# Water Regulation Services from Catchments


Adrian L. Vogl

Stanford University & The World Bank

avogl@worldbank.org


PROGREEN

natural capital PROJECT

ANCHOR environmental

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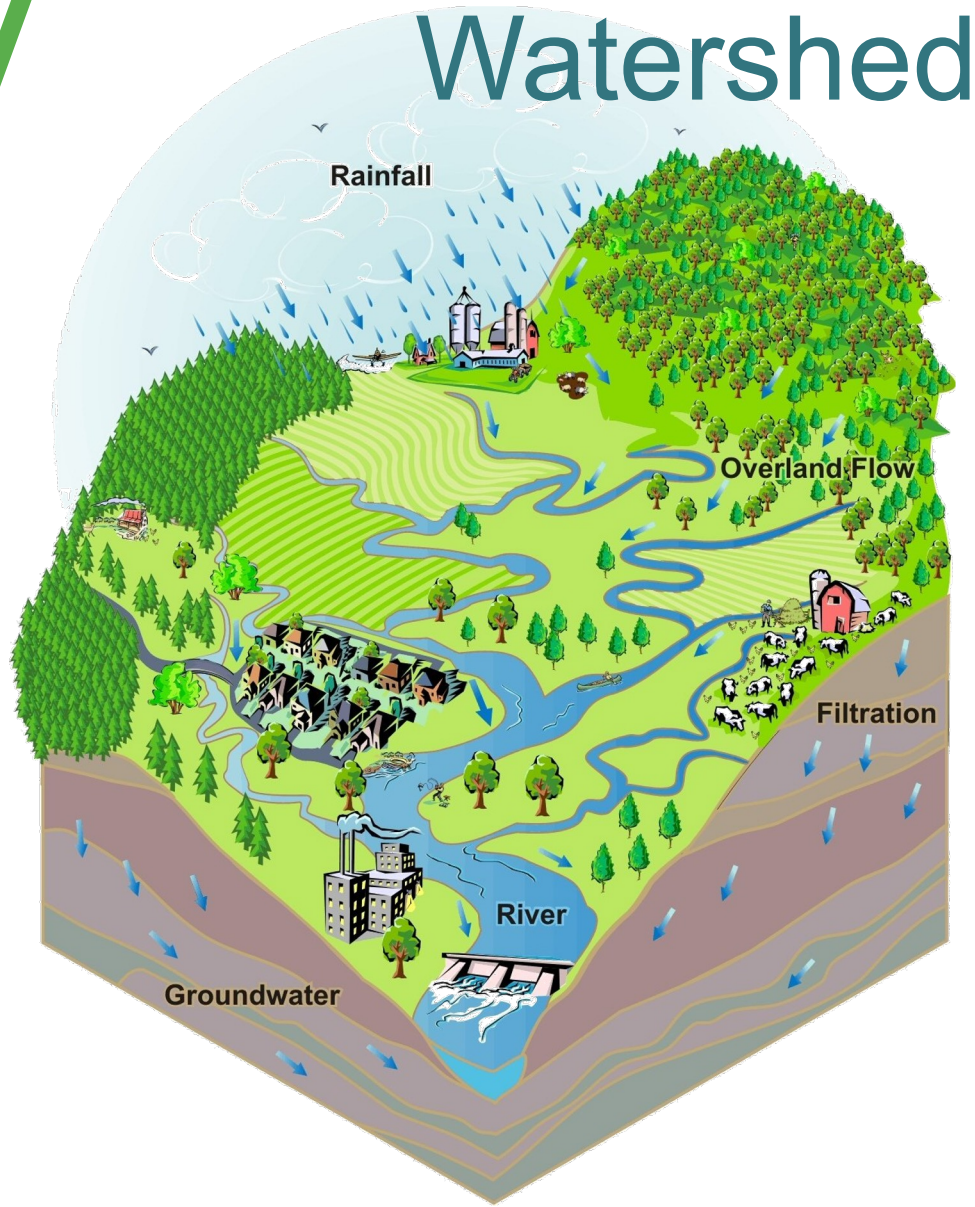
# Watersheds as natural capital




- Watersheds provide essential ecosystem services to downstream communities, irrigation projects, hydropower projects, and local residents.
- Watersheds regulate water flows, sediment loads, and nutrient inputs into wetlands and storage reservoirs.
- Communities and economies directly depend on the maintenance of such services.

# Some key questions for water regulation

- How will land degradation affect the infiltration of water, runoff, and dry season flows?
- What areas produce the most runoff that can contribute to flooding risk?
- How might rangeland or cropland management and climate change affect these contributions?

