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UNIVERSIDAD NACIONAL DE COLOMBIA
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Towards a water governance index (WGI-Mw) for Andean micro-watersheds using pressure-state-response indicators and fuzzy logic system

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Water crisis

- Projections show that 40% of the world's population currently lives in water-stressed river basins, and that will rise the water demand will by 55% in 2050
- In 2050, 240 million people are expected to remain without access to clean water, and 1.4 billion without access to basic sanitation (OECD, 2015)
- **There is increasing recognition that the "water crisis" is mainly a crisis of governance**

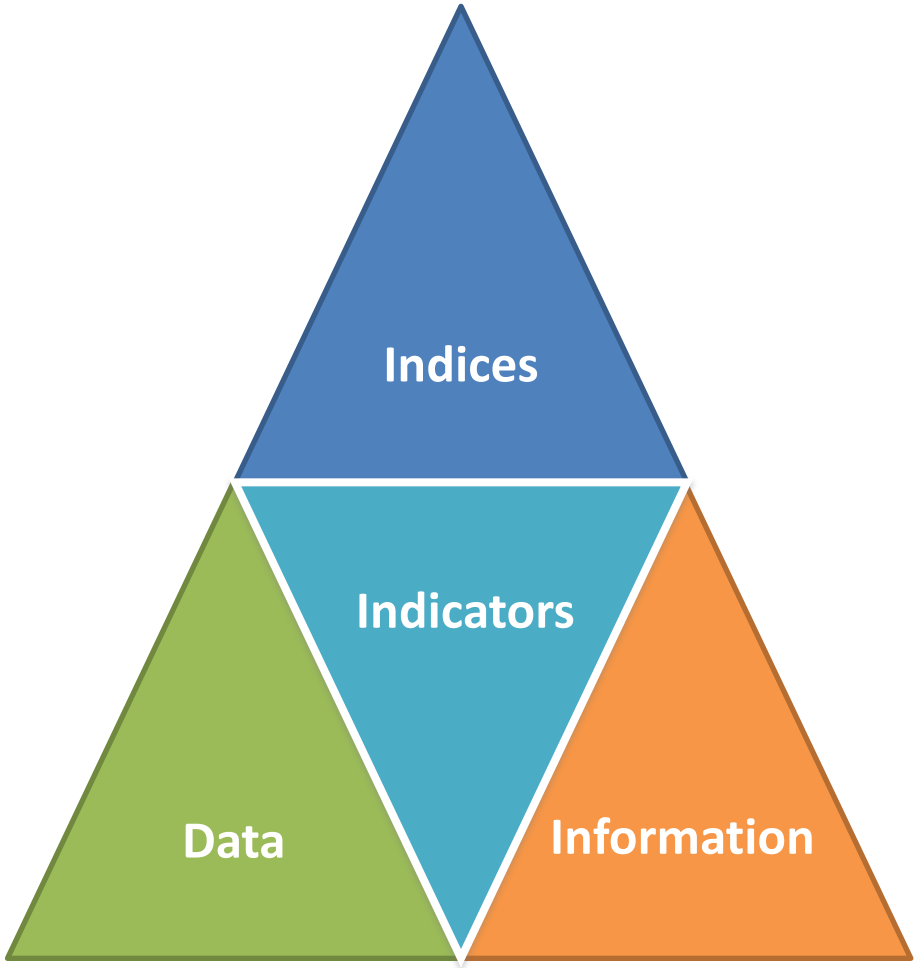
Cauca River-Colombia

Dagua River-Colombia

Indices

Decision makers need the appropriate indicators and indices to:

- To assess, track and equitably weigh integrated socio-economic, environmental and ecological factors
- To foster sustainability in watershed and micro- watershed.



Some water governance indices

- **Sustainable water governance index (SWGI)**

- **Asia water governance index (AWGI)**

Aspect:

- **Access**
- **Planning**
- **Participation**

Dimensions:

