Role of geospatial data in water resources planning and management

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under the auspices of UNESCO

SUSTAINABLE DEVELOPMENT GOALS

IWRM planning cycle

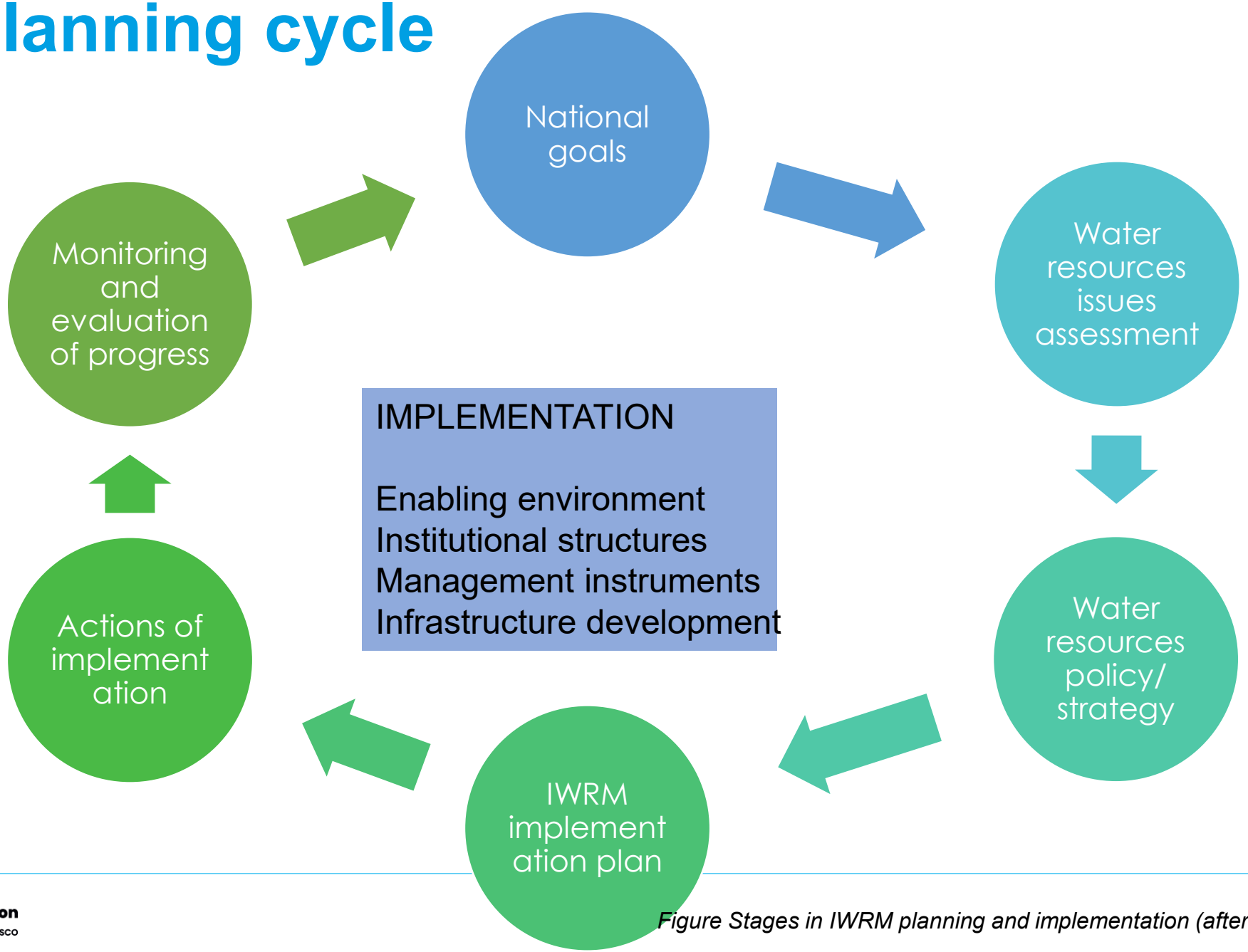
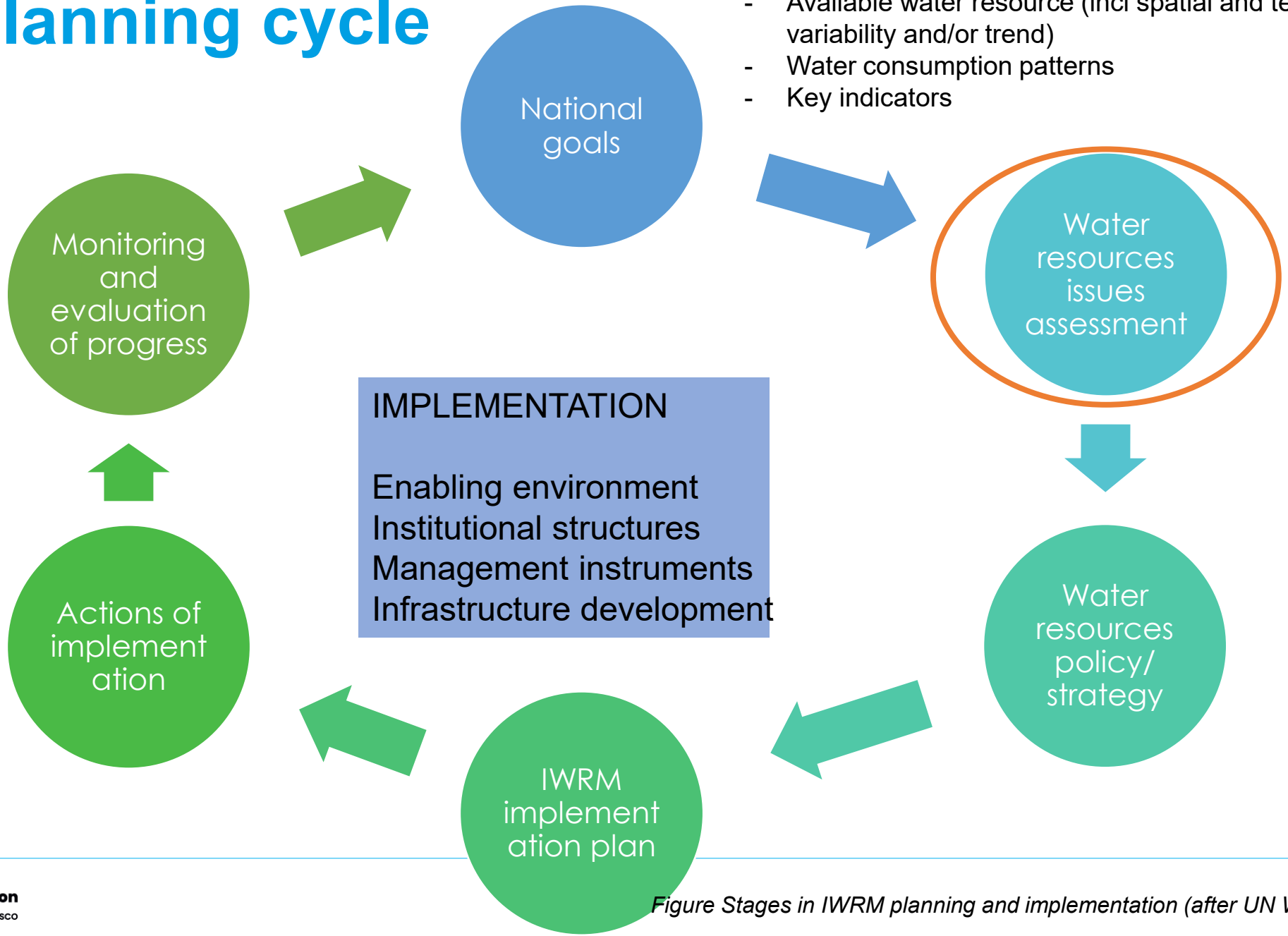


