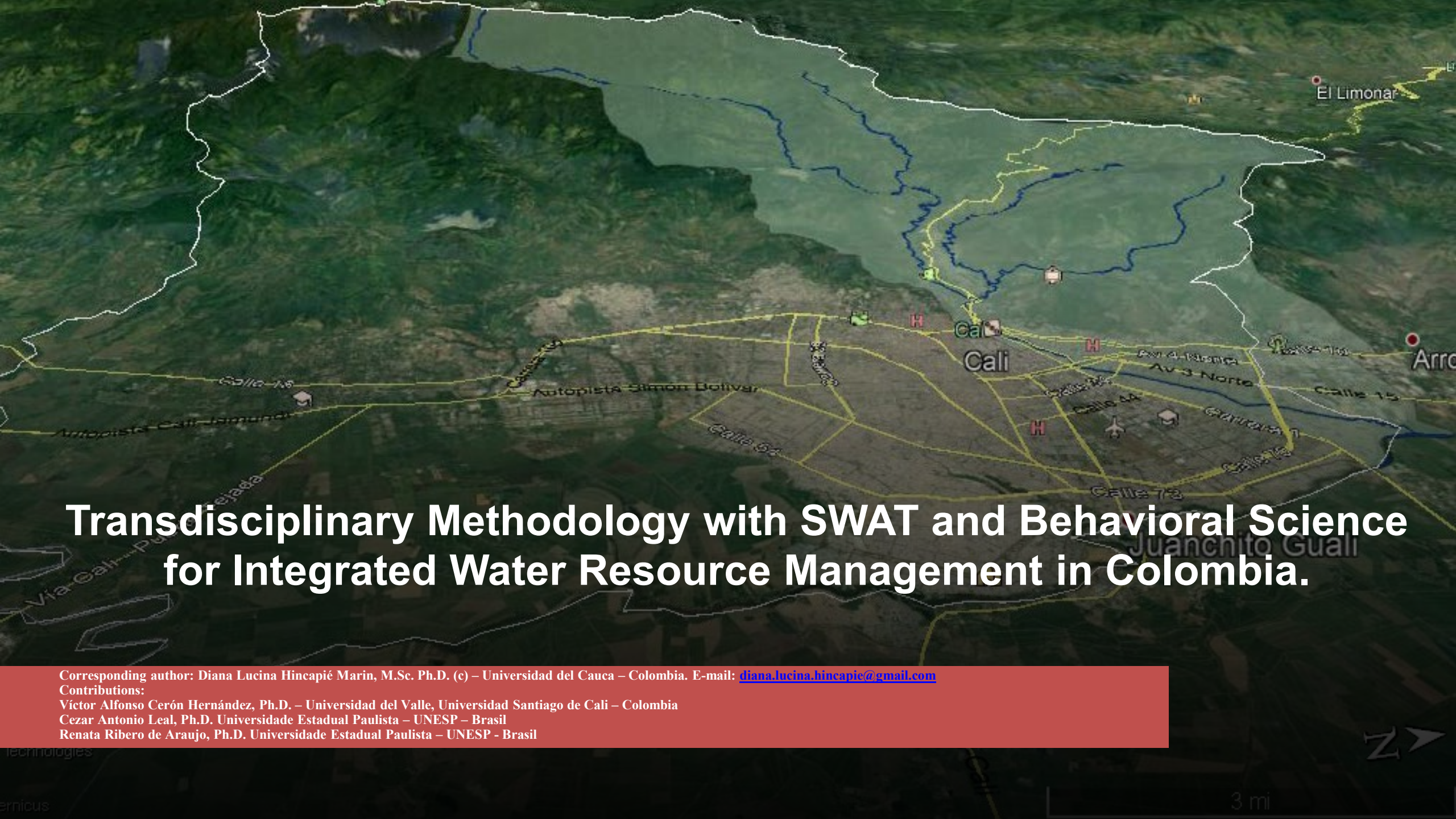
ISO 9001:2015 SC- CER 450832

IQNet: CO- SC-CER450832

Una Acreditación con Rostro Humano

Hacia una Universidad comprometida con la paz territorial



Transdisciplinary Methodology with SWAT and Behavioral Science for Integrated Water Resource Management in Colombia.

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Cezar Antonio Leal, Ph.D. Universidade Estadual Paulista – UNESP – Brasil
Renata Ribero de Araujo, Ph.D. Universidade Estadual Paulista – UNESP - Brasil

Colombia's → IWRM

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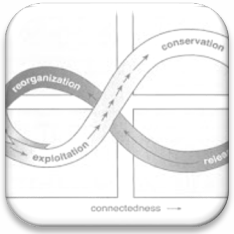
Country: Is divided by hydrographyps subzones - HSZ

System: In each HSZ a Management Plan must be implemented and executed

Problem: Top-Down System → solution: Bottom-up System



Conclusion: It requieres an holistic and systemic approach to assess the dynamic emergence between components of social-water coupled systems

“People’s problems are systemic, but the goverment is fracture”

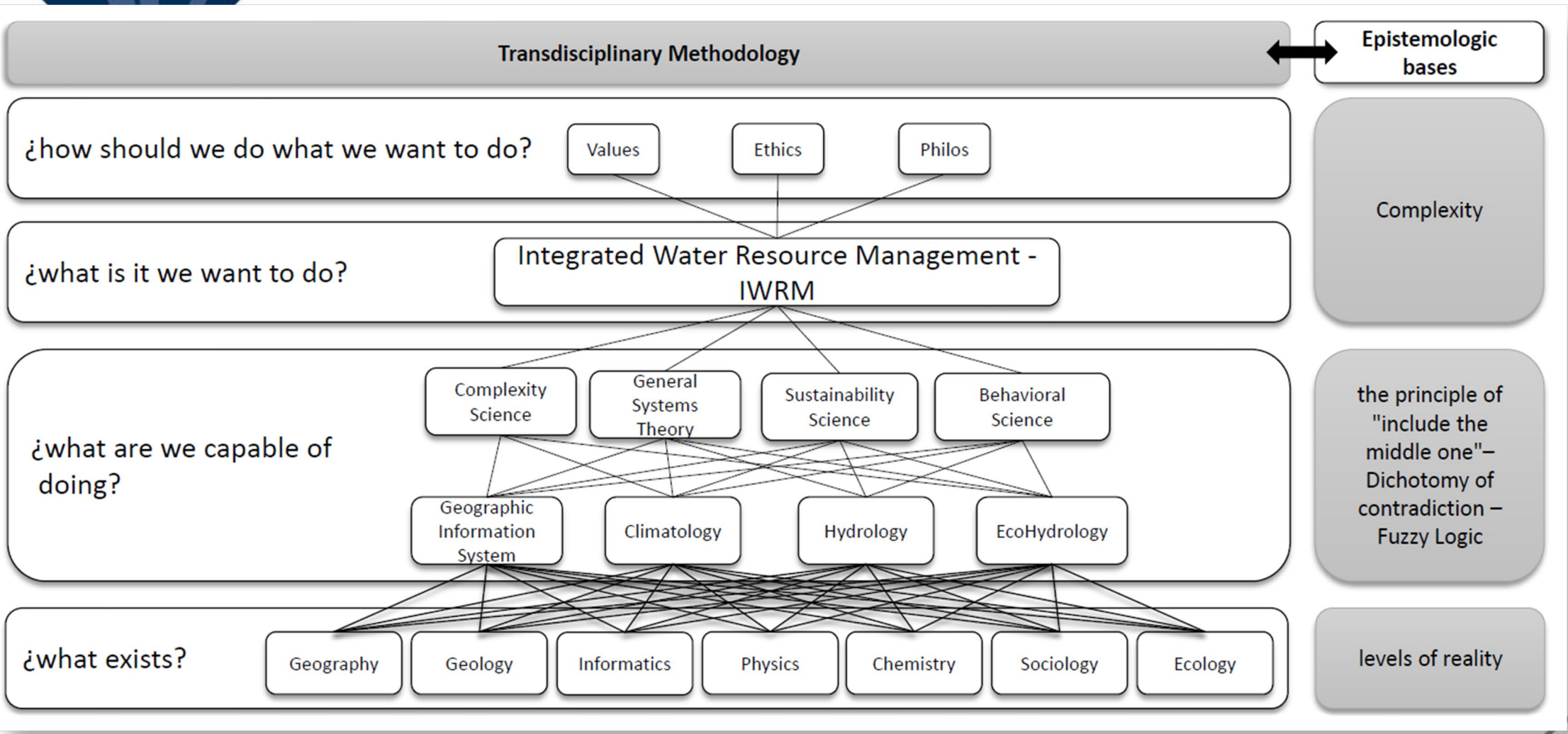
Concept: Vulnerability as an emergente property of the socioecological system

Social response to environmental changes that produces actions in terms of IWRM.(Gunderson & Holling, 2002)(Berkes, Colding, & Folke, 2003) (Gallopín, 2006) (Becker, 2010) (Holland, 2014)

In this investigation, the vulnerability was interpreted as a positive property of the socioecological system attributable to change that leads a beneficial transformation of it, from this point of view, vulnerability was taken as a tool to assess socioecological system's sustainability within IWRM context.

In that sense, this investigation had two objectives: (i) To design a transdisciplinary methodology for comprehensive Integrated Water Resource Management under the SES approach, and (ii) to evaluate the vulnerability as an emergent property of the SES of Cali River Basin - Colombia.

Methodologically, was proposed that **vulnerability** is composed of **the system's sensitivity and its capacity to adapt**, and emerges on river basin territory. **Sensitivity is** a **constant internal disturbance that affects the ecosystems** that provide water ecosystem services, whereas, **the capacity to adapt is the positive response of auto-organized stakeholder groups which perform IWRM** in the drainage area.



Max-Neef, 2005

Theorical chart

PHENOMENOM: Vulnerability as an emergente property

OBJECT OF INVESTIGATION: socioecological system

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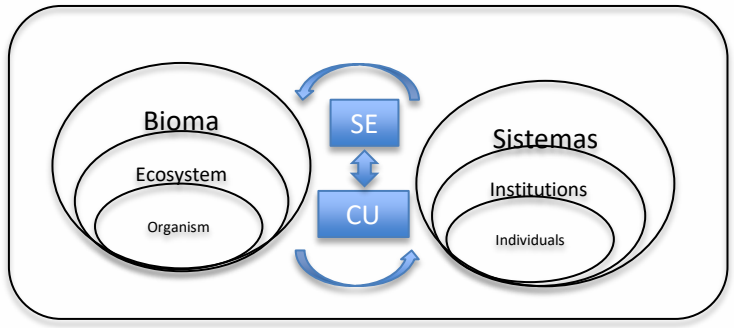
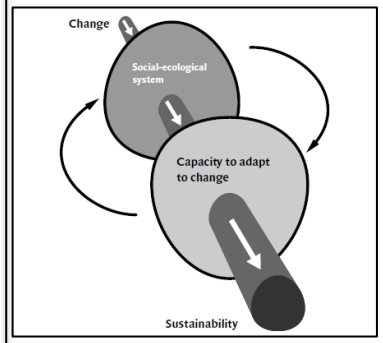
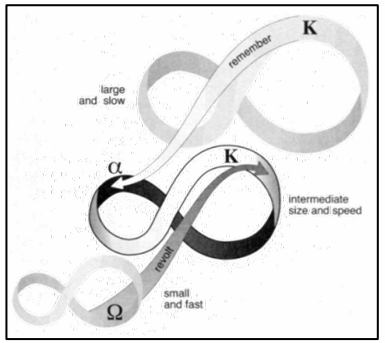
1. Complex Adaptative System.