- **Legal**
- **Policy**
- **Administration**

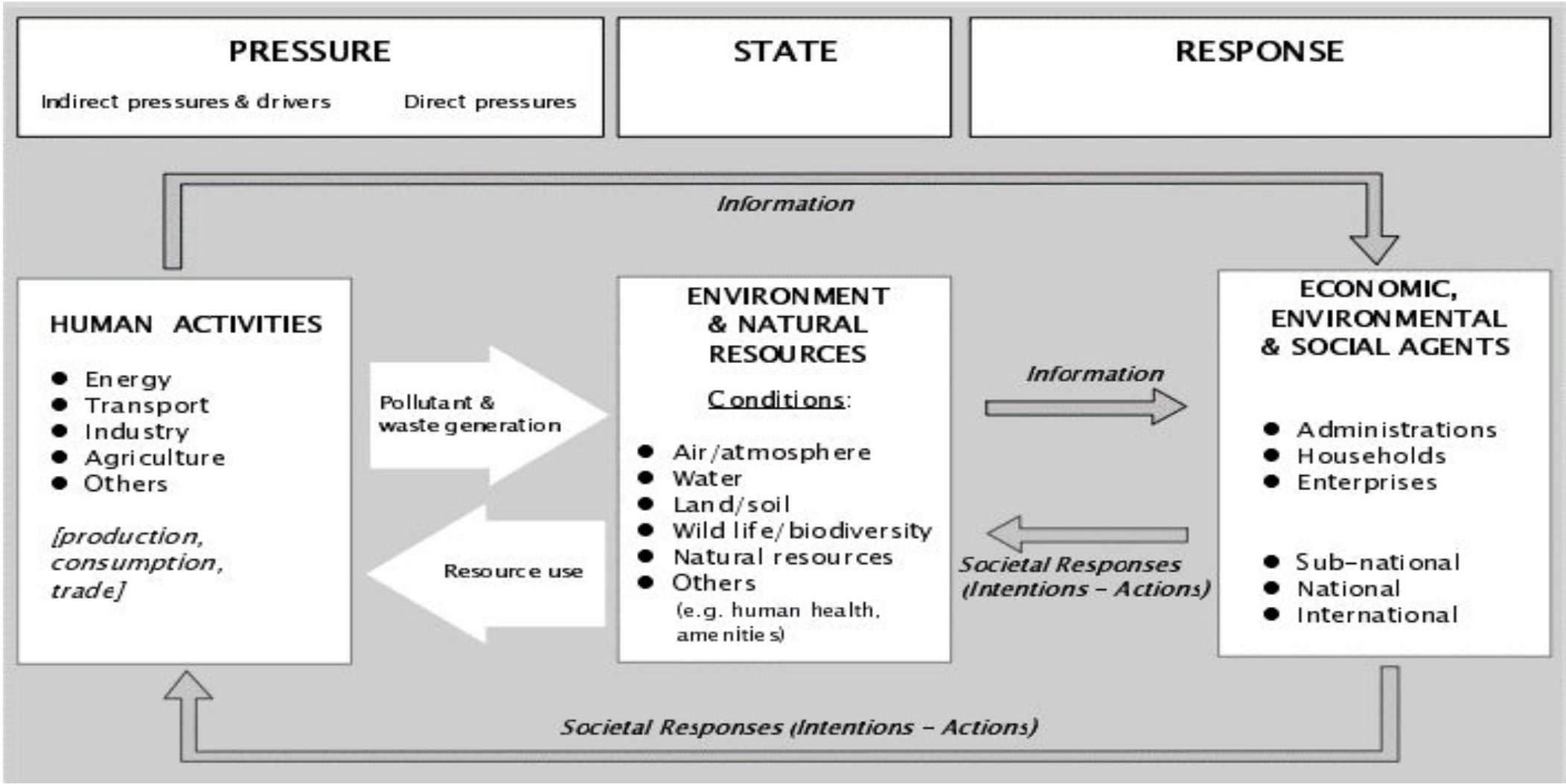
Micro-watershed in Andean Region

The 77.4% of the population and the 85% of Colombian economic activity is concentrated in the Andean region (Bernal, Martínez, Pabón, et al, 2010)