Figure Stages in IWRM planning and implementation (after UN Water & GWP, 2007)

IWRM planning cycle

What is the current state of the basin?
- Available water resource (incl spatial and temporal variability and/or trend)
- Water consumption patterns
- Key indicators



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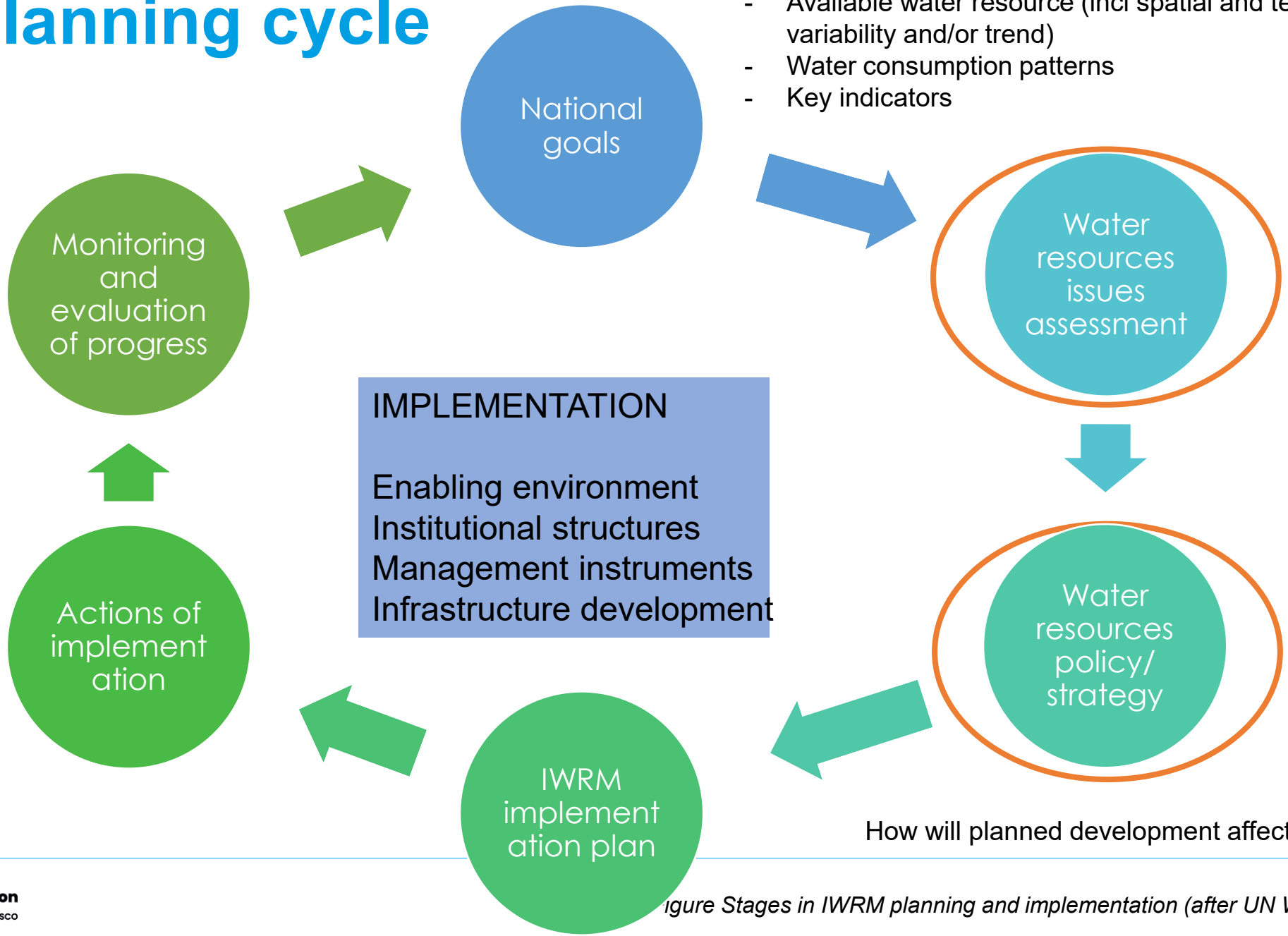


How will planned development affect resources

igure Stages in IWRM planning and implementation (after UN Water & GWP, 2007)

IWRM planning cycle

Do improved agricultural practices implemented in the basin have the required result (eg improved WP)

National goals

What is the current state of the basin?
- Available water resource (incl spatial and temporal variability and/or trend)
- Water consumption patterns
- Key indicators