Cerón-Hernández y otros, 2019



Berkes, Colding &Folke, 2003

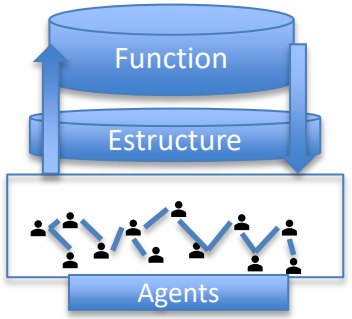


Gunderson & Holling, 2002

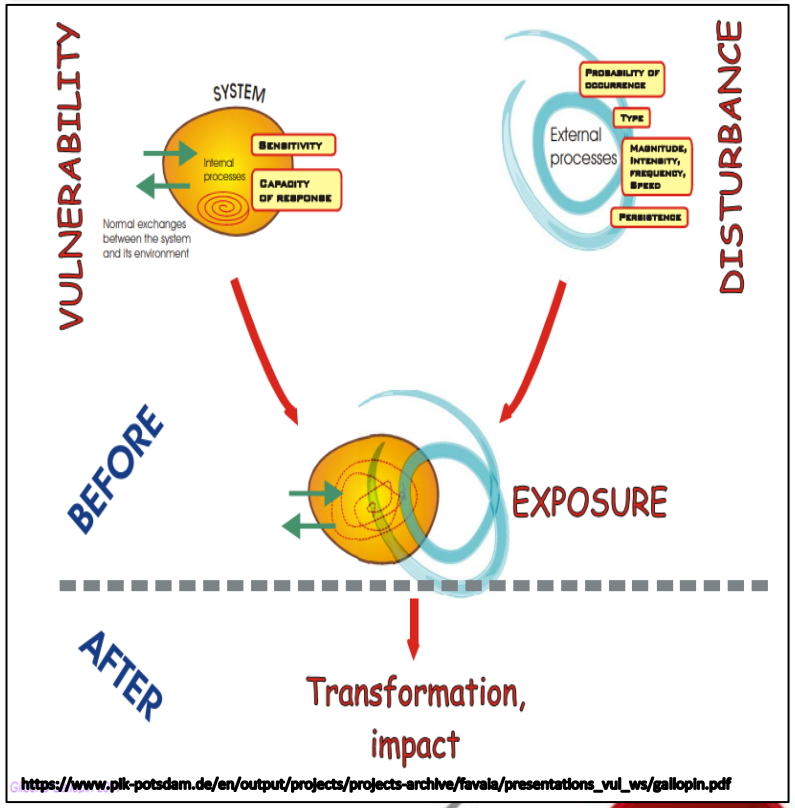
2. Emergent properties.

https://www.amigastronomicas.com/2017/02/28/sinergia-el-vuelo-de-los-gansos/

http://snowcrystals.com/

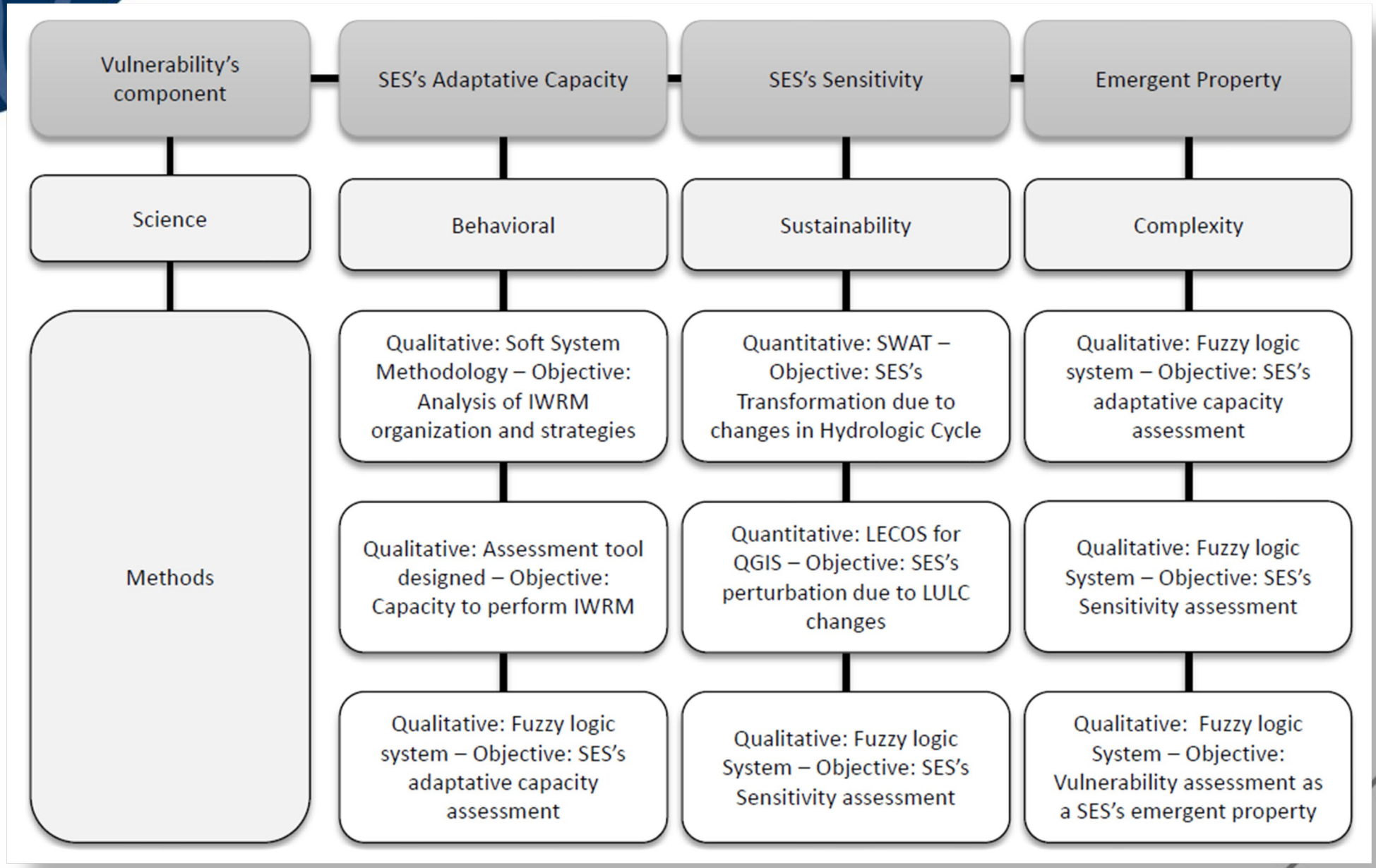


3. Phenomenon



https://www.pik-potsdam.de/en/output/projects/projects-archive/favaia/presentations_vul_ws/gallopin.pdf

METHODOLOGY DESIGNED



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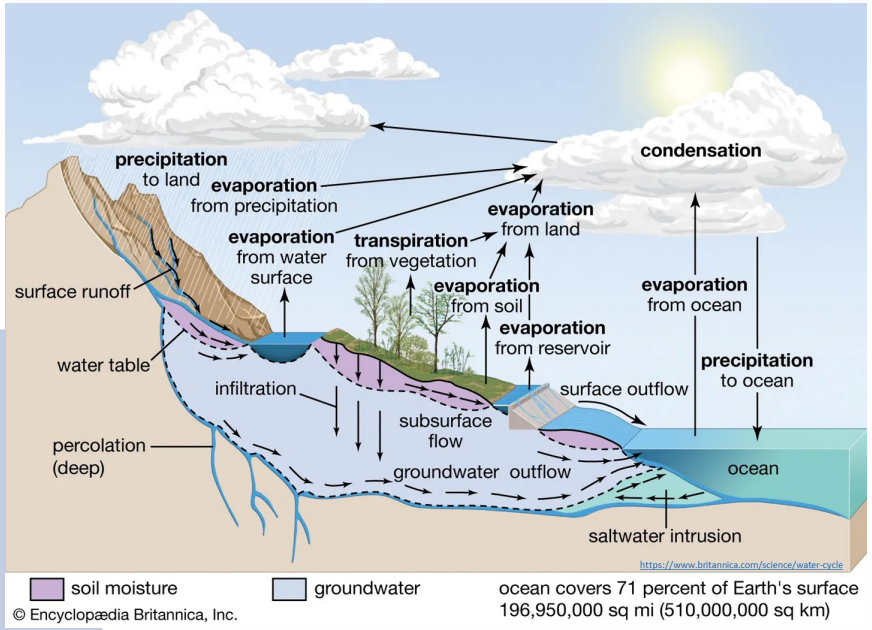
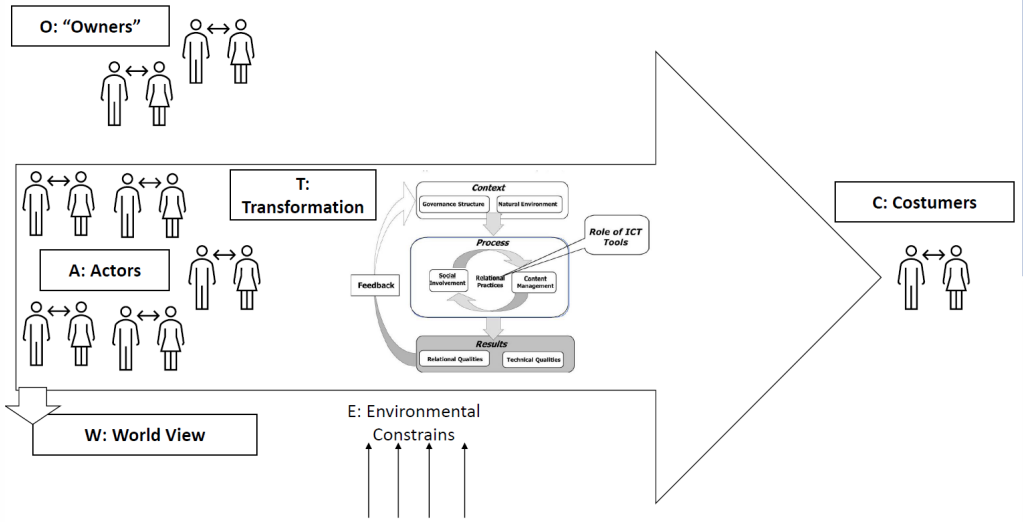
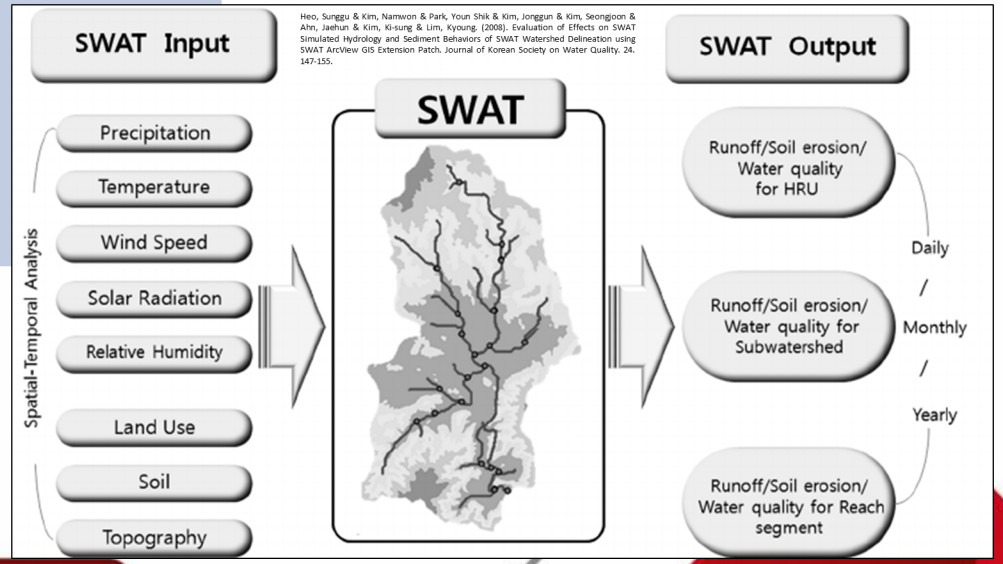
PEOPLE → CAPACITY TO ADAPT