# Seasonal Water Yield Model

InVEST

integrated valuation of ecosystem services and tradeoffs

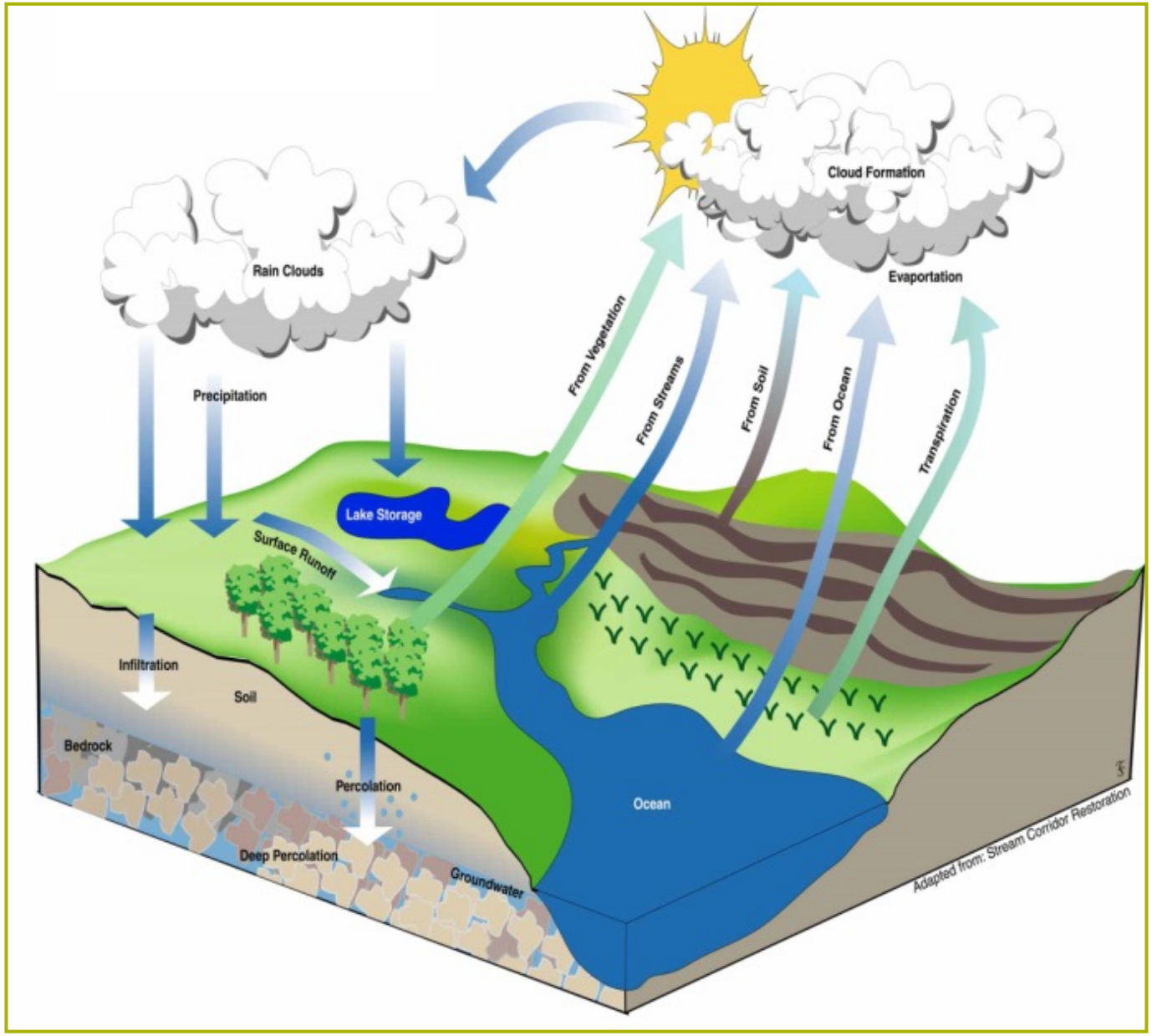
https://naturalcapitalproject.stanford.edu/software/invest-models/seasonal-water-yield

# SWY differentiates between Quickflow and Baseflow

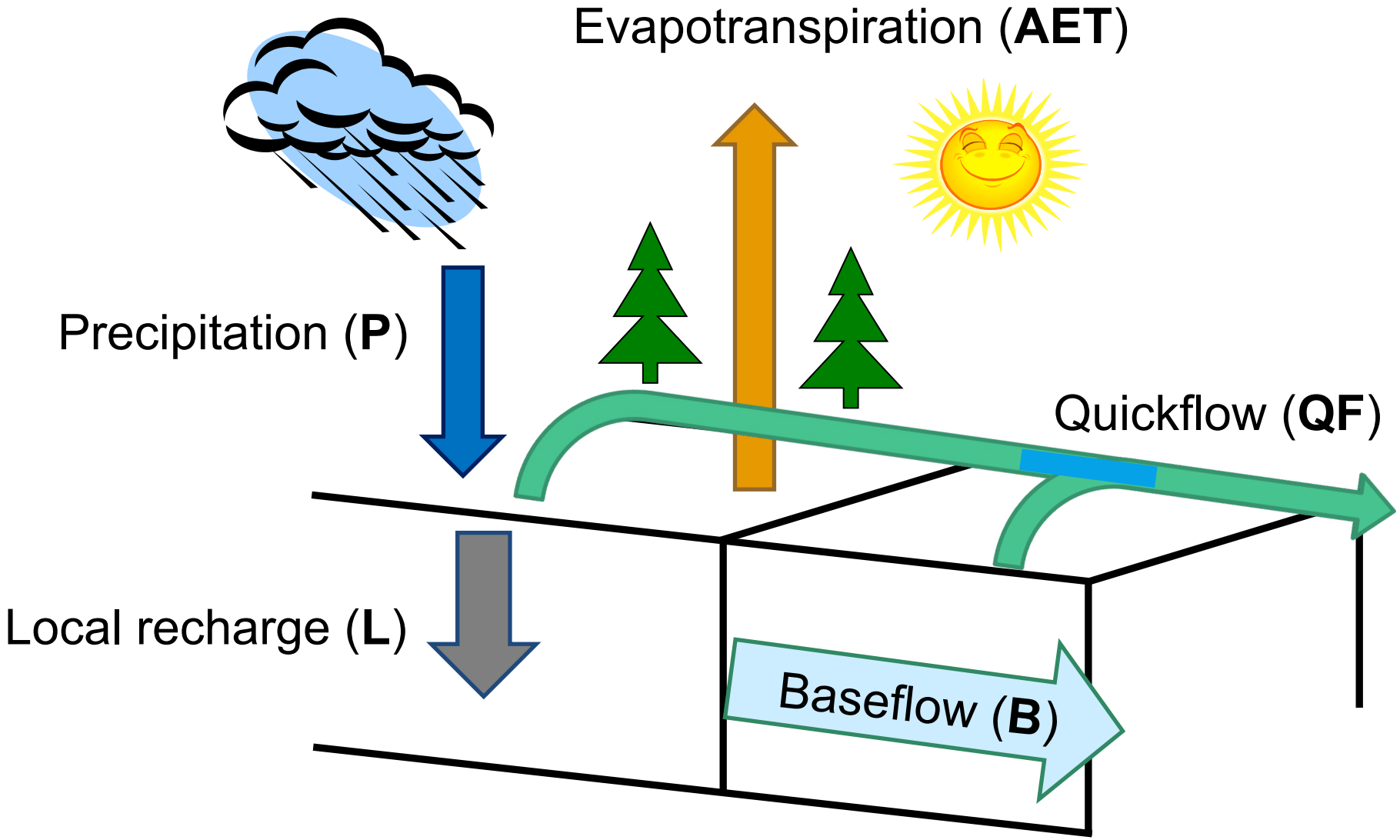
**Quickflow** – water reaching streams during or shortly after rain events (direct runoff)