Water resources issues assessment

Water resources policy/ strategy

How will planned development affect resources

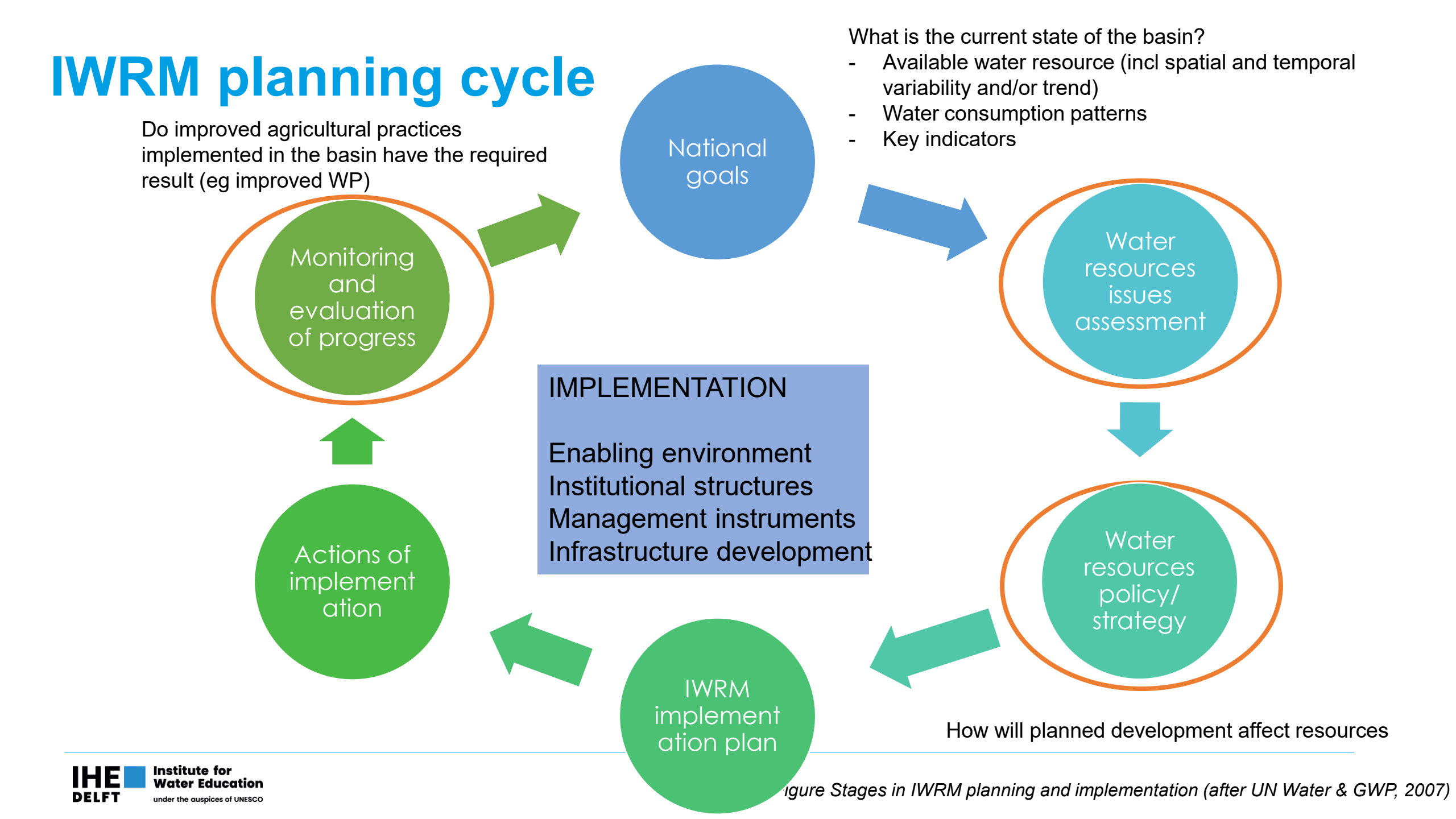
IWRM implement ation plan

IMPLEMENTATION

Enabling environment
Institutional structures
Management instruments
Infrastructure development

Actions of implement ation

Monitoring and evaluation of progress



igure Stages in IWRM planning and implementation (after UN Water & GWP, 2007)

Developing a water resources assessment

"An assessment of the quantity and quality of the water available"

(WMO, 1997)

Including

- Naturally occurring water availability
- Water resources projects and use

- Stages in a water resources assessment:

Objective
- Reporting
- Evaluation
- Monitoring

Domain
- Administrative
- Hydrological boundaries

Geospatial data (specifically Remote Sensing)

- Benefits
  - Observation networks are declining and often provide only point data
  - Able to recreate historical data (upto a point)
  - Able to monitor fluxes that are difficult to observe directly (eg evapotranspiration)
  - Provides spatial data on various processes
  - Quality and accuracy are continuously improving

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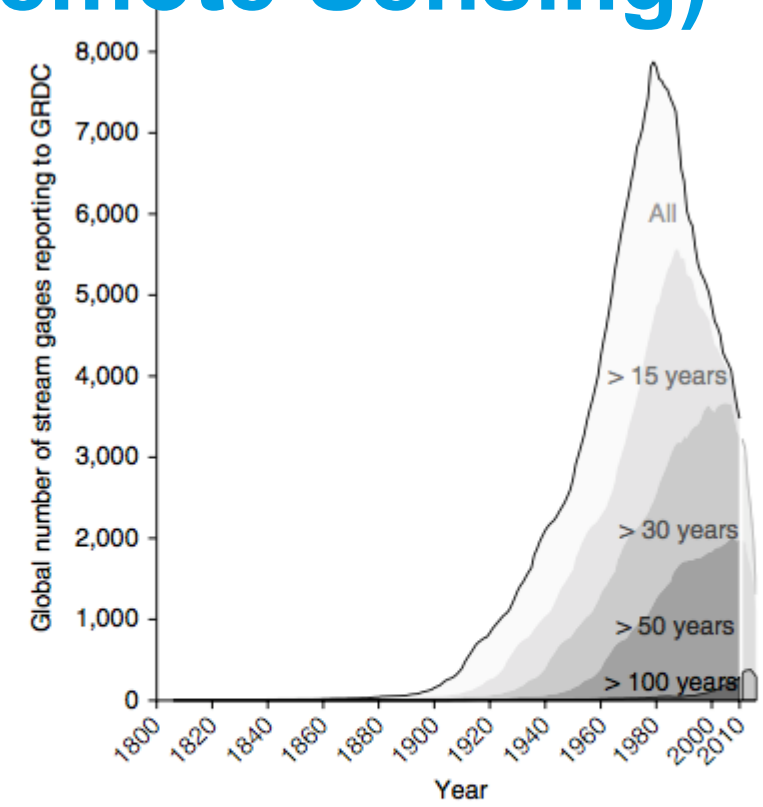


Fig. 1 | Global trends in streamgaging stations reporting to the Global Runoff Data Centre. We classified stations by age class (length of the discharge record, in years). The number of reporting stations peaked in 1979 and decreased sharply thereafter. Comparisons to 2010 (white vertical line) accounts for lags in data reporting, but trends to the present-day are shown.

Ruhi, A., Messager, M.L. & Olden, J.D. Tracking the pulse of the Earth's fresh waters. *Nat Sustain* **1,** 198–203 (2018).

What kind of geospatial data did you use in your MSc research?

What is your experience of using this data?