ECOSYSTEM → SENSITYBITY







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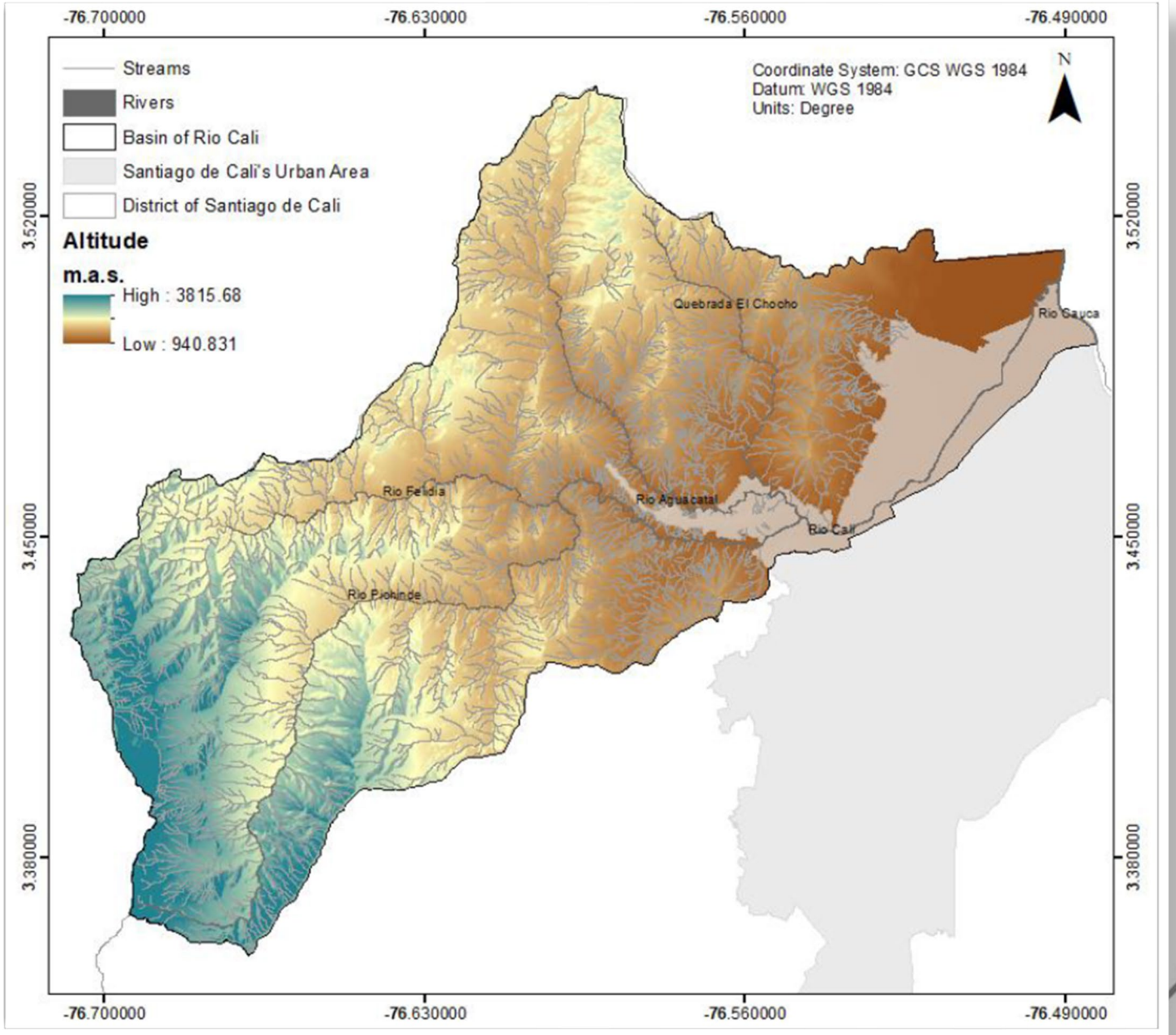
Methodology

STUDY AREA



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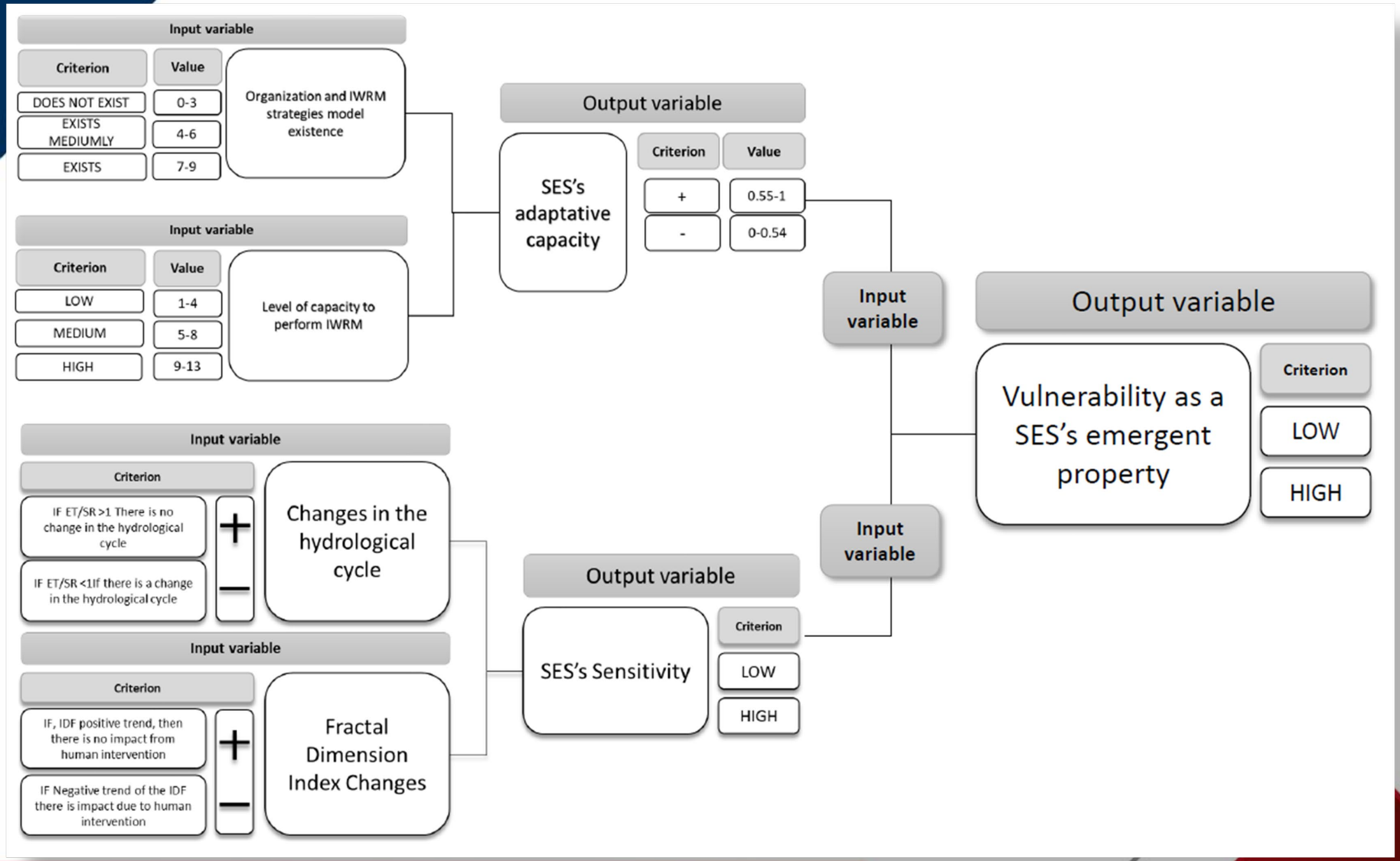
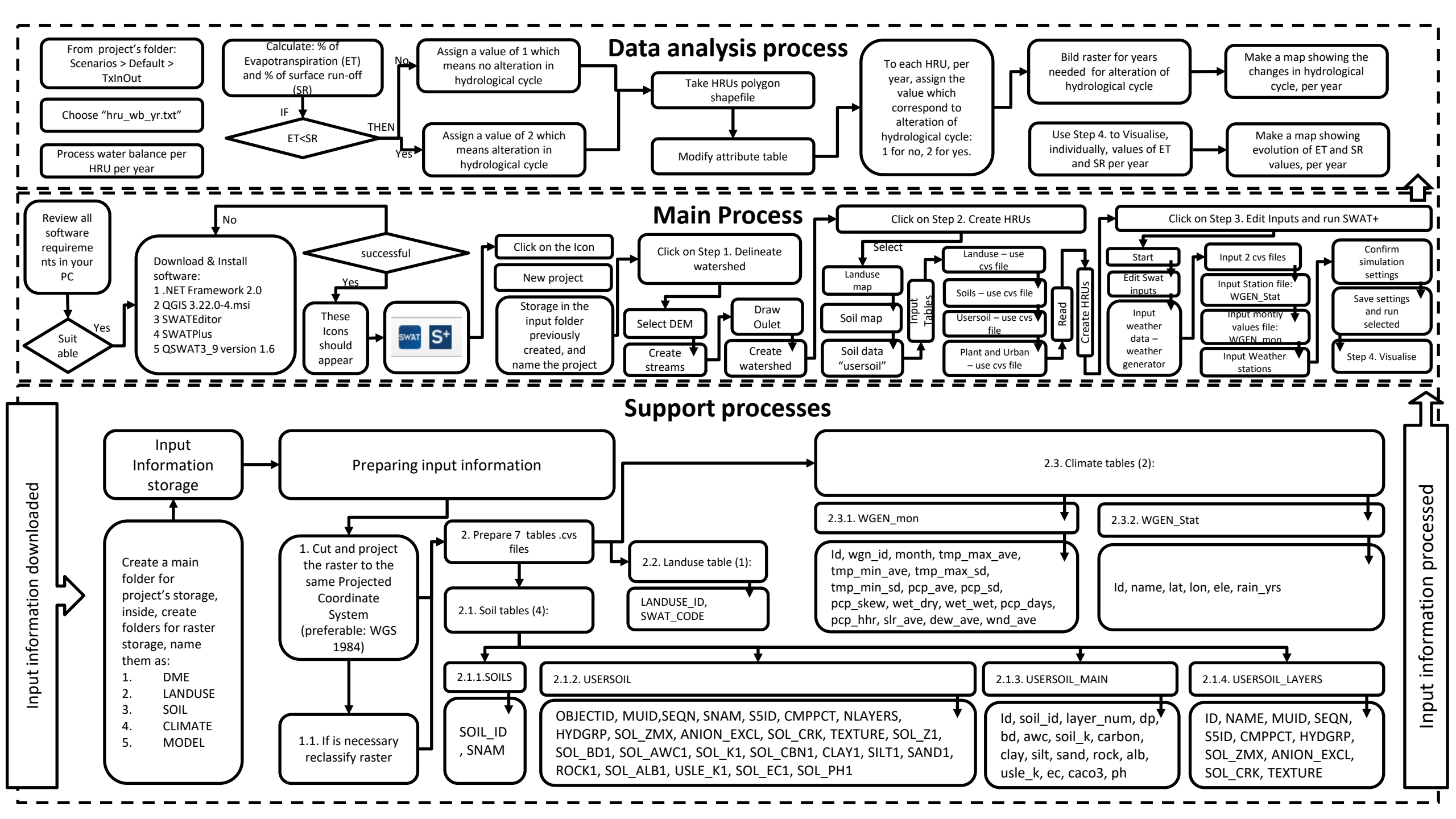
FUZZY LOGIC