**Baseflow** – water reaching streams later (between rain events; during dry season; residence times of months to years)

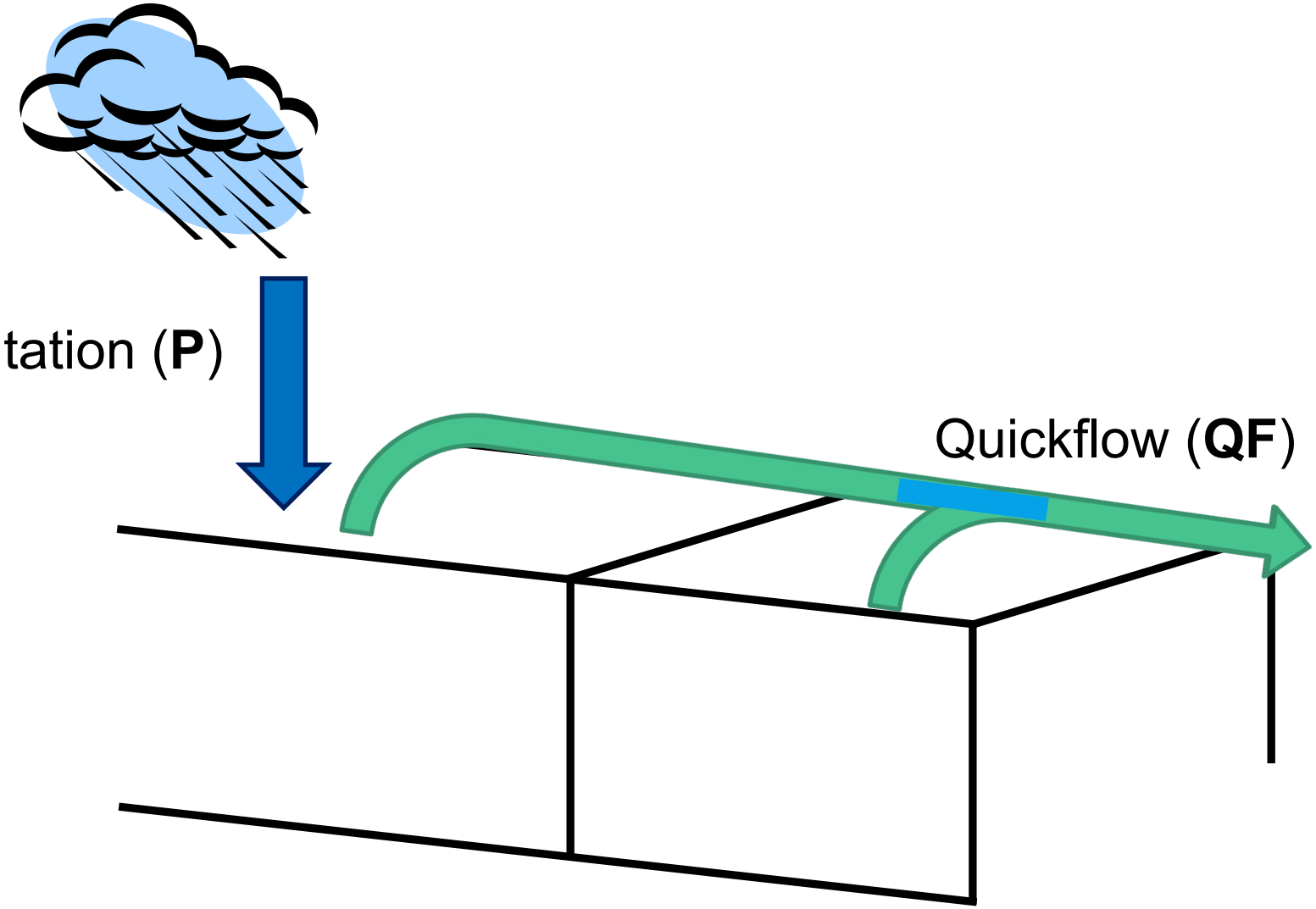
# Water Balance



# The Model


Evapotranspiration (**AET**)
Precipitation (**P**)
Quickflow (**QF**)
Local recharge (**L**)
Baseflow (**B**)