Concerns of using Geospatial data

- Availability of the data
  - Open access
  - Near real time
  - Future projections

- Quality of the data
  - Comparable to observed data
  - Differences between different products

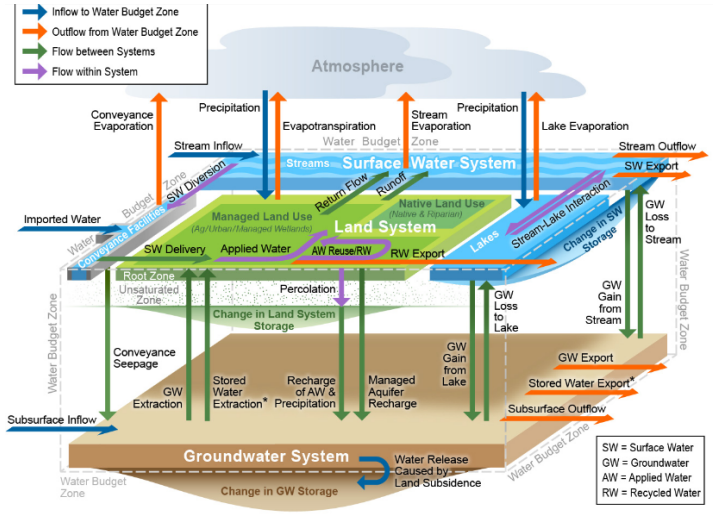
- Skills / experience using/ processing and interpreting geospatial data
- ..

Examples of evaluation of geospatial data products for Ethiopia

- Precipitation:
  - Hydrological performance evaluation of multiple satellite precipitation products in the upper Blue Nile basin, Ethiopia (https://www.sciencedirect.com/science/article/pii/S2214581818302520)
  - Evaluating the performances of gridded satellite/reanalysis products in representing the rainfall climatology of Ethiopia (https://www.tandfonline.com/doi/full/10.1080/10106049.2023.2278329#d1e2889)
- Soil moisture:
  - A comprehensive evaluation of satellite-based and reanalysis soil moisture products over the upper Blue Nile Basin, Ethiopia (https://www.sciencedirect.com/science/article/pii/S2666017224000579)

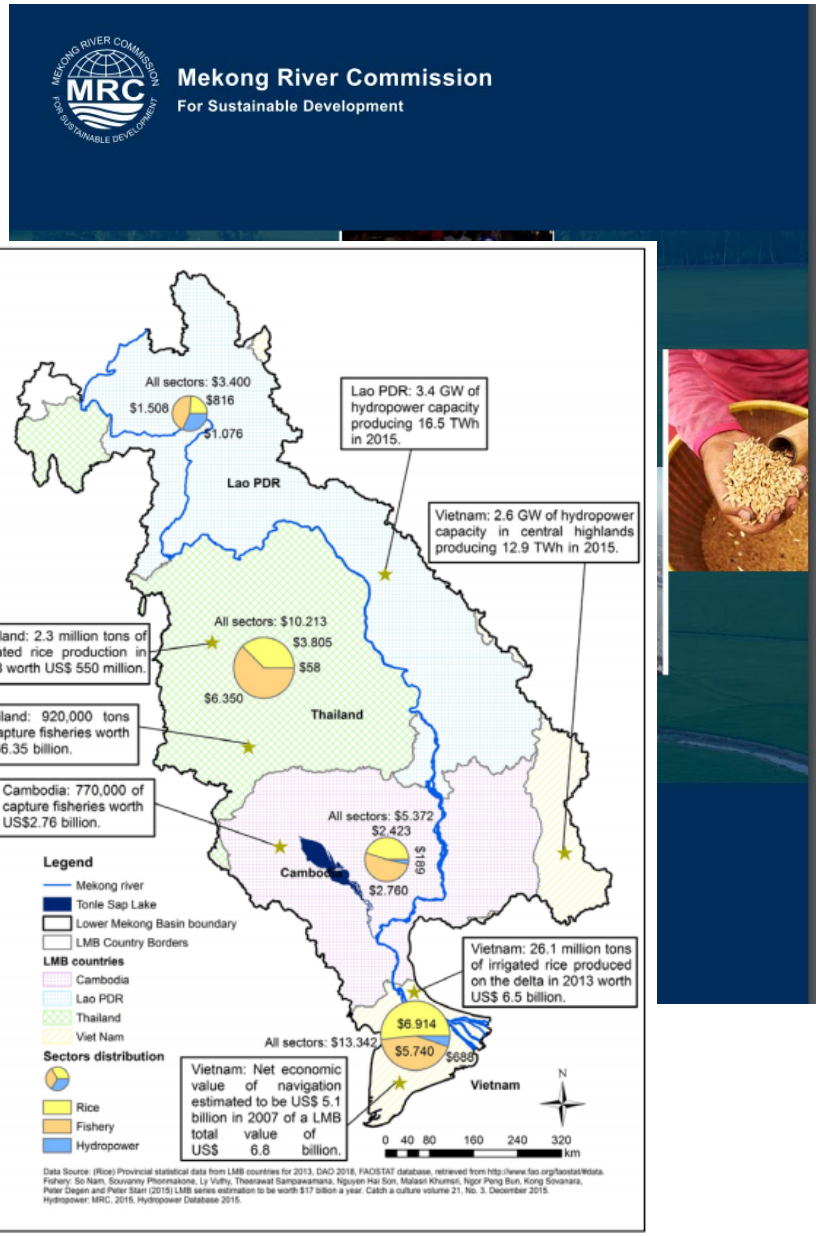
Examples of water resources assessments

- State of the basin
- Water budgets
- Water accounting
- …



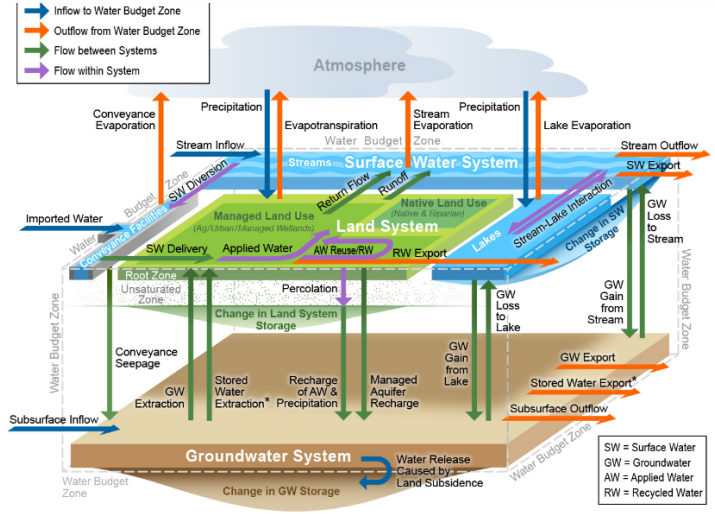
State of the basin - Mekong

- Compiled about every five years based on the facts and figures of the available data and information, the report assesses conditions within the basin and the impacts, both positive and negative, that development and use of the water and related natural resources are having.



https://www.mrcmekong.org/assets/Publications/SOBR-v8_Final-for-web.pdf

Water budget -California



A water budget is a critical element of water management planning as it provides an understanding of historical conditions and how future changes to supply, demand, hydrology, population, land use, and climatic conditions will affect a geographic area