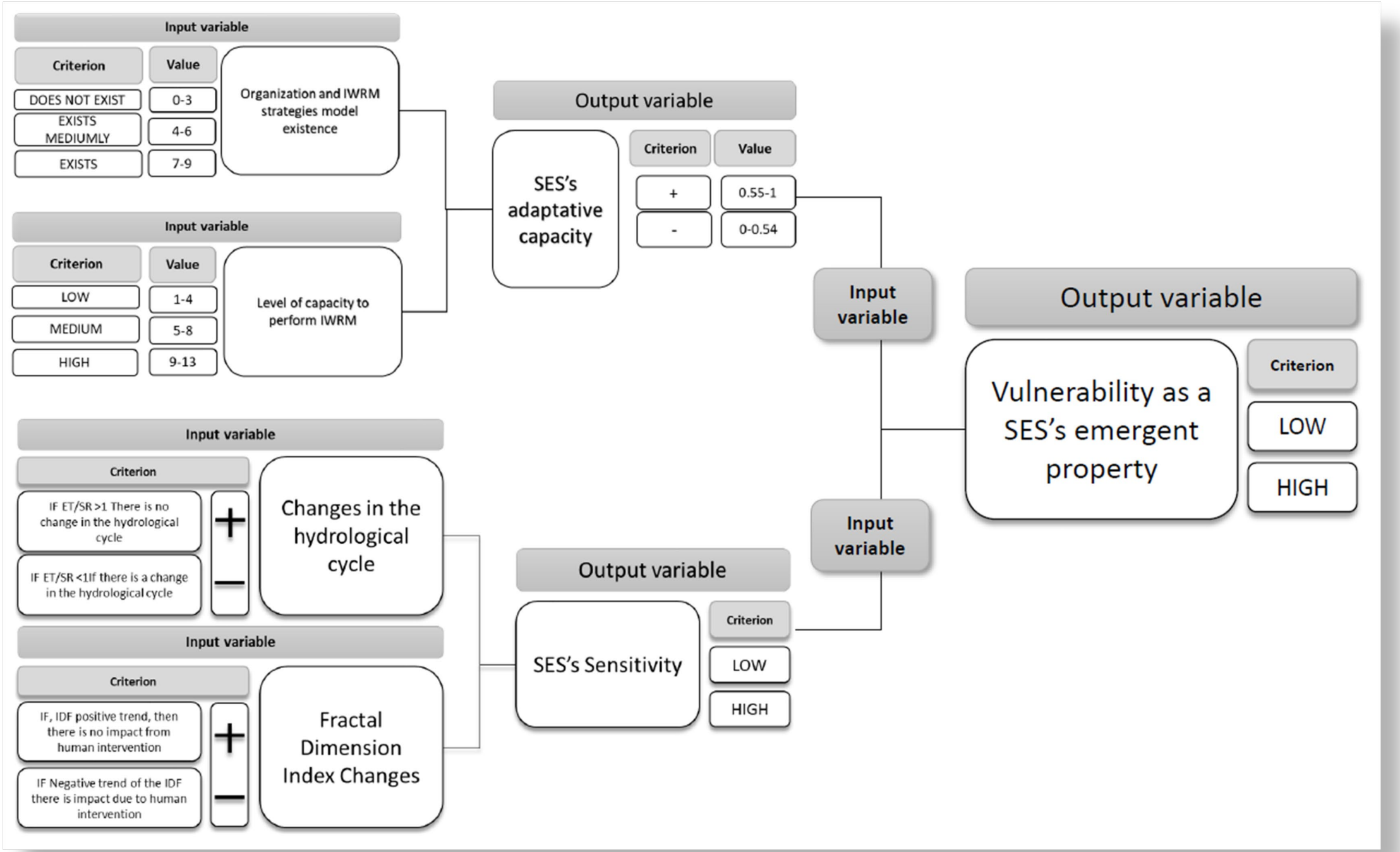

Input variable
Criterion
Value
DOES NOT EXIST
0-3
EXISTS MEDIUMLY
4-6
EXISTS
7-9
Organization and IWRM strategies model existence
Input variable
Criterion
Value
LOW
1-4
MEDIUM
5-8
HIGH
9-13
Level of capacity to perform IWRM
Output variable
SES's adaptative capacity
Criterion
Value
+
0.55-1
-
0-0.54
Input variable
Input variable
Criterion
IF ET/SR >1 There is no change in the hydrological cycle
IF ET/SR <1If there is a change in the hydrological cycle
+
—
Changes in the hydrological cycle
Input variable
Criterion
IF, IDF positive trend, then there is no impact from human intervention
IF Negative trend of the IDF there is impact due to human intervention
+
—
Fractal Dimension Index Changes
Output variable
SES's Sensitivity
Criterion
LOW
HIGH
Input variable
Output variable
Vulnerability as a SES's emergent property
Criterion
LOW
HIGH

Assessment tool for capacity to perform IWRM

Theoretical elements	Key concepts	Indicator Description	Measurement Variable	Variable value	Reference
Epistemological - Aesthetic	Local ecological knowledge-ecohydrology	Who produces the knowledge	Community	1	(Zarei et al., 2020)
			administration/ environmental authority	0	
			academy	0	
		This knowledge is co-produced with the community	Yes	1	
			No	0	
		It is embedded in traditional cultural rules and norms derived from a longstanding association and feedback with ecological processes.	Yes	1	(Raymond et al., 2010)
			No	0	
Environmental Ethics	Social behavior	What is the level of citizen participation	High	1	(Behmel et al., 2018b)
			Low	0	
		The communication system between and within the groups achieves their continuous interaction so that such activities lead to meetings or concrete actions.	Yes	1	
			No	0	(Tippett et al., 2005)
Environmental ethics	Adaptive Management: IWRM - EE	People are at the center of decision making	Yes	1	(Guerrero, E.; De-Keizer, O.; Córdoba, R., 2006)
			No	0	
		The purpose of the meeting is materialized in concrete activities	Si	1	(Burge, 2015)
			No	0	
		Financial resources are managed for the development of these activities	Si	1	
			No	0	
		Who manages the financial resources	Community	1	
			administration/ environmental authority	0	
			academy	0	
		The process is sustained after the financial aid is withdrawn	Yes	1	(Jackson, 2019)
			No	0	


Data analysis process
From project's folder: Scenarios > Default > TxtInOut
Choose "hru_wb_yr.txt"
Process water balance per HRU per year
Calculate: % of Evapotranspiration (ET) and % of surface run-off (SR)
IF
ET<SR
THEN
No
Yes
Assign a value of 1 which means no alteration in hydrological cycle
Assign a value of 2 which means alteration in hydrological cycle
Take HRUs polygon shapefile
Modify attribute table
To each HRU, per year, assign the value which correspond to alteration of hydrological cycle: 1 for no, 2 for yes.
Bild raster for years needed for alteration of hydrological cycle
Make a map showing the changes in hydrological cycle, per year
Use Step 4. to Visualise, individually, values of ET and SR per year
Make a map showing evolution of ET and SR values, per year
Main Process
Review all software requirements in your PC
Suitable
Yes
No
Download & Install software:
1 .NET Framework 2.0
2 QGIS 3.22.0-4.msi
3 SWATEditor
4 SWATPlus
5 QSWAT3_9 version 1.6
successful
Yes
These Icons should appear
Click on the Icon
New project
Storage in the input folder previously created, and name the project
Click on Step 1. Delineate watershed
Select DEM
Create streams
Draw Oulet
Create watershed
Click on Step 2. Create HRUs
Select
Landuse map
Soil map
Soil data "usersoil"
Input Tables
Landuse – use cvs file
Soils – use cvs file
Usersoil – use cvs file
Plant and Urban – use cvs file
Read
Create HRUs
Click on Step 3. Edit Inputs and run SWAT+
Start
Edit Swat inputs
Input weather data – weather generator
Input 2 cvs files
Input Station file: WGEN_Stat
Input montly values file: WGEN_mon
Input Weather stations
Confirm simulation settings
Save settings and run selected
Step 4. Visualise
Support processes
Input information downloaded
Input Information storage
Create a main folder for project's storage, inside, create folders for raster storage, name them as:
1. DME
2. LANDUSE
3. SOIL
4. CLIMATE
5. MODEL
Preparing input information
1. Cut and project the raster to the same Projected Coordinate System (preferable: WGS 1984)
1.1. If is necessary reclassify raster
2. Prepare 7 tables .cvs files
2.1. Soil tables (4):
2.1.1.SOILS
SOIL_ID , SNAM
2.1.2. USERSOIL
OBJECTID, MUID,SEQN, SNAM, S5ID, CMPPCT, NLAYERS, HYDGRP, SOL_ZMX, ANION_EXCL, SOL_CRK, TEXTURE, SOL_Z1, SOL_BD1, SOL_AWC1, SOL_K1, SOL_CBN1, CLAY1, SILT1, SAND1, ROCK1, SOL_ALB1, USLE_K1, SOL_EC1, SOL_PH1
2.1.3. USERSOIL_MAIN
Id, soil_id, layer_num, dp, bd, awc, soil_k, carbon, clay, silt, sand, rock, alb, usle_k, ec, caco3, ph
2.1.4. USERSOIL_LAYERS
ID, NAME, MUID, SEQN, S5ID, CMPPCT, HYDGRP, SOL_ZMX, ANION_EXCL, SOL_CRK, TEXTURE
2.2. Landuse table (1):
LANDUSE_ID, SWAT_CODE
2.3. Climate tables (2):
2.3.1. WGEN_mon
Id, wgn_id, month, tmp_max_ave, tmp_min_ave, tmp_max_sd, tmp_min_sd, pcp_ave, pcp_sd, pcp_skew, wet_dry, wet_wet, pcp_days, pcp_hhr, slr_ave, dew_ave, wnd_ave
2.3.2. WGEN_Stat
Id, name, lat, lon, ele, rain_yrs
Input information processed