# The Model

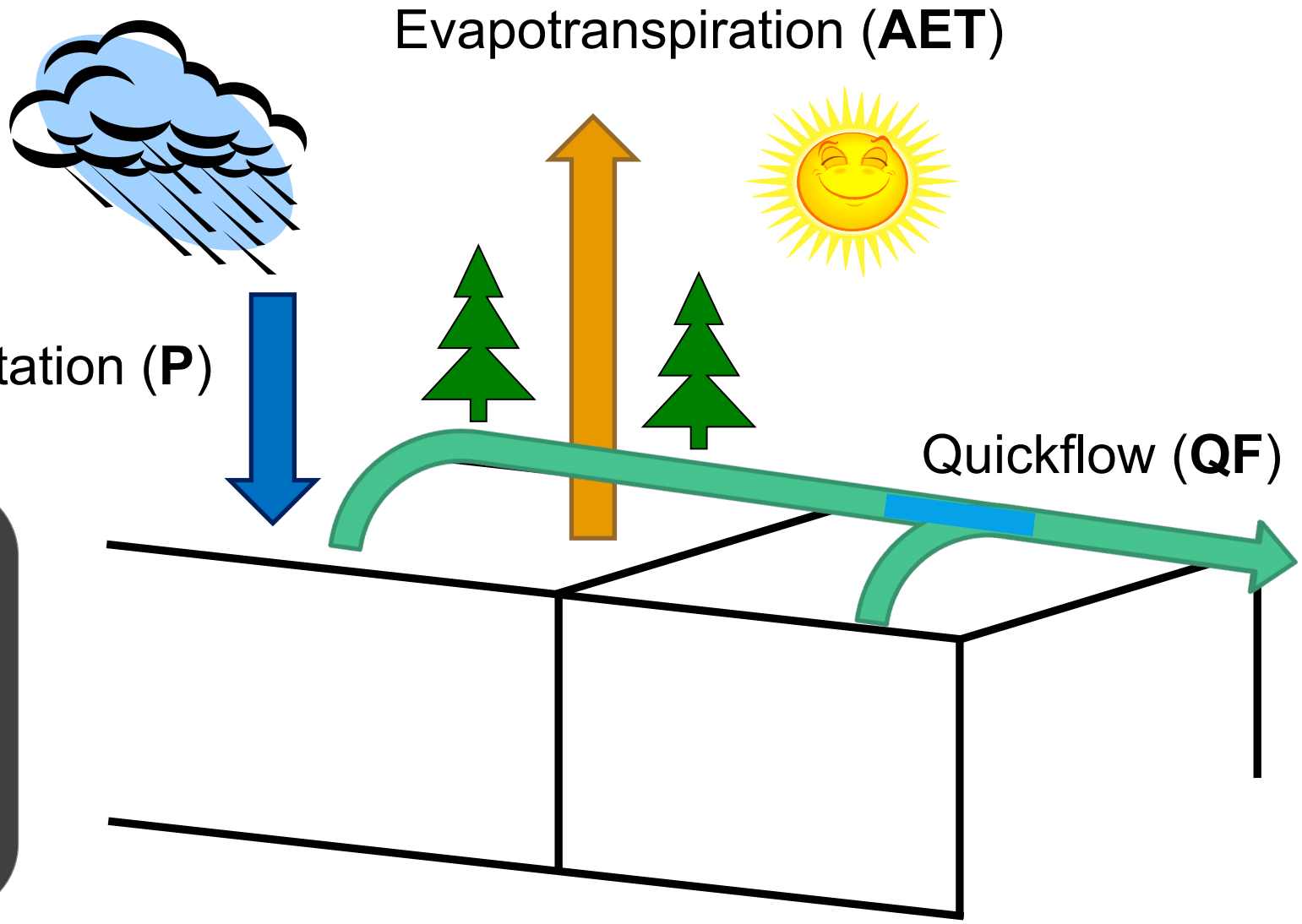





**QF** is a function of:

- *Precipitation Depth*
- *# Precip Events*
- *Curve Number*

# The Model

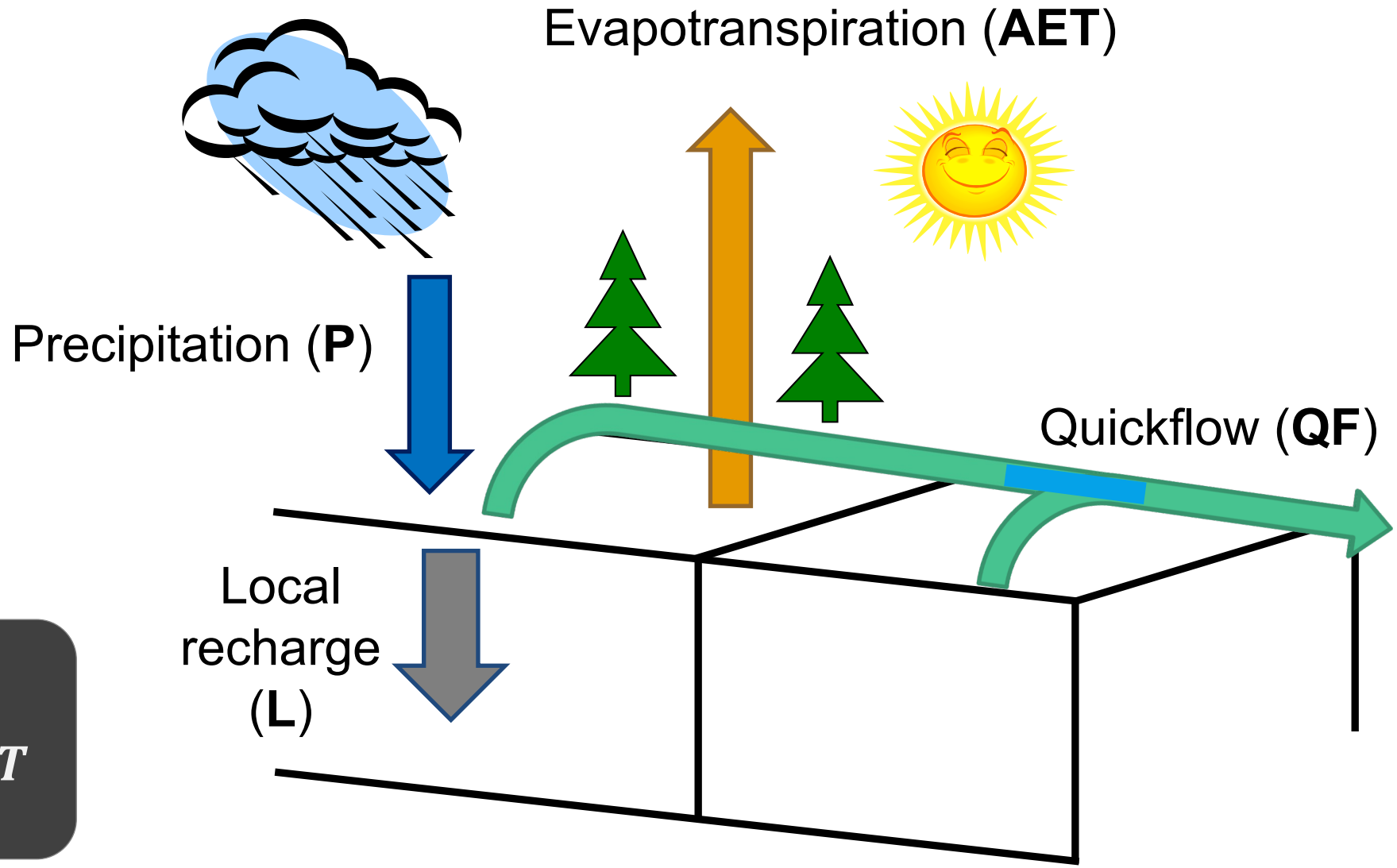