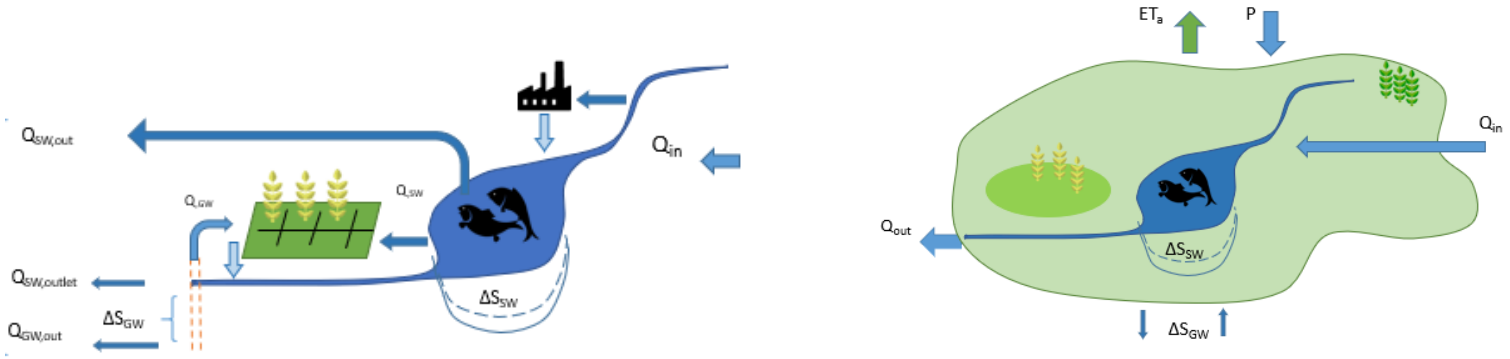
Water agencies may use water budgets for a variety of purposes, such as water supply planning, preparing feasibility studies, facilitating integrated water resources management, estimating and quantifying water resources, identifying data gaps, and forecasting optimum water management actions.

https://data.cnra.ca.gov/dataset/water-budget-handbook/resource/bda1606e-34f4-44e6-8da4-8c8a615543ef

Water Accounting

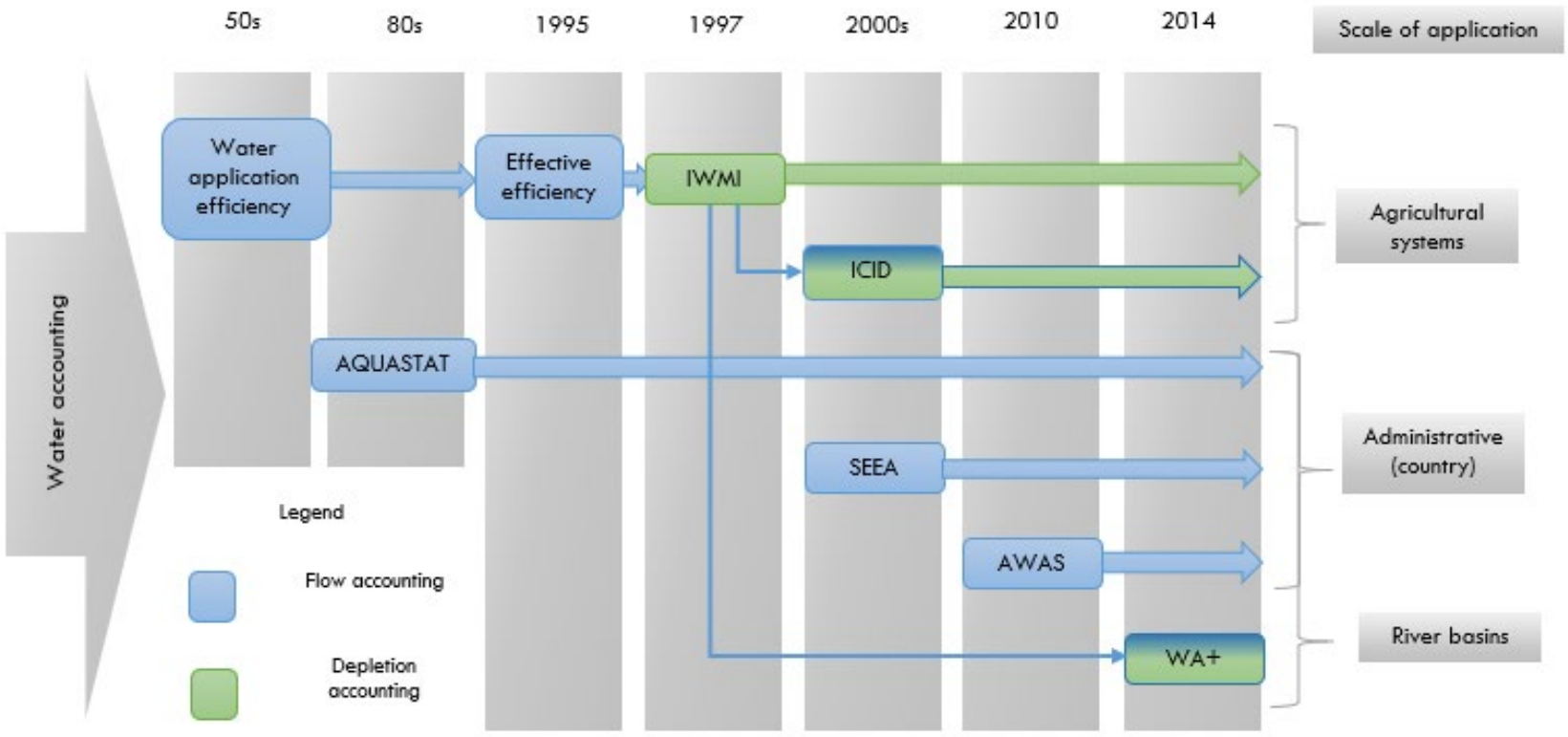
Water Accounting can be defined as the systematic acquisition, analysis and communication of data and information relating to stocks and fluxes of water in natural, disturbed or heavily engineered environments, within a geographical domain