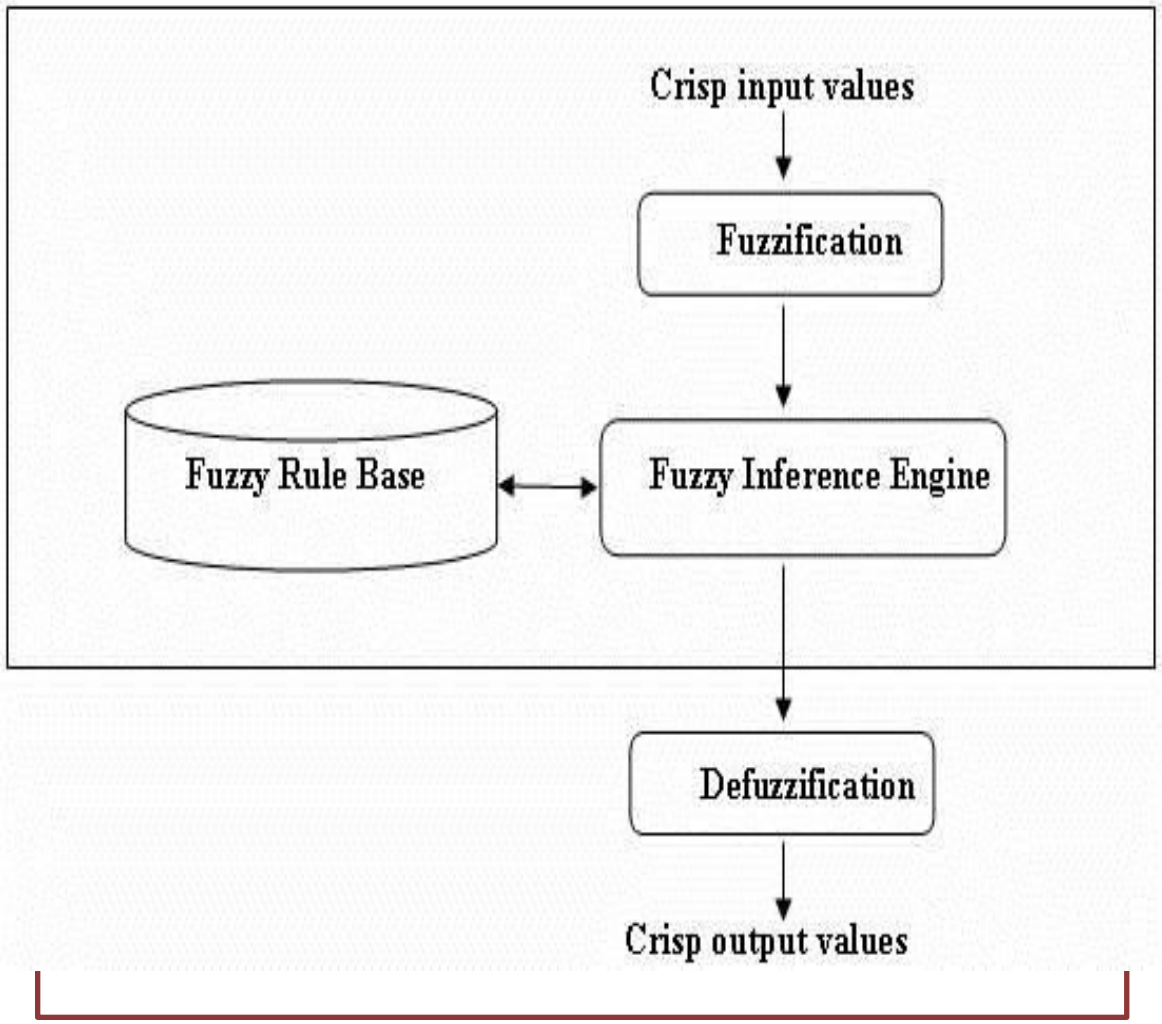
The Andean region counts only with the 13% of the country's total water supply (IDEAM, 2010)

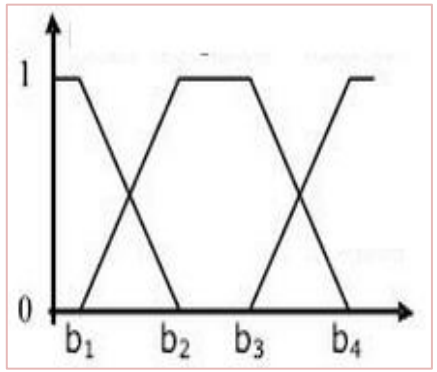
The 29% of the total forest loss in Colombia is located in the Andean zone (IDEAM, 2013)

Pressure-State-Response Framework (OCDE, 2013)

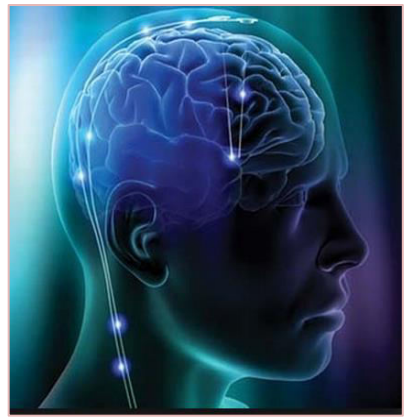


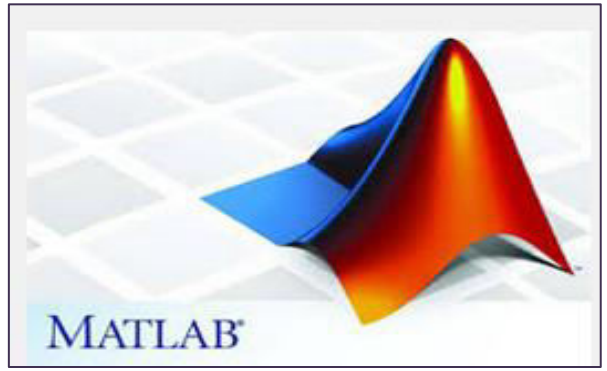
Fuzzy Logic System– artificial intelligence (Zadeh, 1965)





