Mashreq Waters Knowledge Series
Disruptive Technologies for Improved Groundwater Management in the Mashreq Region

Water and Wastewater Affairs
Ministry of Energy
I R Iran

June 2021

IRAN

- **Area:**
  1.648 million km²
- **Population:**
  82 million
- **No of provinces:**
  31
- **Average Rainfall:**
  250 mm
- **Neighboring Countries:**
  Afghanistan, Pakistan, Iraq Turkmenistan, Azerbaijan, Armenia, Turkey Arab States in the Persian Gulf
- **Language:** **Persian, Azerbaijani, Kurdish, …**

Elements of Water Resources Management

Private Sector

Competent Consulting firms and Contractors

Governance

- Water and Wastewater Affairs of Ministry of Energy
- Provincial Water Authorities (Holding Company, IWRMC)
- Water & Wastewater Engineering Companies (Holding Company, NWWEC)

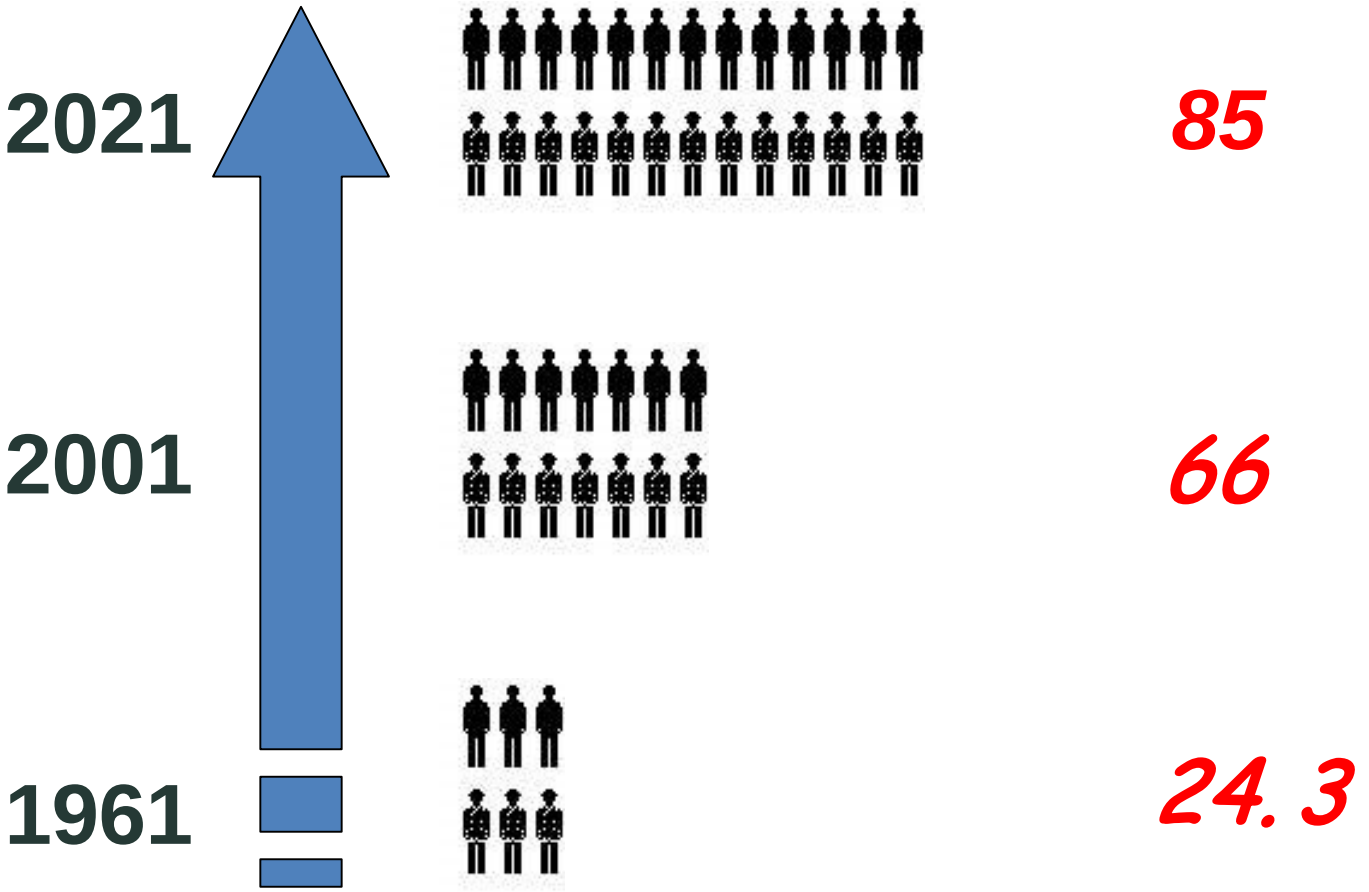
Other Stakeholders

Ministry of Agriculture, Environmental Protection Organization, Ministry of Industries & Mines, Ministry of Housing, Roads and Urban Development, ...