**AET** is limited by:

- *Plant demand (PET)*
  *OR*
- *Available water from upslope*

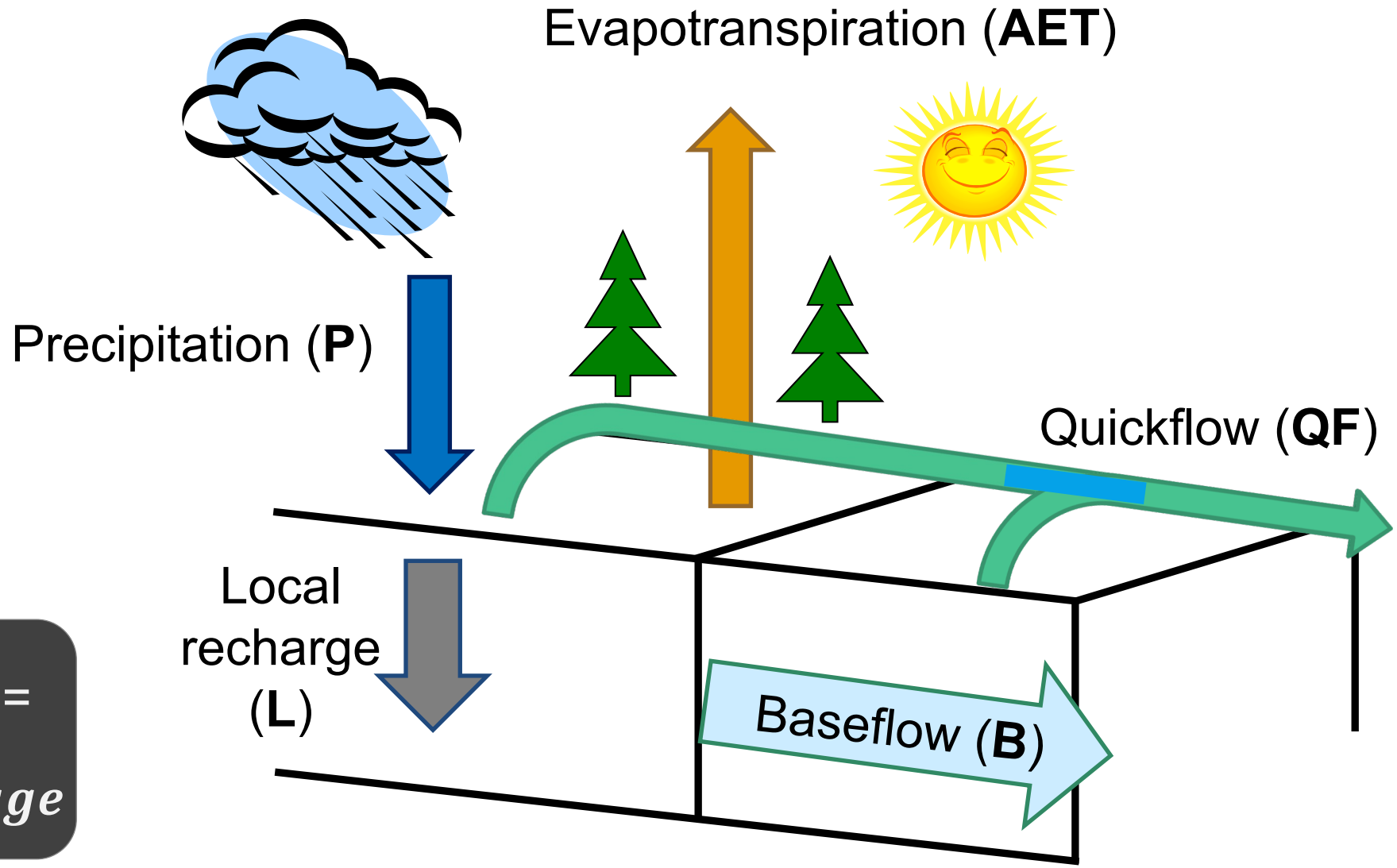
# The Model




Local recharge:

$$L = P - QF - AET$$

# The Model

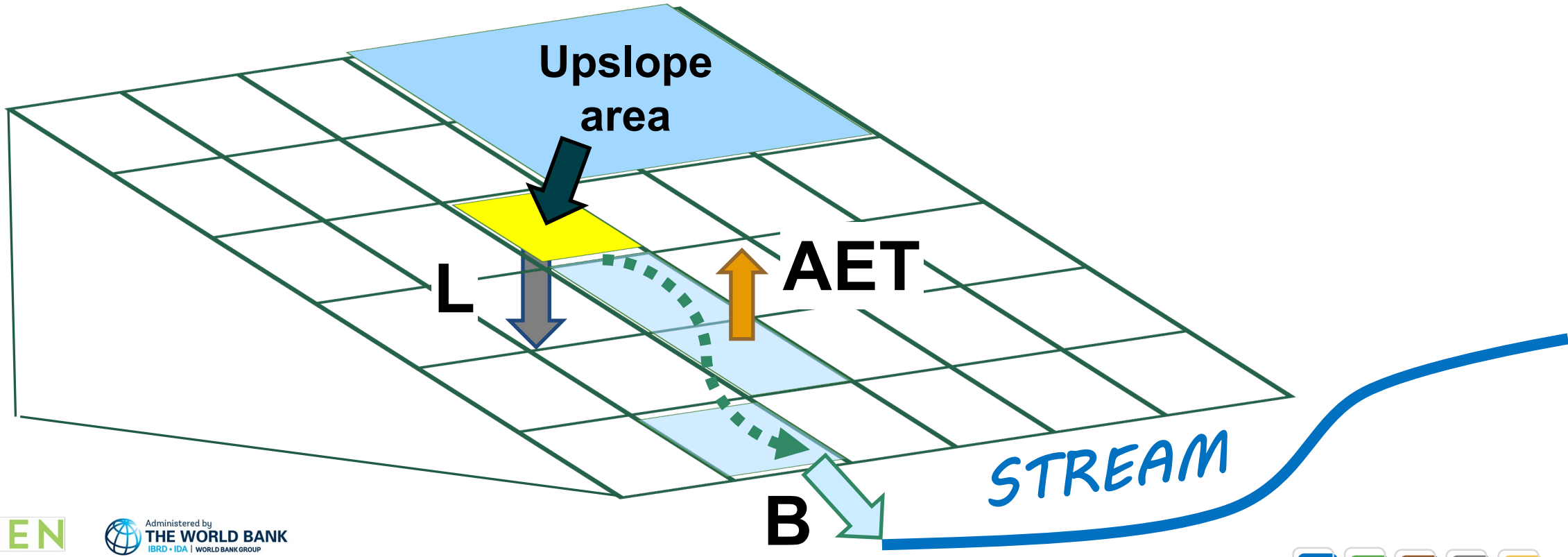



**$B_{sum}$** at the stream =

$$\Sigma\ Local\ recharge$$

# The Model

- **Local recharge (L)** – Potential contribution to Baseflow
- **Baseflow (B)** – Total flow actually reaching stream

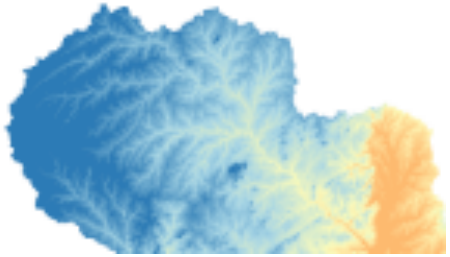


# Limitations

- Monthly average Quickflow, annual Baseflow
- Baseflow is a relative index only, not absolute
- Simplified flow routing (upslope contribution to AET)