FUZZY LOGIC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Criterion
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+
—
Changes in the hydrological cycle
Input variable
Criterion
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—
Fractal Dimension Index Changes
Output variable
SES's Sensitivity
Criterion
LOW
HIGH
Input variable
Output variable
Vulnerability as a SES's emergent property
Criterion
LOW
HIGH

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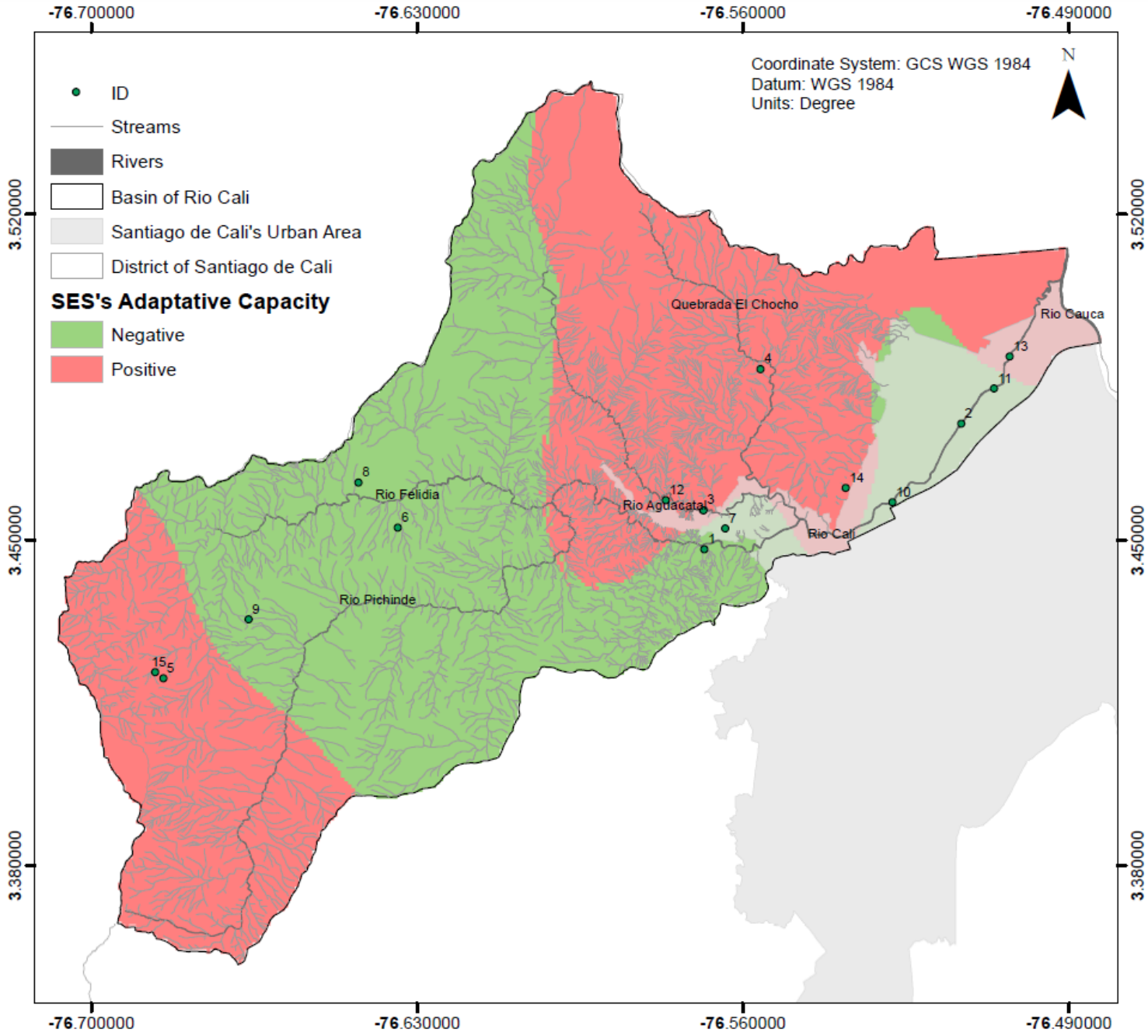
Results

Capacity to adapt



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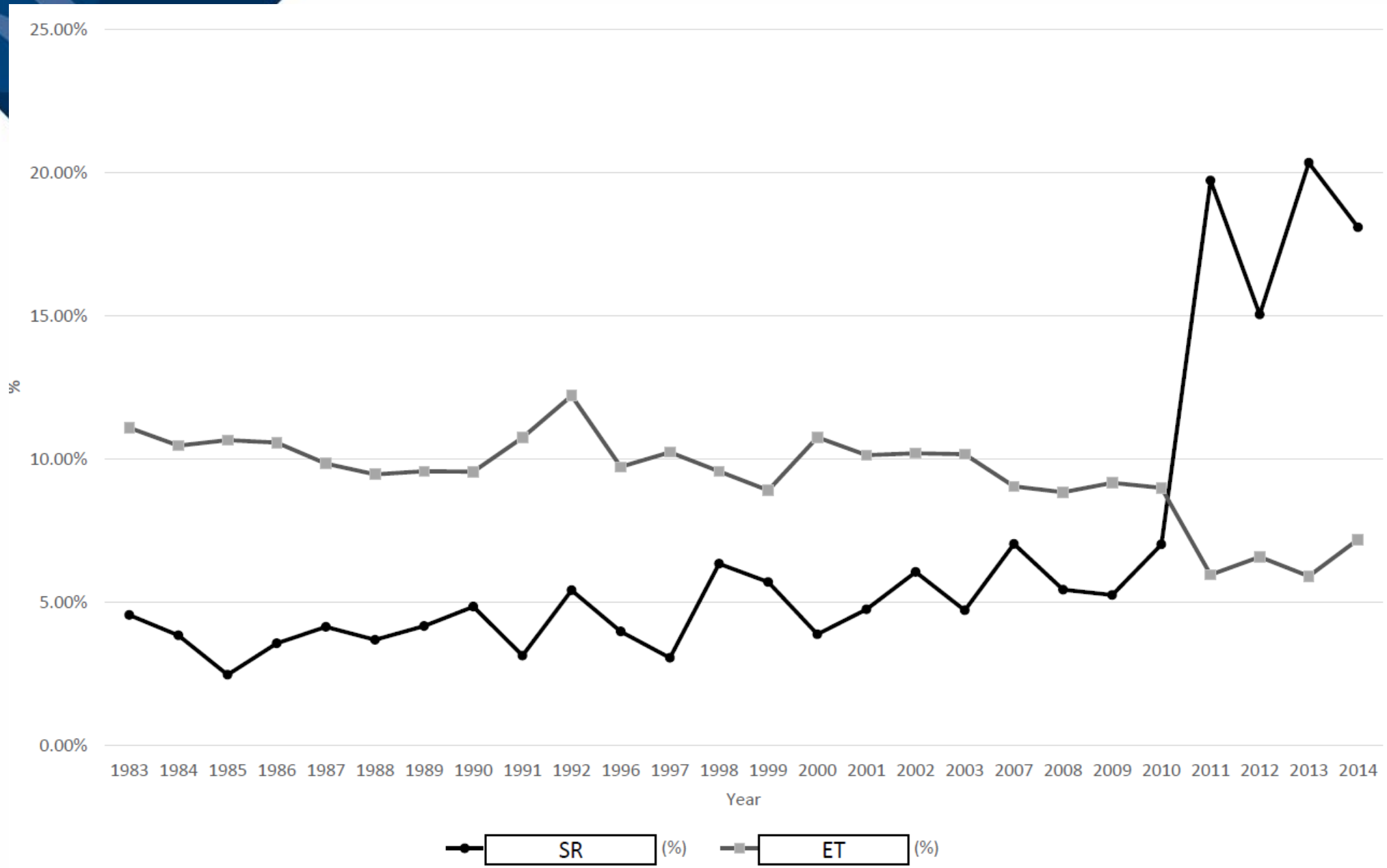
System’s sensitivity