Difuze rules

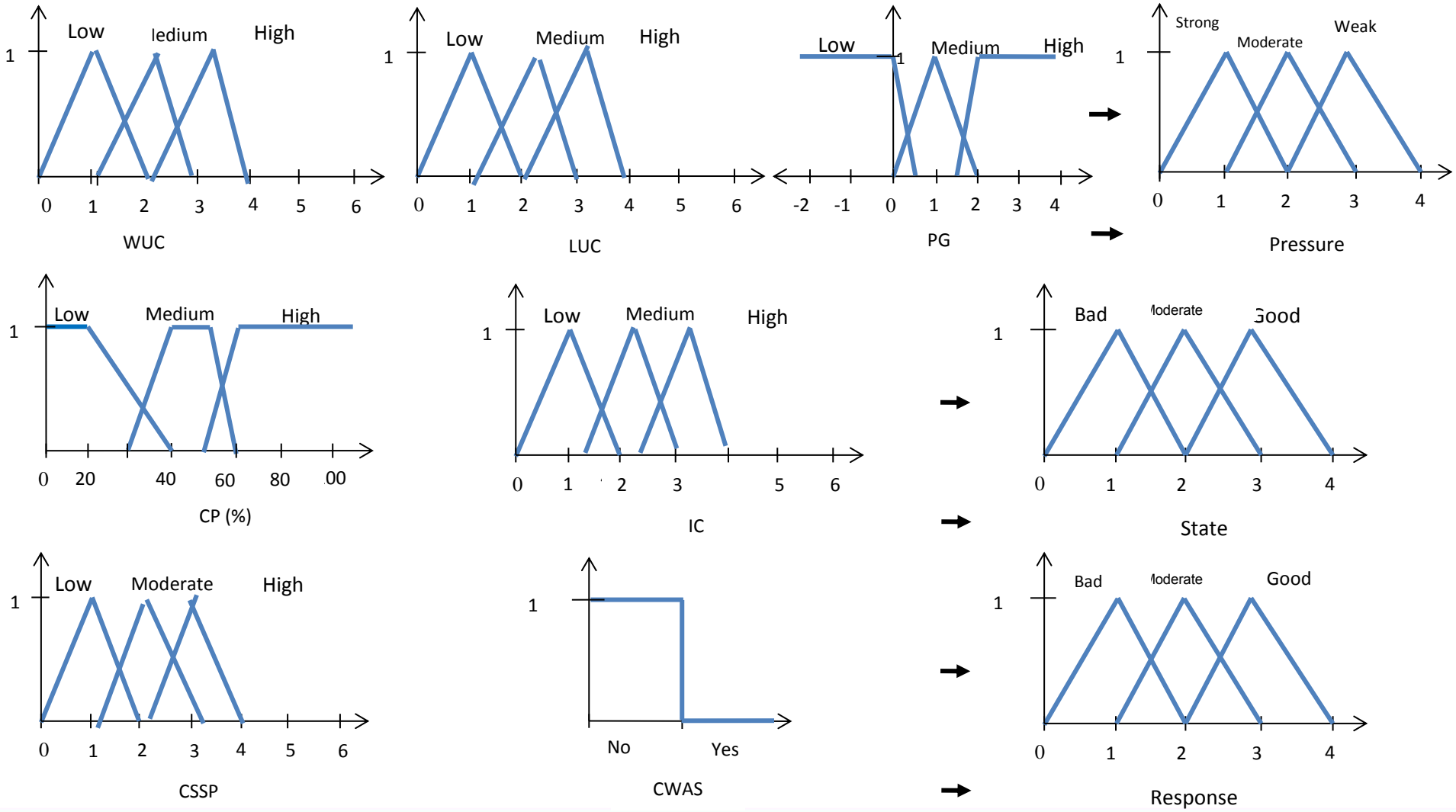




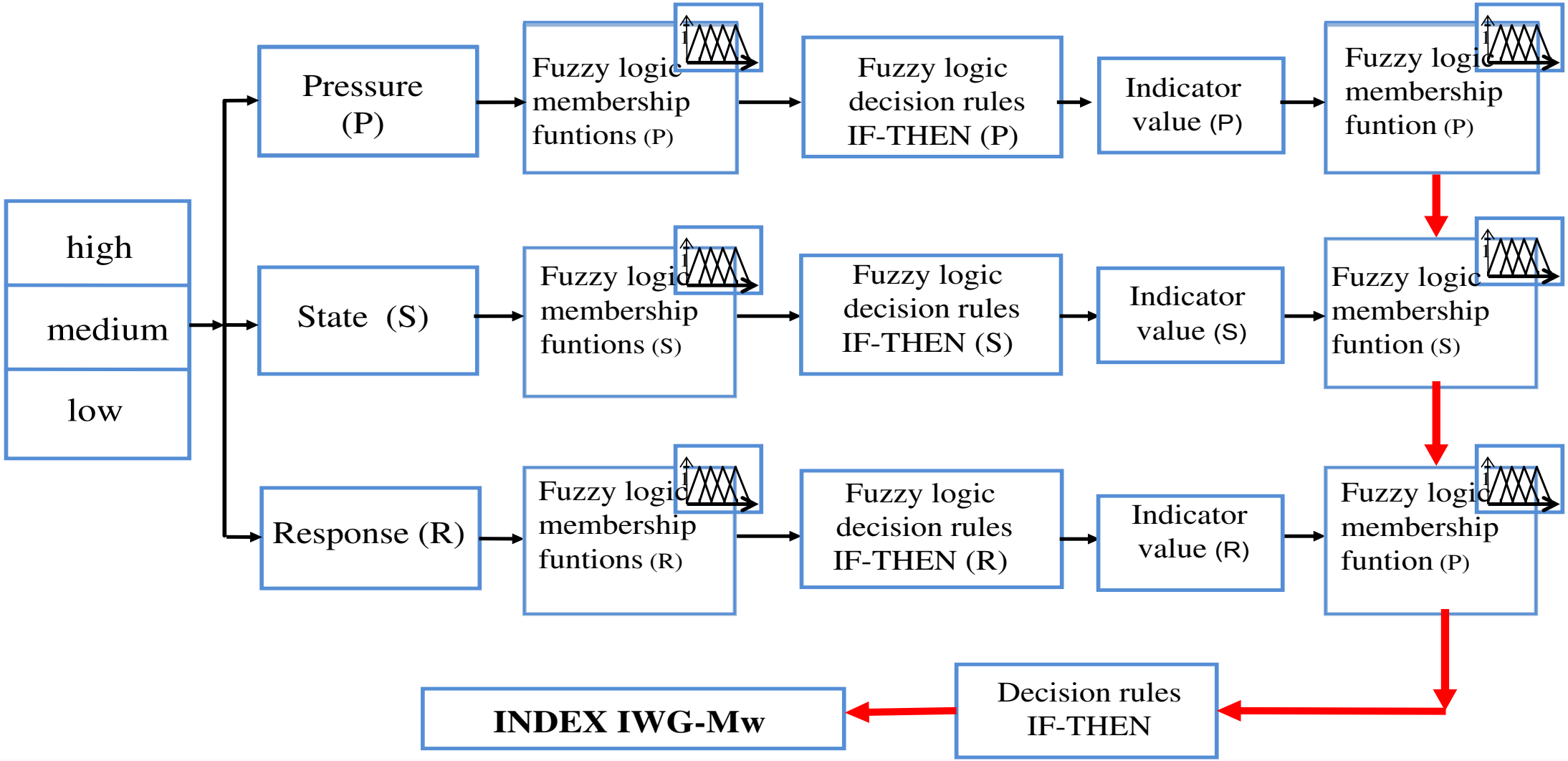
PSR indicators

Pressure	State	Response
Water use conflicts (WUC) Land use conflicts (LUC) Population growth (PG)	Community participation (CP) Institutional coordination (IC)	Communication strategies and social participation (CSSP) Council watershed with its own administrative system (CWAS)

Some examples



Fuzzy Logic System– artificial intelligence