Policy Makers

- Supreme Water Council
- Parliament

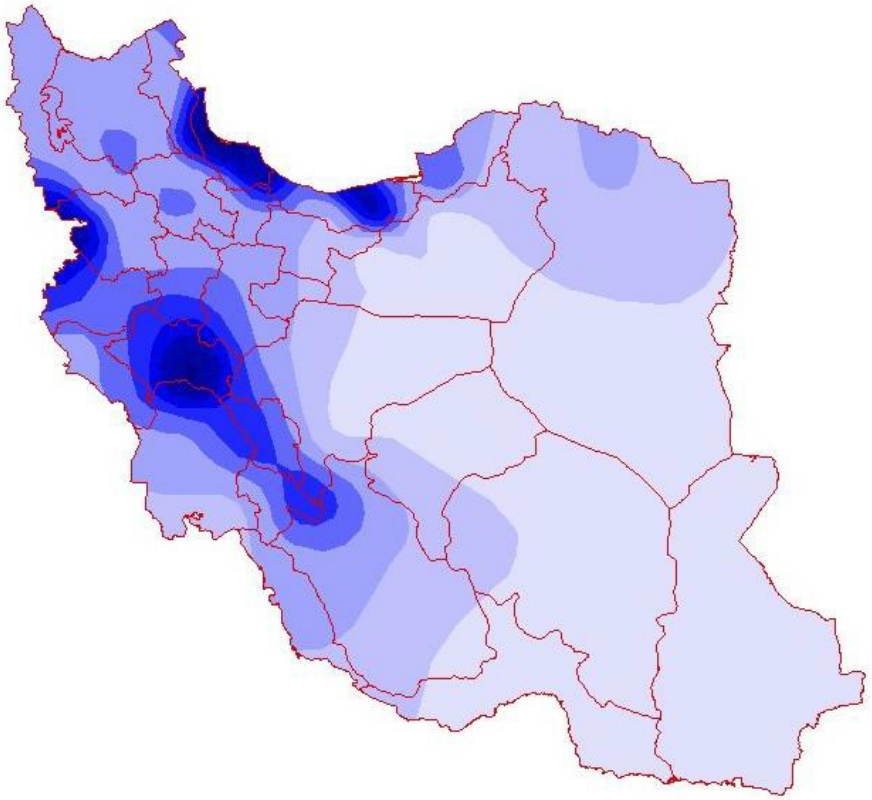