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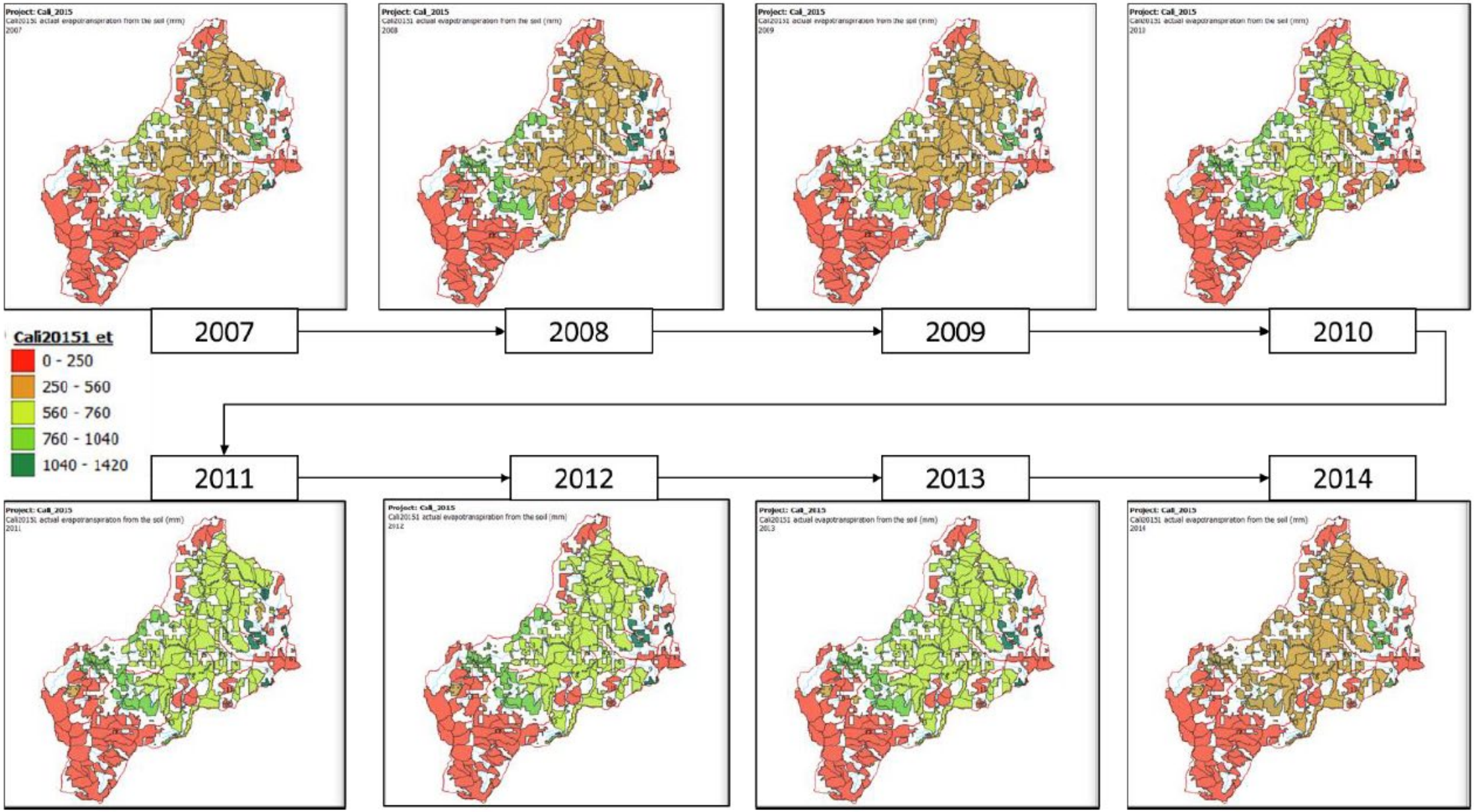
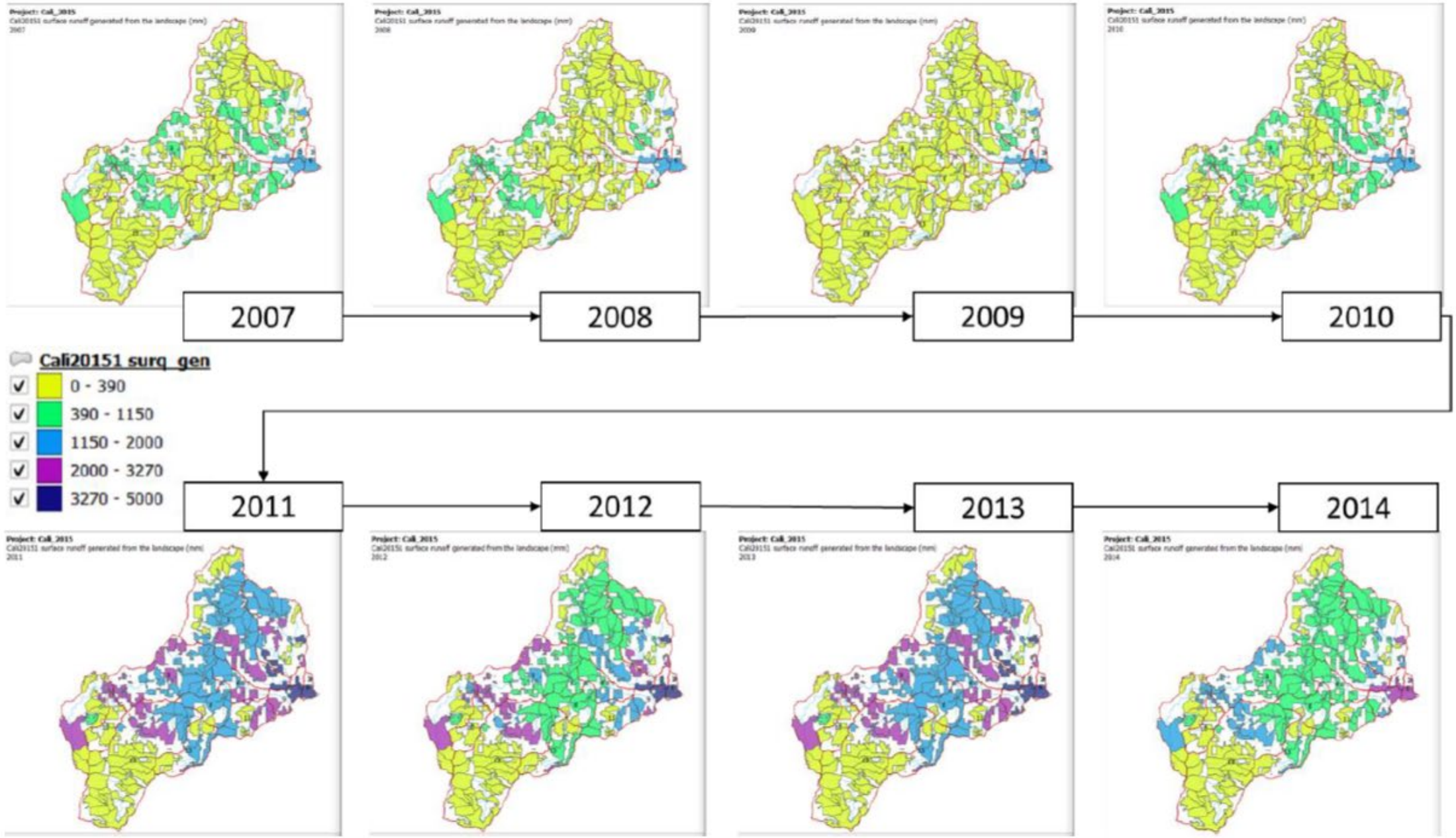
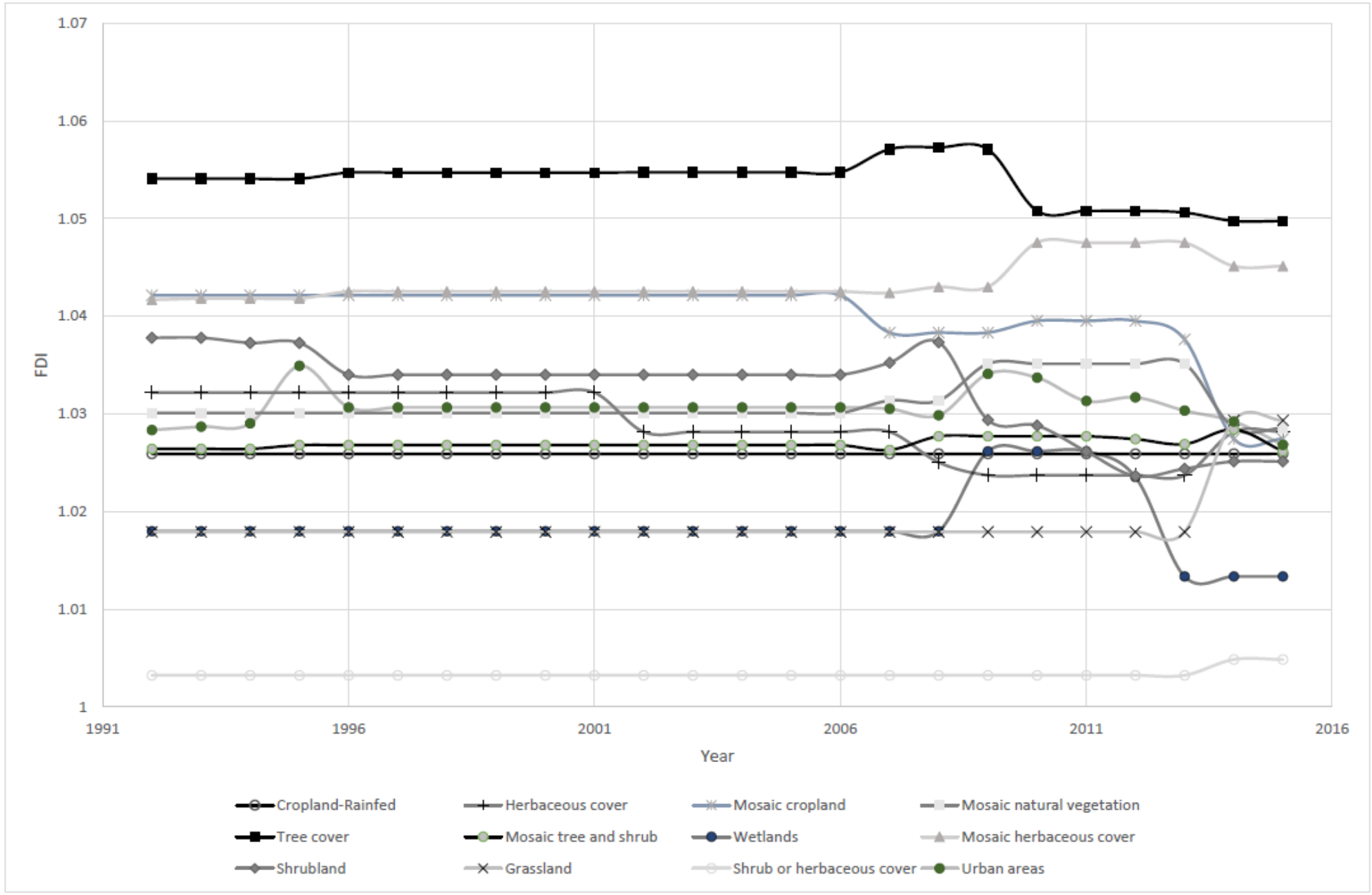

Project: Cali_2015
Cali20151 actual evapotranspiration from the soil (mm)
2007
2008
2009
2010
2011
2012
2013
2014
Cali20151 et
0 - 250
250 - 560
560 - 760
760 - 1040
1040 - 1420


2007
2008
2009
2010
Cali20151 surq_gen
0 - 390
390 - 1150
1150 - 2000
2000 - 3270
3270 - 5000
2011
2012
2013
2014