# Model Inputs

**Watershed**
Area of interest

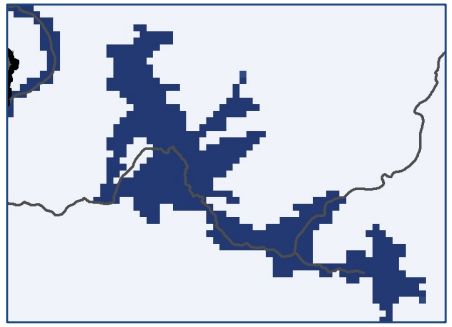


**Topography**
DEM,
Threshold flow accumulation

**Land Use/Land Cover**
Curve numbers,
Evapotranspiration coefficients

**Climate (monthly)**
Precipitation,
evapotranspiration,
# of rain events

**Soils**
Hydrologic soil groups



**Optional**
Climate zones,
recharge layer

# Questions?

# Scenario analysis basics

# What are scenarios?

- Scenarios are simplified representations of possible futures

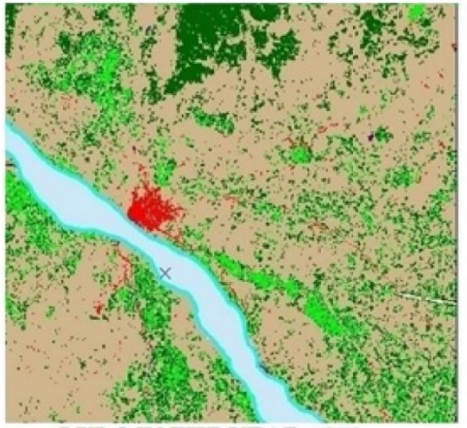


# What are scenarios?

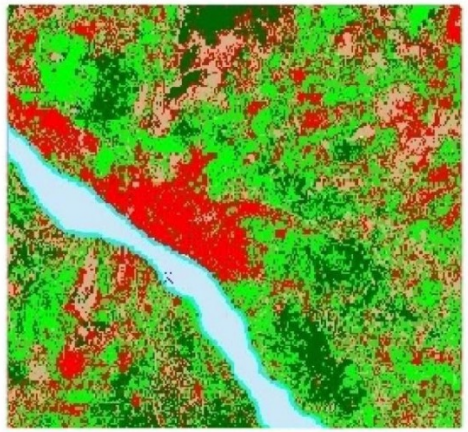
- Scenarios can take many forms
  - Narratives
  - Numbers
  - Drawings
  - Maps

# Approaches to create scenarios

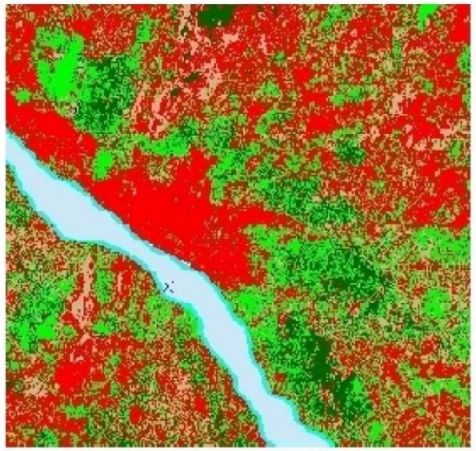
- Scenarios can be developed using various approaches
  - Modelling techniques
  - Participatory methods
    - Stakeholders
    - Technical experts
  - GIS processing
  - Or some combination