Population growth



Unit: Million inhabitants

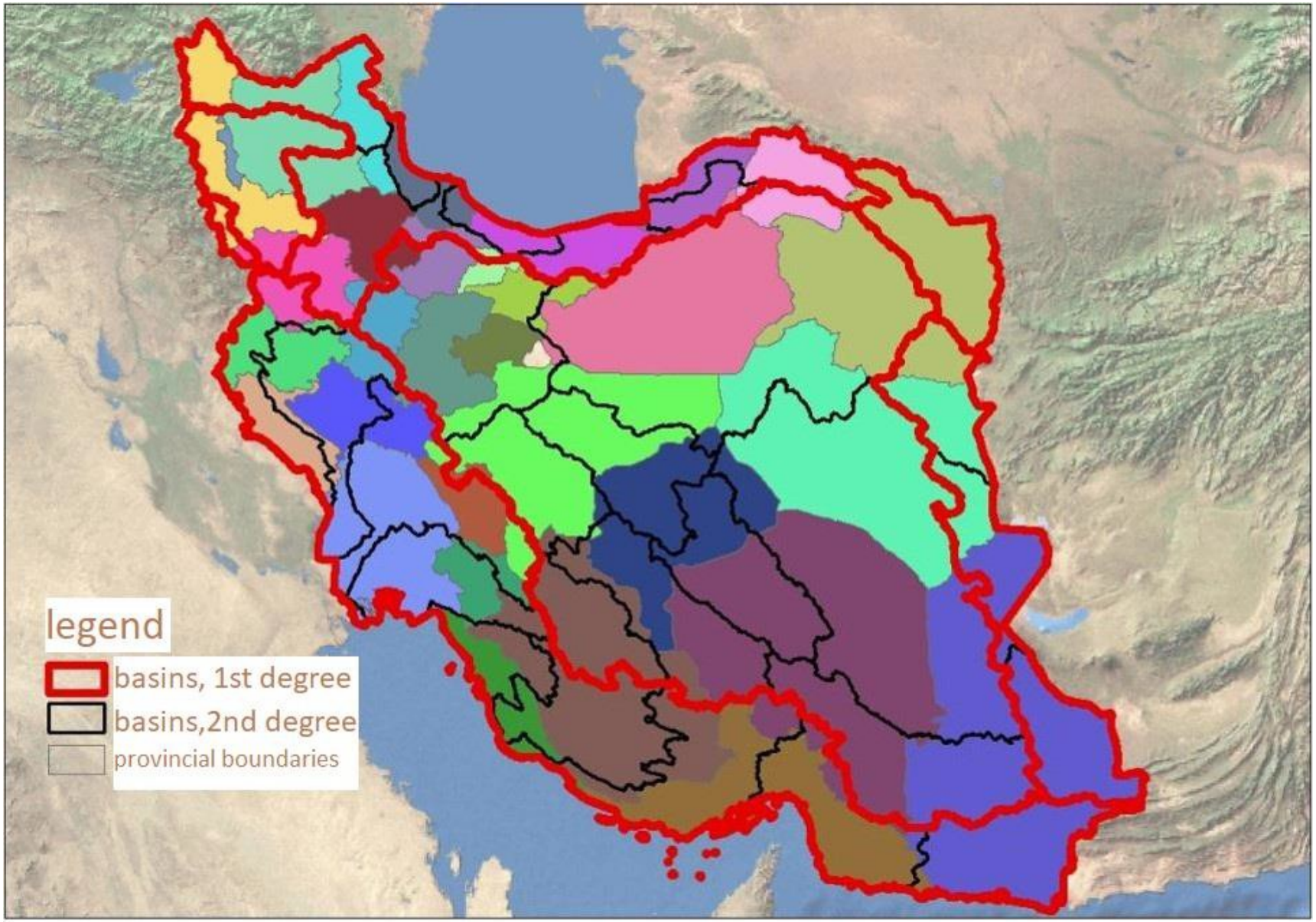