Rules for pressure indicator – IWQ-Mw

Rule No.	WUC	LUC	PG	Pressure	Rule
1	Low	Low	Low	Weak	IF (WUC IS LOW) AND (LUC IS LOW) AND (TCP IS LOW) THEN PRESSURE IS WEAK
2	Low	Medium	Low	Medium	IF (WUC IS LOW) AND (LUC IS MEDIUM) AND (TCP IS LOW) THEN PRESSURE IS MEDIUM
3	Low	High	Low	Strong	IF (WUC IS LOW) AND (LUC IS HIGH) AND (TCP IS LOW) THEN PRESSURE IS STRONG
4	Low	Low	Medium	Weak	IF (WUC IS LOW) AND (LUC IS LOW) AND (TCP IS MEDIUM) THEN PRESSURE IS WEAK
5	Low	Medium	Medium	Medium	IF (WUC IS LOW) AND (LUC IS MEDIUM) AND (TCP IS MEDIUM) THEN PRESSURE IS MEDIUM
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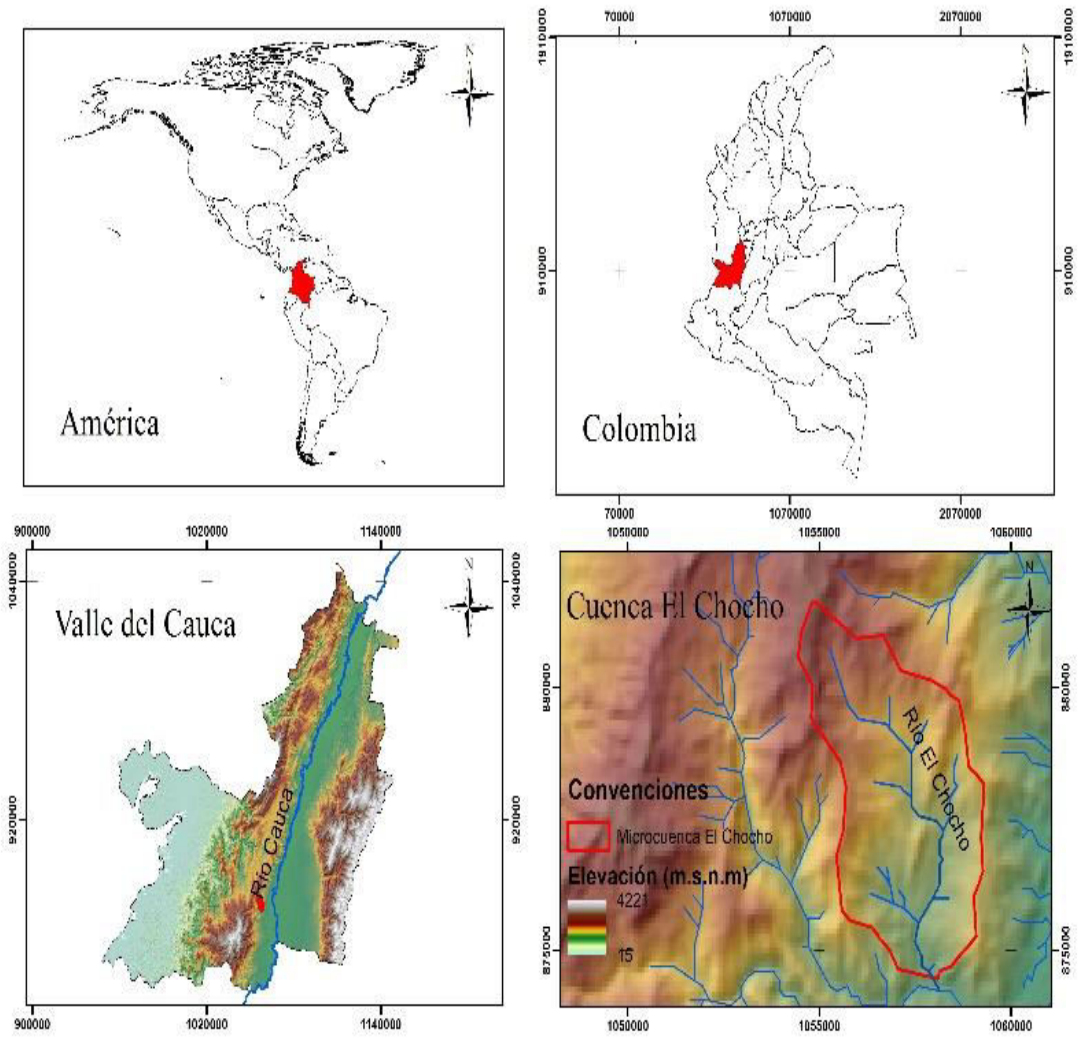
::	::	::	::	::	:::
26	High	Medium	High	Strong	IF (WUC IS HIGH) AND (LUC IS MEDIUM) AND (TCP IS HIGH) THEN PRESSURE IS STRONG
27	High	High	High	Strong	IF (WUC IS HIGH) AND (LUC IS HIGH) AND (TCP IS HIGH) THEN PRESSURE IS STRONG