adapted from Steduto et al., 2012; Batchelor et al., 2016

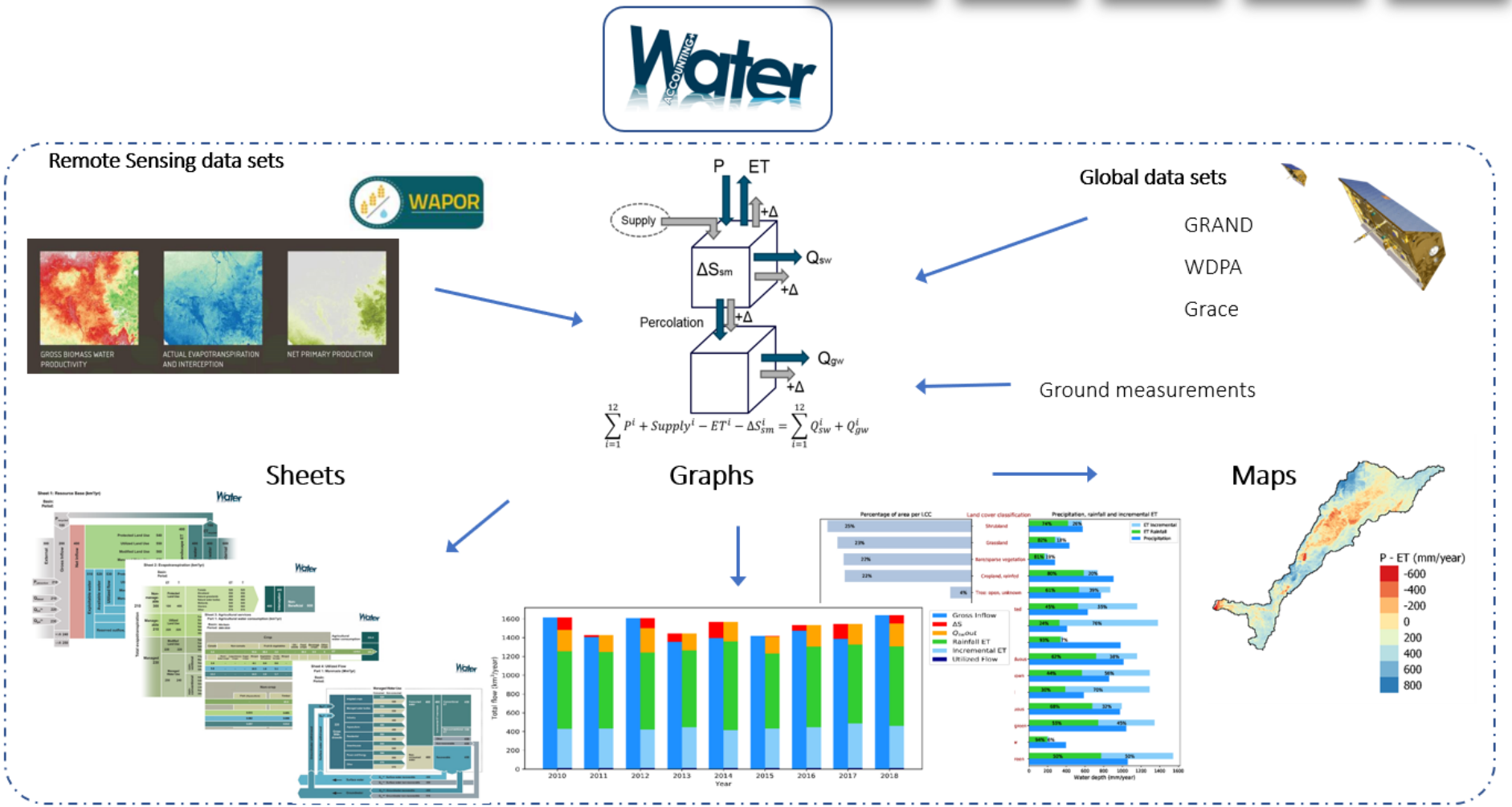


The Flow (a) and Depletion (b) Accounting Concepts applied to a river basin

Historical development of Water Accounting frameworks

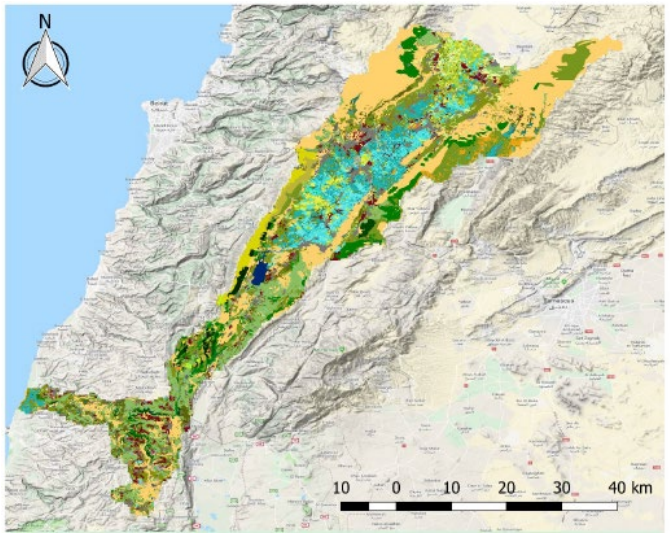


Water Accounting Plus



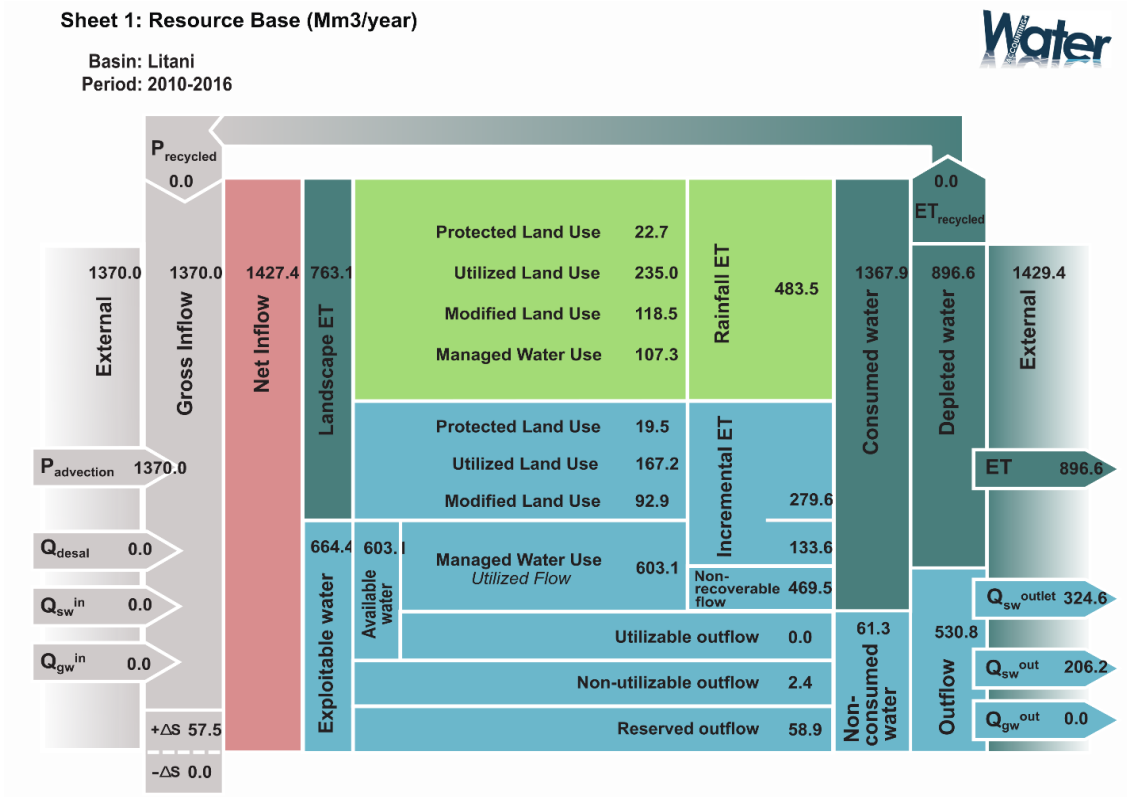
Example Litani - Lebanon

- An important river that provides water for
  - agriculture in Bekaa valley (~50,000 ha, about 50% of irrigated area in Lebanon)
  - Agriculture Qasmeye- coastal region
  - hydropower production,
  - domestic water use for Beirut