LULC IN THE YEAR 1973



LULC IN THE YEAR 2014

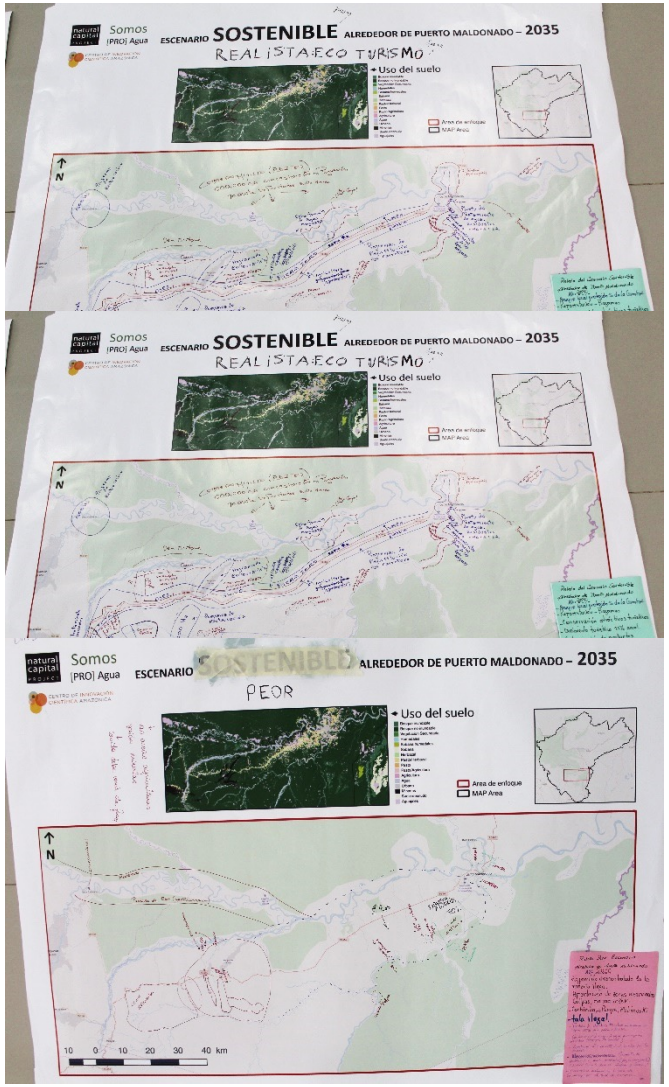


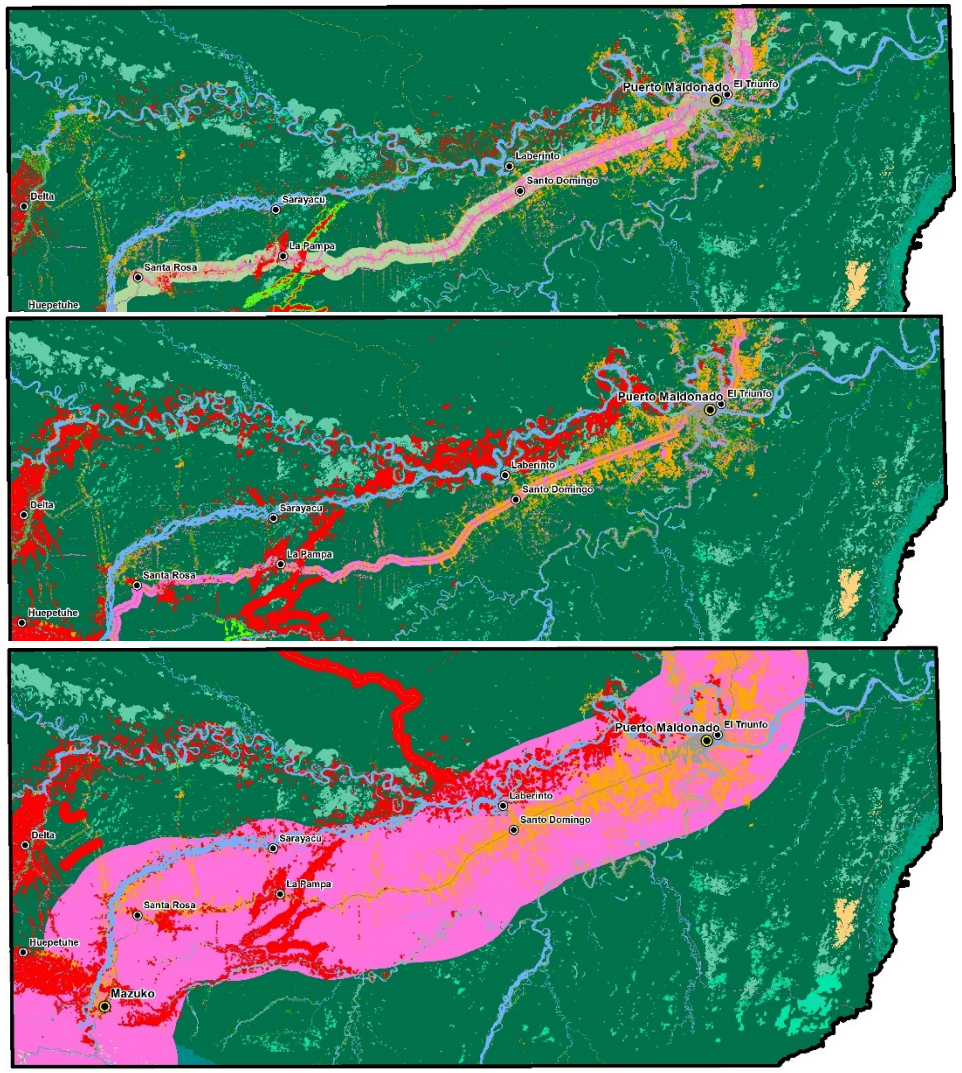
LULC IN THE YEAR 2040

1.Restoration scenario

2.Moderate development + restoration

3.Degraded scenario





**Stakeholder-drawn maps** + **Population projections** + **GIS processing**

# From scenarios to model inputs

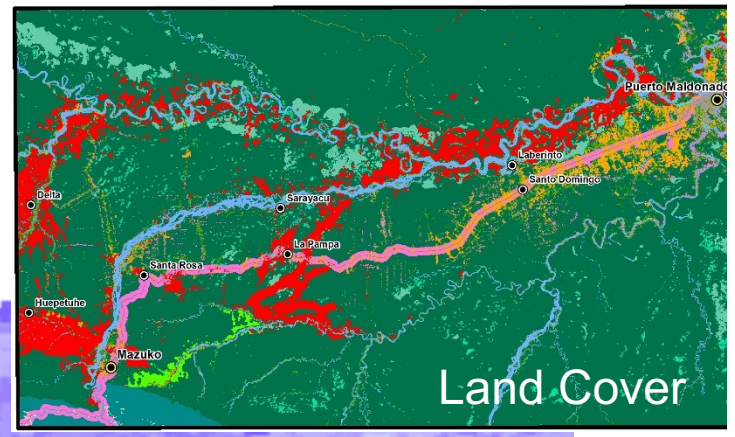


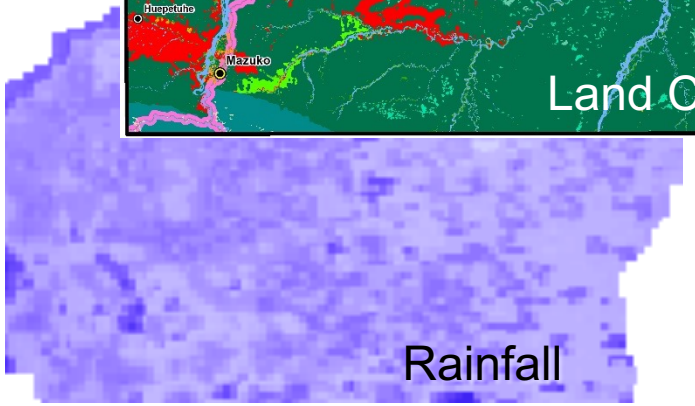
Narratives

Maps

Projections

GIS processing




Tables + Parameters

| description | lucode | Kc_1 | Kc_2 | Kc_3 | Kc_4 | Kc_5 | Kc |
|---|---|---|---|---|---|---|---|
| Urban | 111 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | |
| Pasture | 231 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | |
| Mosaic | 241 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | |
| Secondary Vegetation | 323 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | |
| Barren | 333 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | |
| Water | 413 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | |
| Wetlands | 512 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | |
| Crops | 2211 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | |
| Forest | 31111 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | |
| Grasslands | 32112 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | |
| Mangroves | 600000 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | |
| Seagrass | 610000 | 0 | 0 | 0 | 0 | 0 | |