Water Resources characteristics

Major Basins

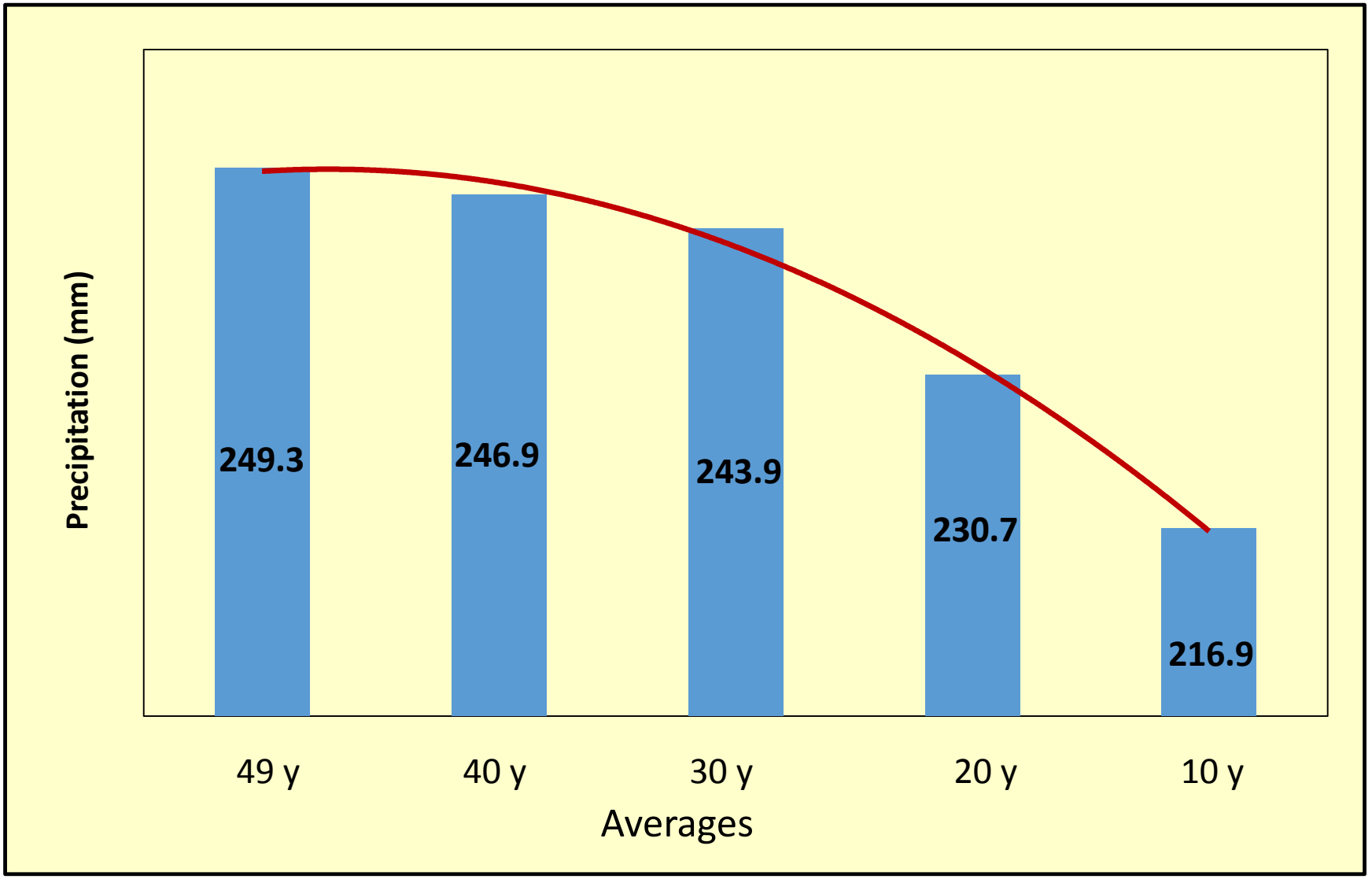


Precipitation patterns