- Experiencing water shortage (eg 2014) and increasing challenges to meet the water demands
- Major issues with regard to water quality (lack of waste water treatment)
- Large group of Syrian refugees habiting the area



Water Resources Issues assessment

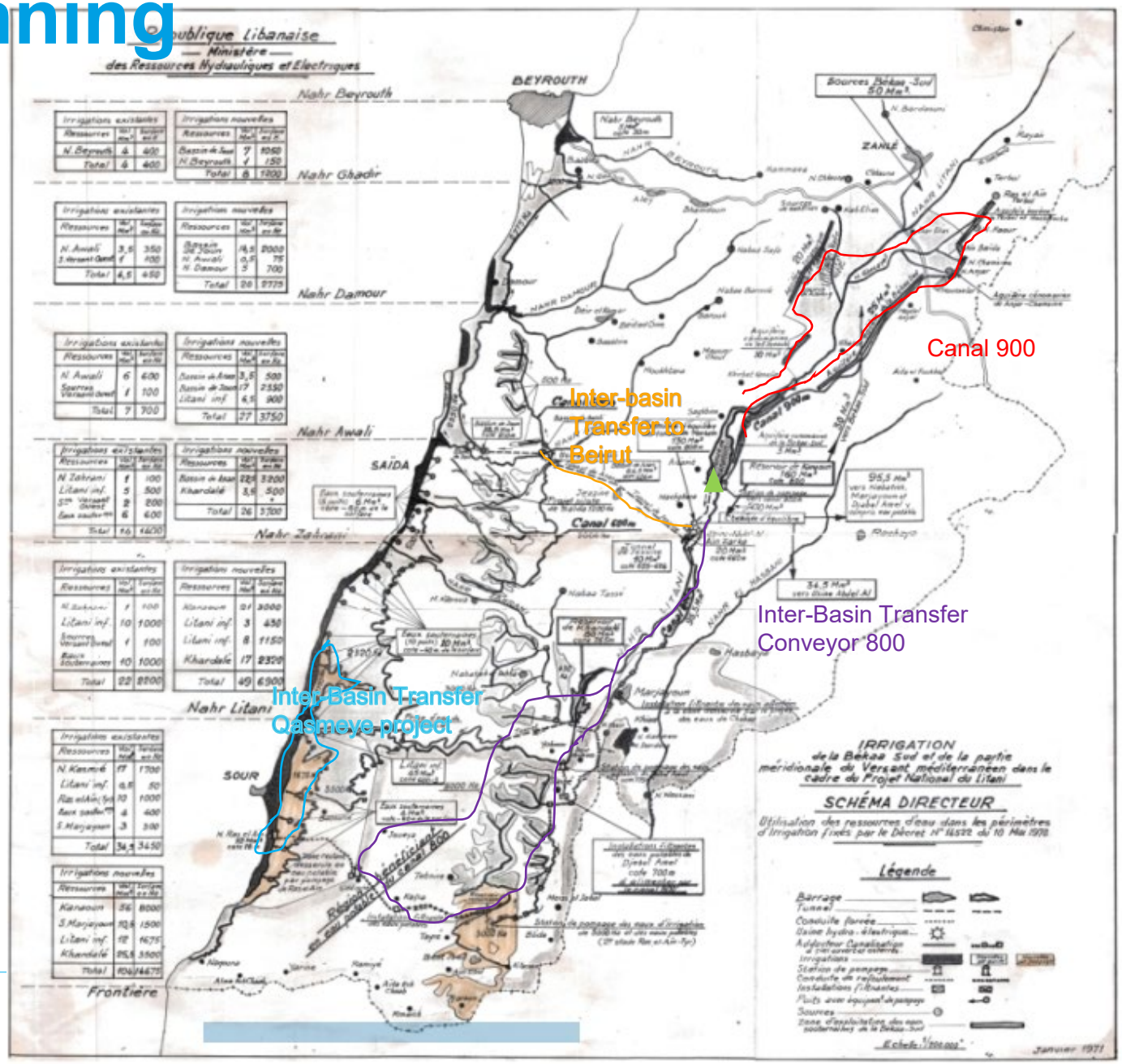
- Renewable water resources 600 Mm^3/yr
- Long term storage depletion of 57.5 Mm^3/yr
- 30% of the available exploitable water is being utilized outside of the basin
- Water pollution level (based on global grey footprint is 469 Mm^3/yr)
- Environmental flow requirement (27%) is not met