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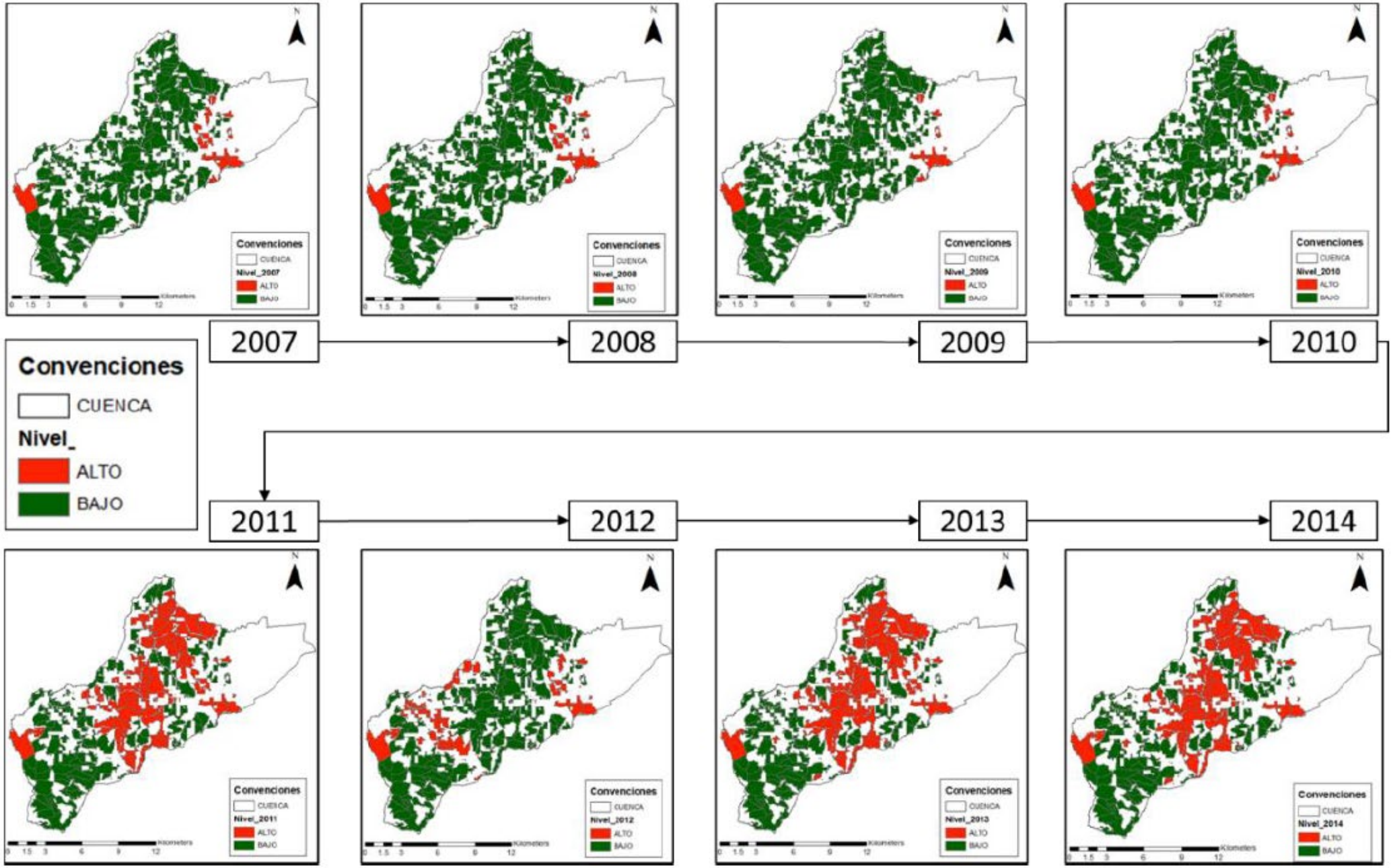
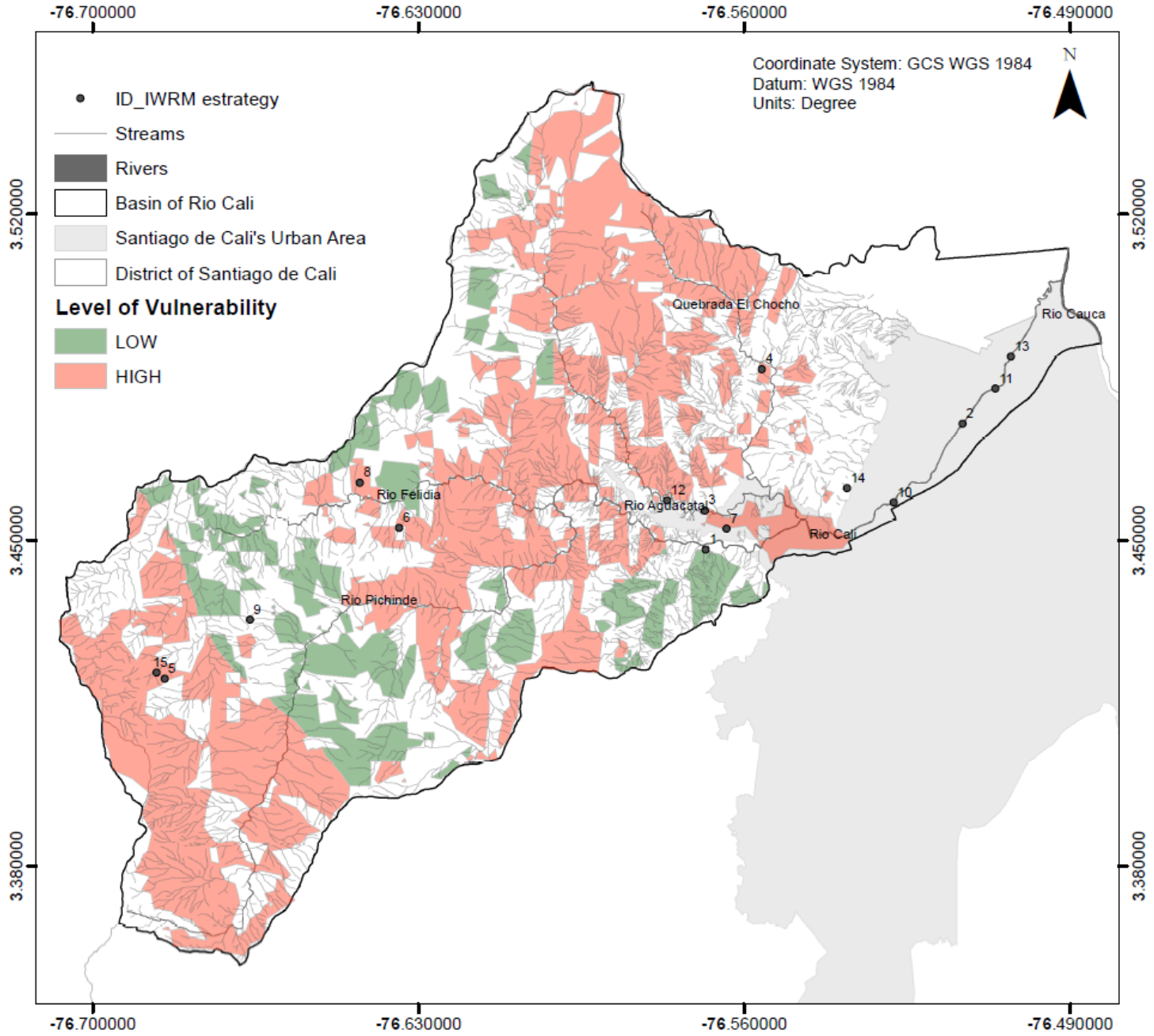

Convenciones
CUENCA
Nivel_
ALTO
BAJO
2007
2008
2009
2010
2011
2012
2013
2014

Vulnerability as an emergent property



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Discusion & Conclusions

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- Panarchy, adaptative cycles and multiscales (time-territory)
- Social responses to environmental change (hydrological cycle)
- Environmental changes → exposure/sensitivity
- (i) elements can be found that help improve the participation of stakeholders in IWRM to improve water governance. (ii)Vulnerability as an emerging property of the system can indicate where to strengthen the different stakeholder groups and where to invest in territories exposed to climate change, based on the increase in surface runoff, however, this should be incorporated into IWRM planning actions, though, this tool has limitations in its use, due to the scarcity of climatic data and thematic cartography maps.

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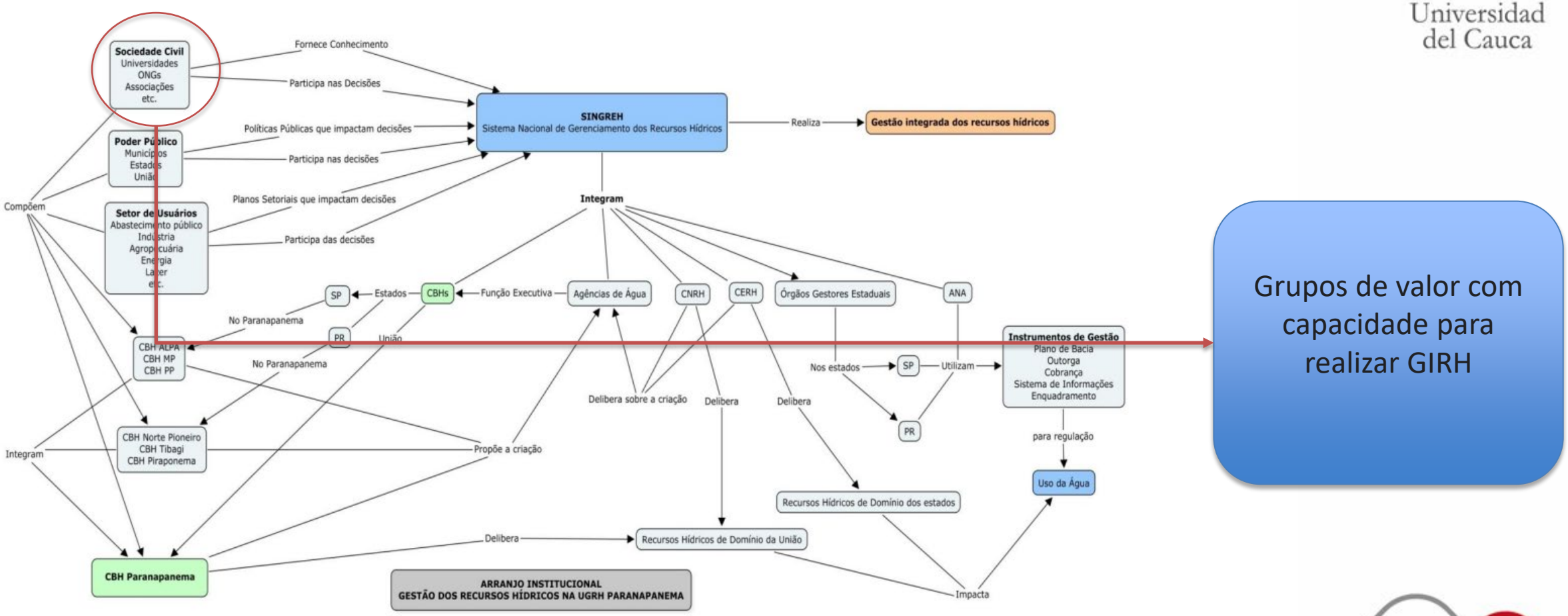
- Models such as SWAT are essential to support the process and obtain results, particularly with regard to water sustainability. Although the transdisciplinary methodology is preliminary and concerns to data integration

- In this sense, SWAT can incorporate IWRM modules, based on the response capacities of the interested groups to perform these strategies, can improve to perform multi-temporal analysis of the landscape and detect areas with relevant coverage changes, and consequently, SWAT can be used as IWRM with SES approach for Colombia.