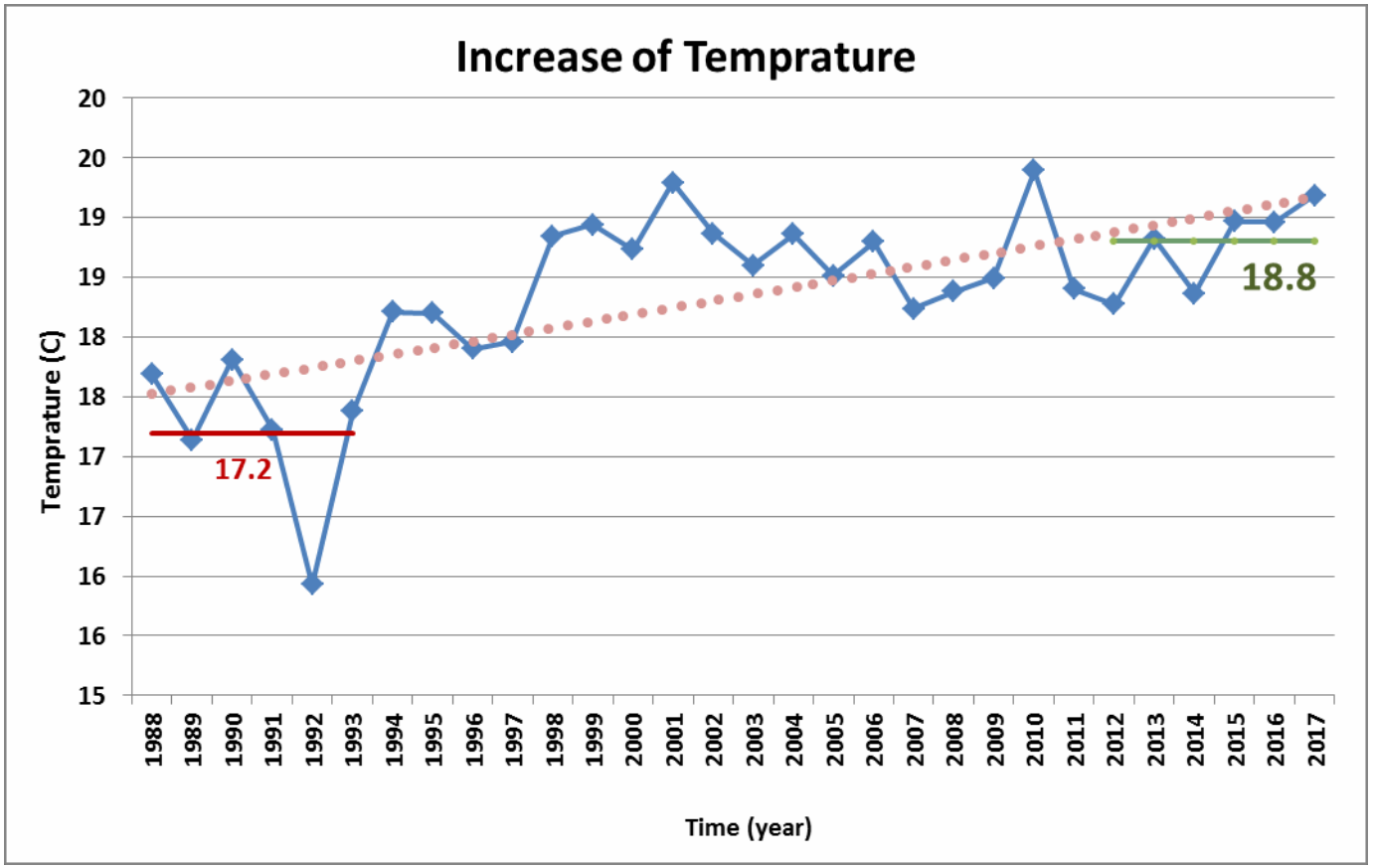
Basins vs. Provinces national map