Water resources planning

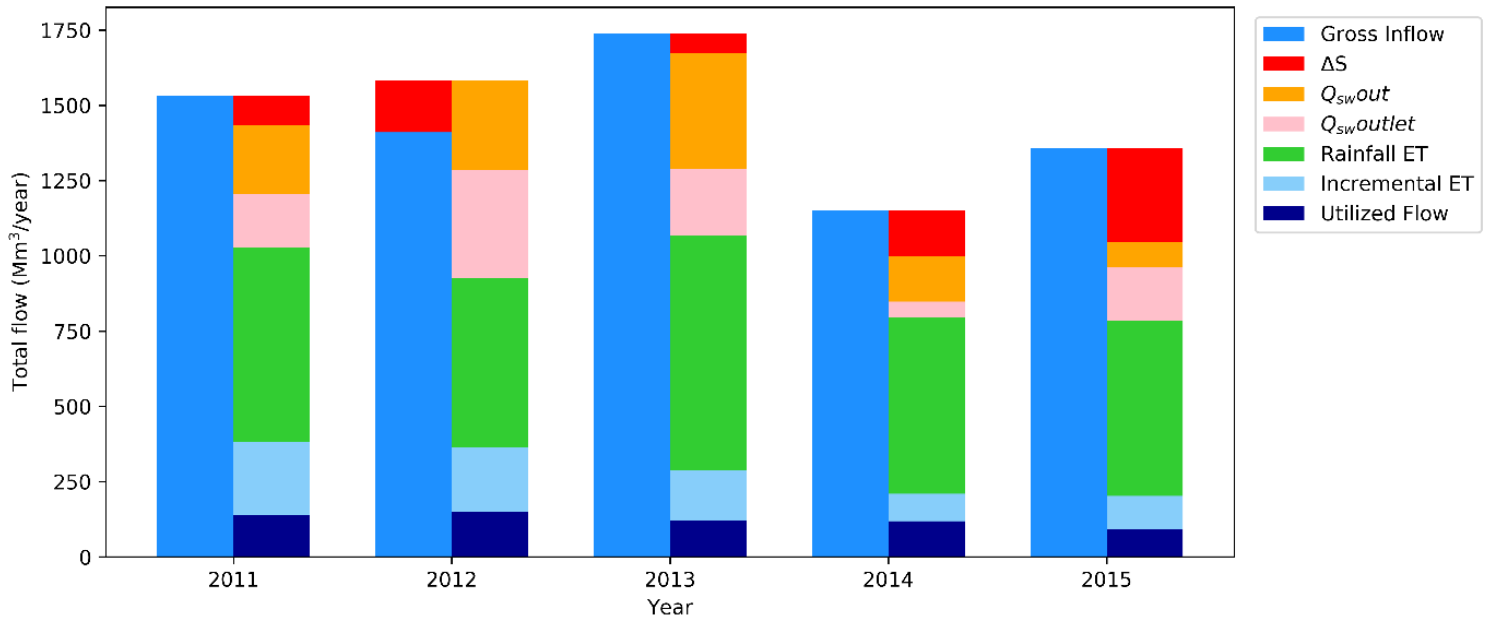
- Water resources development plan from 1970 contains large projects for development
  - Transfer to Beirut (26 Mm^3/yr)
  - Canal 900 – irrigating Bekaa valley from Quaroon dam (210 Mm^3/yr)
  - Inter- basin transfer South Lebanon irrigation project – Conveyor 800 (110 Mm^3/yr)
  - Inter-basin transfer Qasmeye project (25 Mm^3/yr)

→ but is there sufficient water for these developments?



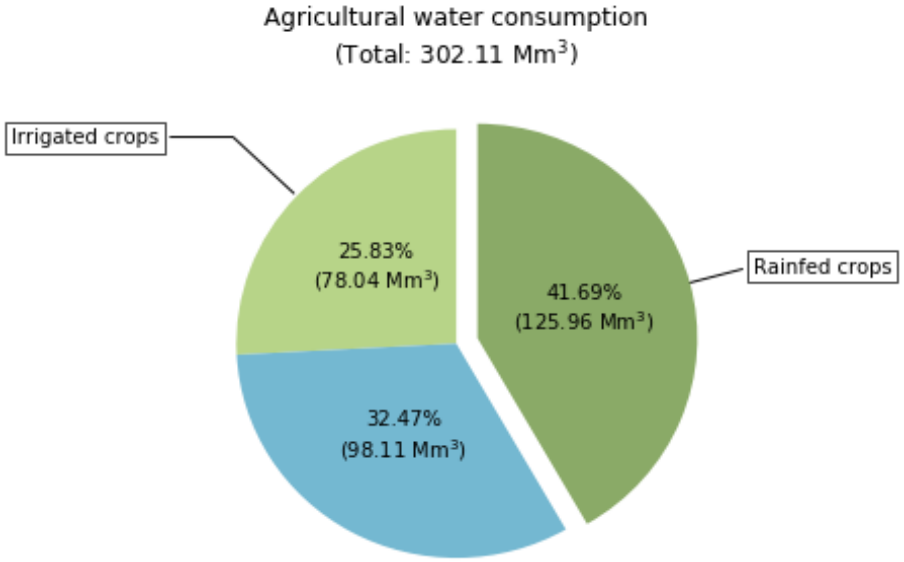
Water resources planning

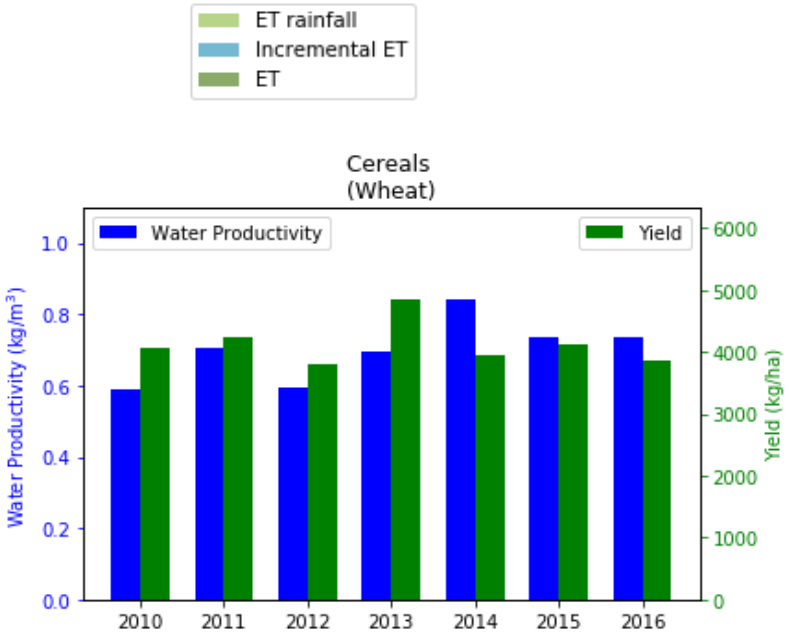
- On average sufficient water available (600 Mm^3/yr) for planned development
  - Dry years (eg 2014 insufficient water available – 349 Mm^3/yr)
    - Existing hydropower at standstill
  - Most water utilized upstream of Quaroon dam
  - Intake for irrigation Conveyor – 800 was halted due to water quality problems



Monitoring and evaluation

- The agricultural water consumption is 302 Mm^3/yr, 50% from groundwater
- Over consumption of groundwater (confirmed with GW model)
- Evaluating water productivity
  - Crop yields and water productivity (WP) was calculated for representative crops
  - In general, irrigated crops have higher yield but lower WP than rainfed crops.
  - In dry year (2014), yield decreased while WP increased => much less water consumed.
  - WP of irrigated wheat and potato is 35% and 48% lower than the global average





Some resources

- Open Spatial Data Resources link: (https://courses.gisopencourseware.org/course/view.php?id=31)
- Python for geospatial analyses: (https://ocw.un-ihe.org/course/view.php?id=272)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