Grupos de valor com capacidade para realizar GIRH

Figura 1. Representação esquemática do arranjo institucional da gestão integrada dos recursos hídricos na UGRH Paranapanema.

https://www.paranapanema.org/wp-content/uploads/2021/08/NT-09-Panorama-Gest%C3%A3o-Consultora.pdf

https://www.paranapanema.org/wp-content/uploads/2021/08/NT-08-Balan%C3%A7o-Quantitativo-Consultora.pdf

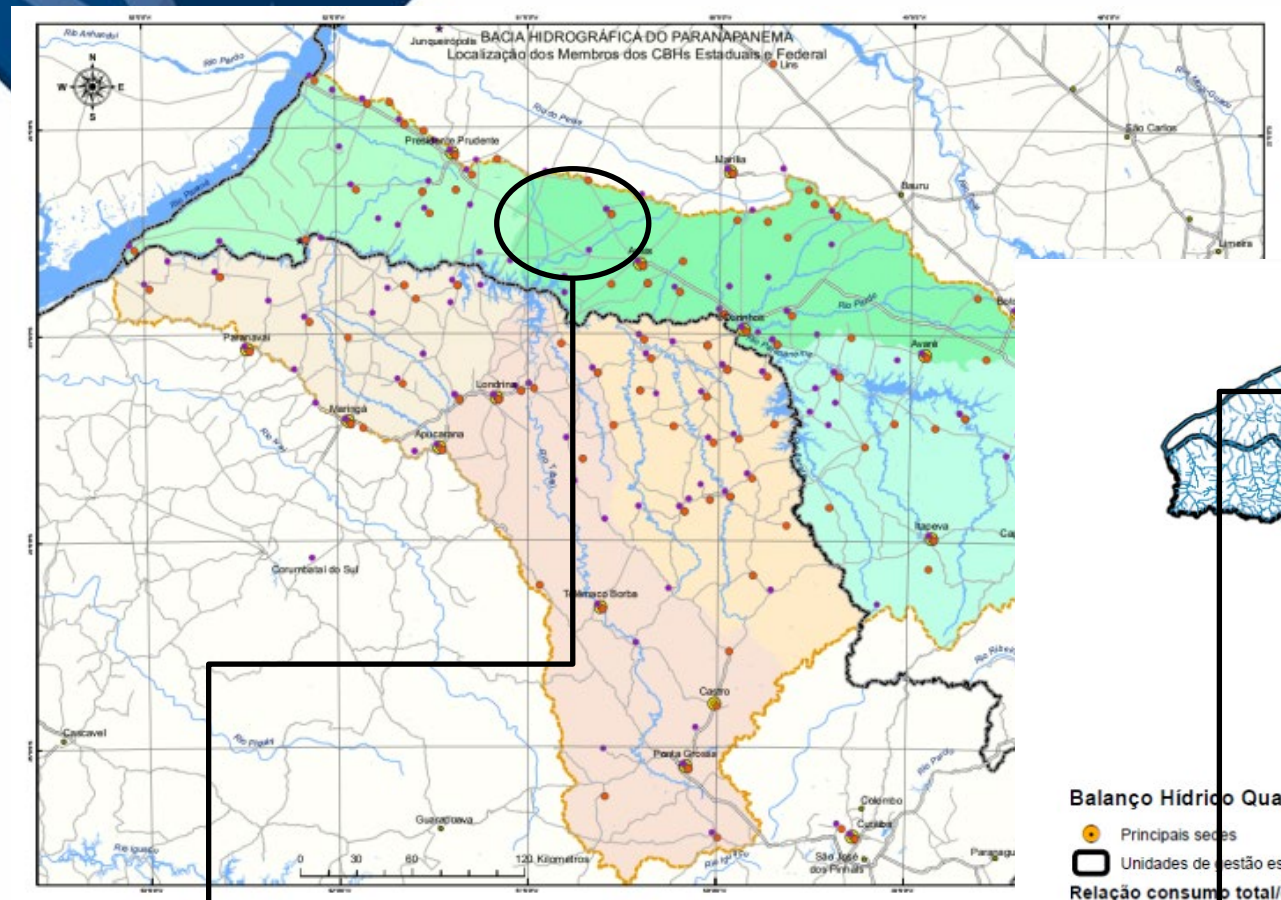
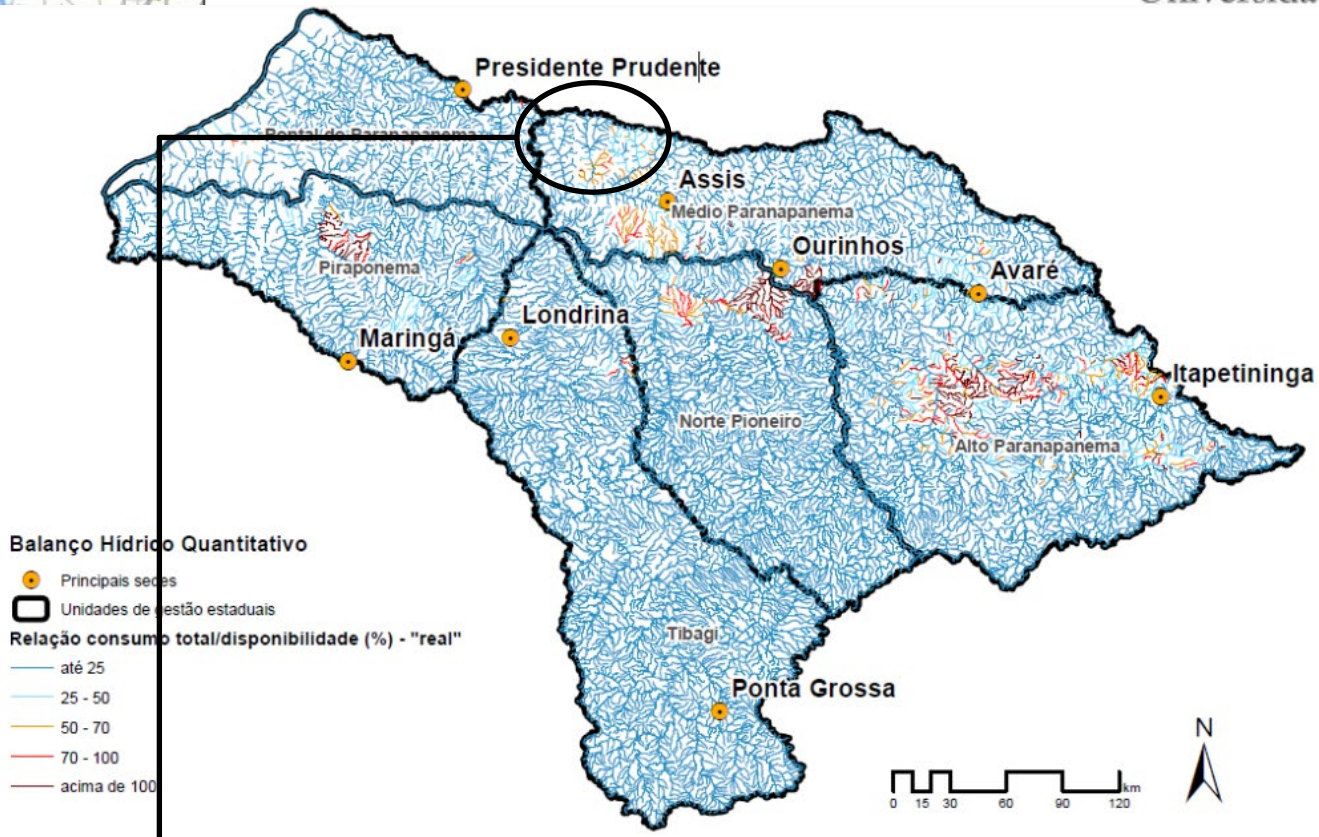


Figura 2. **Distribuição espacial dos membros do CBH Para Afluentes**



Relación consumo/disponibilidad Vs capacidade de gestão

Figura 8- Balanço da "Demanda Captação Superficial"

COMITÊ DO RIO PARANAPANEMA E SENAR/PR PROMOVEM CAPACITAÇÃO SOBRE RESTAURAÇÃO FLORESTAL

Uma das pautas prioritárias do Comitê da Bacia Hidrográfica do Rio Paranapanema (CBH Paranapanema) é a revitalização da bacia, tendo em vista os problemas em relação à erosão apontados no Plano Integrado de Recursos Hídricos (Pirh) Paranapanema. O 2º ciclo de ações para implementação, que vai de 2022 a 2027, tem uma série de atividades voltadas, principalmente, ao setor agropecuário e ao Poder Público Municipal, em relação a esta pauta prioritária.

Neste sentido, o Serviço Nacional de Aprendizagem Rural do estado do Paraná (Senar/PR), juntamente ao CBH Paranapanema, promoveu o curso de Restauração Florestal, em Maringá/PR, com o apoio do Instituto Água e Terra do Paraná e da Prefeitura Municipal de Maringá/PR. Foram 16 participantes, nesta 1ª edição, e objetivo é fomentar novas turmas!

O curso demonstrou como restaurar a vegetação, utilizando práticas de recuperação de áreas degradadas, aliando o plantio de mudas às técnicas de nucleação. Com carga horária de 16h, as aulas teóricas apresentaram os benefícios das florestas e causas da degradação; os aspectos da legislação ambiental; as bases físicas: clima e solo; os fundamentos biológicos: interações entre organismos, sucessão da vegetação e dinâmica de clareiras, fitogeografia e espécies invasoras; a produção de mudas para restauração ecológica; as estratégias e técnicas empregadas em restauração: restauração passiva e métodos silviculturais; a nucleação e outras técnicas que podem ser usadas na restauração; os aspectos envolvendo a adequação ambiental em propriedades rurais; a chave para tomada de decisão: escolha dos procedimentos conforme diagnóstico local; e o monitoramento em áreas de restauração.

Todo o conteúdo teórico pôde ser aplicado na aula prática. Em uma área de proteção permanente da Prefeitura de Maringá/PR, os alunos fizeram a análise do terreno e desenvolveram uma proposta para o reflorestamento da APP.

Para a 2ª vice-presidente do CBH Paranapanema, representante dos usuários de água na Diretoria, por meio da Federação da Agricultura do Estado do Paraná (FAEP), Carla Beck, em colaboração mútua, Senar/PR e CBH Paranapanema, vários projetos podem ser desenvolvidos. "A ideia é mobilizar novas turmas, aproveitando o conhecimento e expertise do Senar em capacitação, para estimular as práticas de revitalização em nossa Bacia. É interesse do produtor rural cuidar dos nossos recursos hídricos e para isso podemos ajudá-lo com orientação e o envolvendo nas atividades do Comitê", reflete.

¡Gracias por su atención!

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www.unicauca.edu.co

Referencias

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