Micro-watershed El Chocho



This micro-watershed has suffered a huge environmental damage, as a consequence of the

- Change in the use of the land
- Increase of the population
- Discharge of wastewater
- Poor management of solid wastes
- Discharge of acid
- Conflicts caused by the use of the water and soils
- Institutions problems
- Low local participation

Main problems in microwatershed “el Chocho”

Acid mine drainage

Occupancy of the protetive zone

Wastewater

Mining

Change in land use, livestock

Conflic for water use

Water contamination

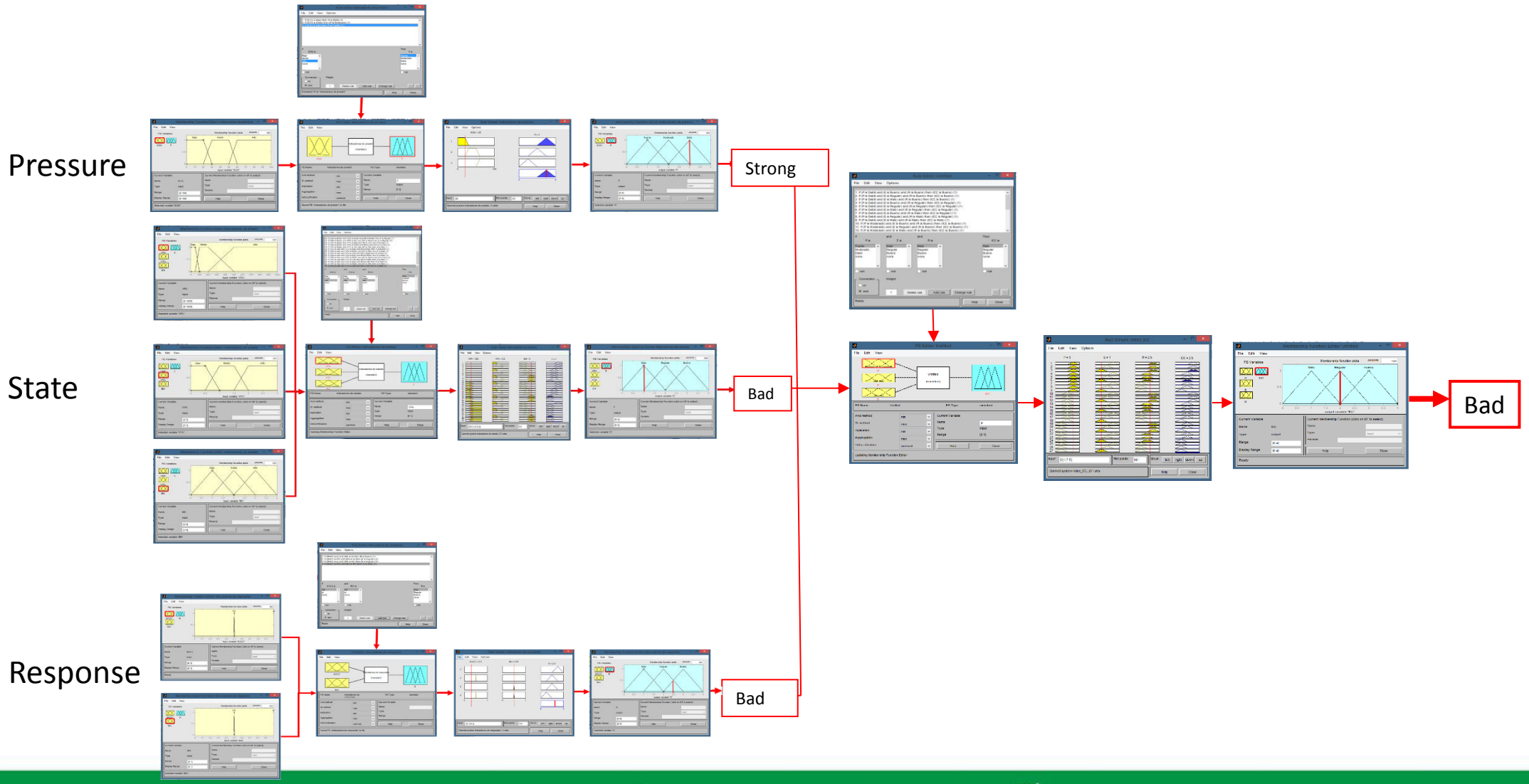
Contamination for mining

Conflicts for water use

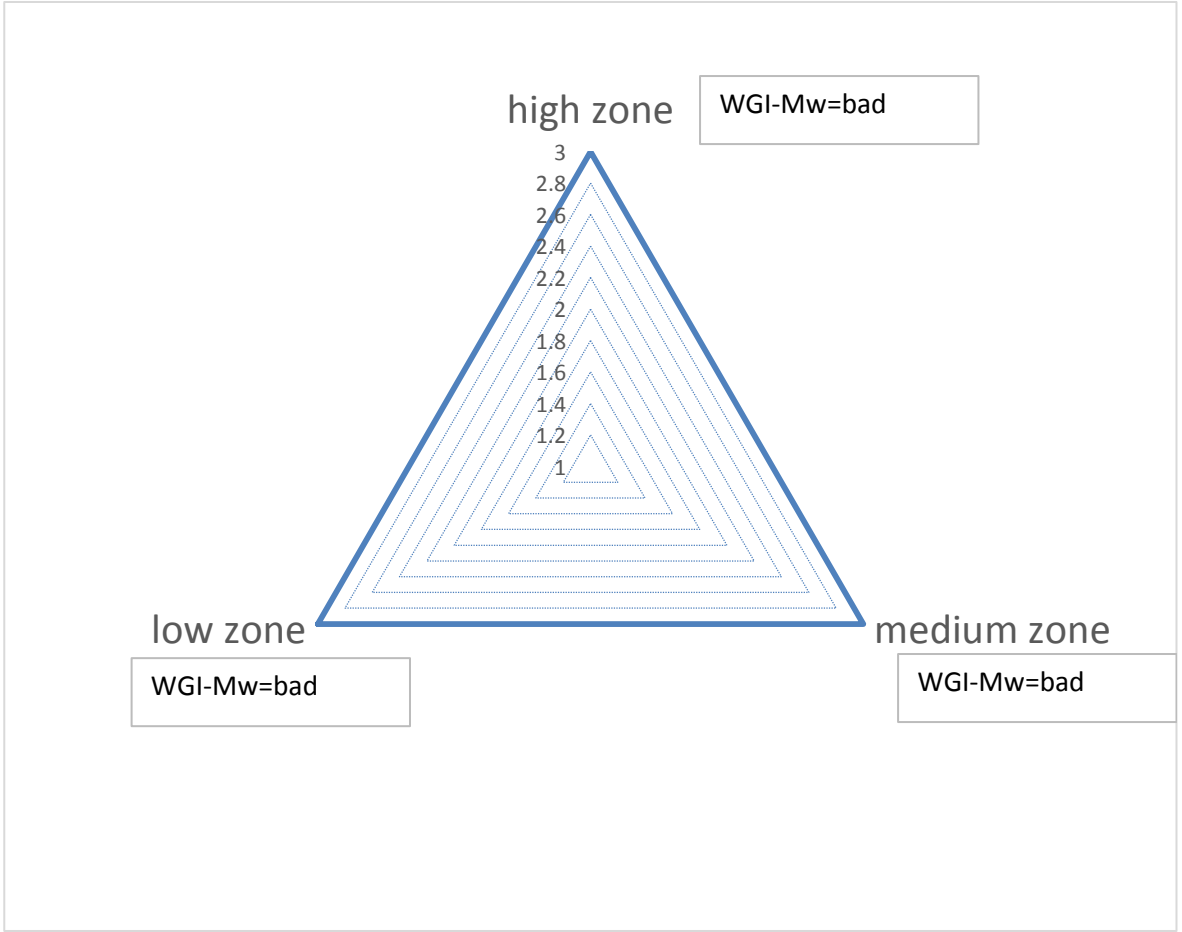
Micro-watershed El Chocho indicators values

Zone	Pressure	State	Response
High	WUC=High LUC=Low PG=0,03	CP=20% IC=Low	CSSP=Low CWAS=No
Medium	WUC=High LUC= High PG=1,9	CP=30% IC=Low	CSSP=Low CWAS=No
Low	WUC=High LUC= High PG=0,1	CP=30% IC=Low	CSSP=Low CWAS=No

Example of Matlab results –WGI-Mw in Chocho

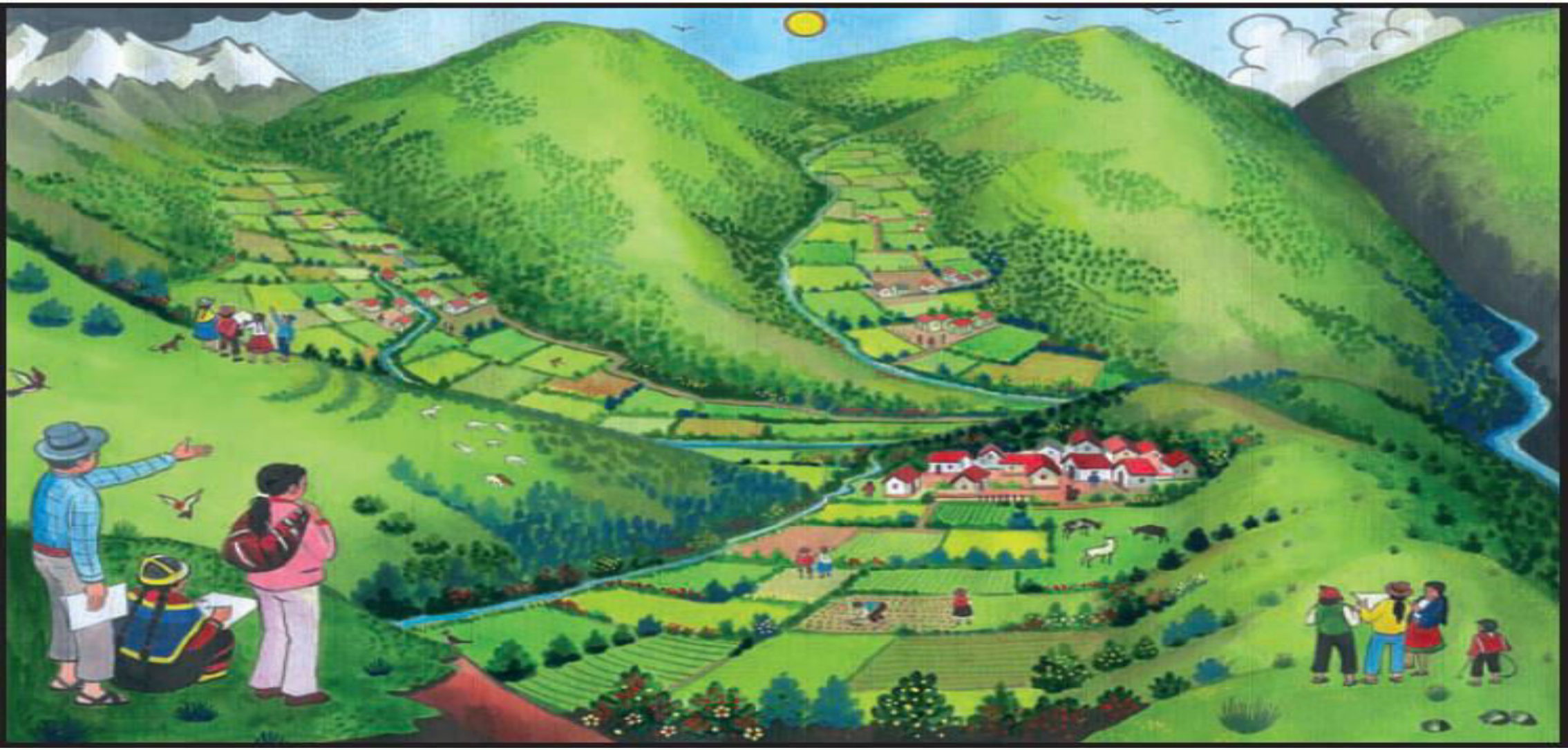


WGI-Mw in Chocho



Some conclusions

- A new index for the assessment of the water governance in micro-watershed Andean was developed WGI-Mw
- The index can be used to assessment the governance level in different temporal and spatial scales
- It is necessary to do more applications in others Andean micro-watersheds to evaluated the indicators and the index results
- It is necessary to do applications in other scale levels: sub-watershed and watershed

Thanks for your attention

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