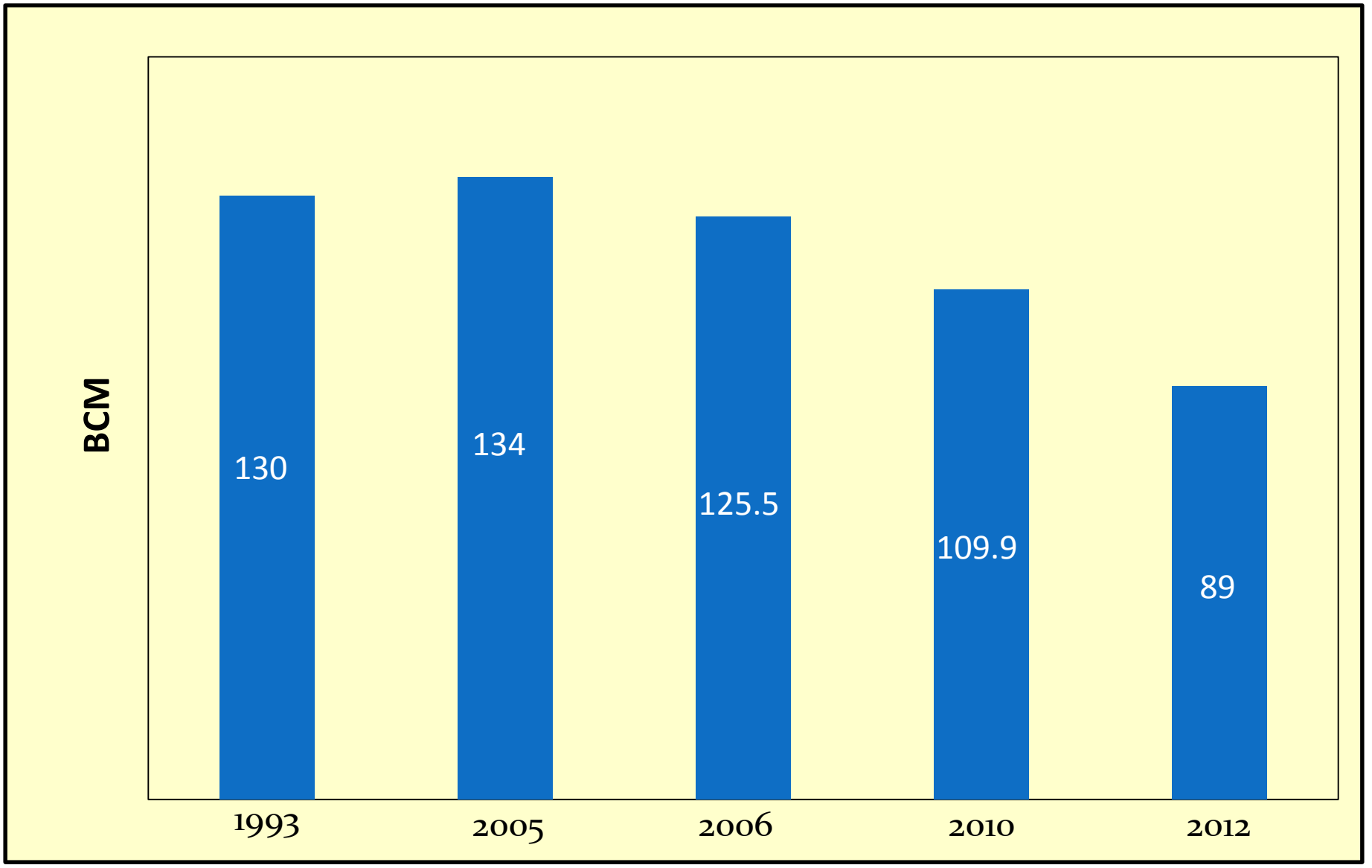
33 mm decrease in average rainfall in less than 50 years (more than 10 %)



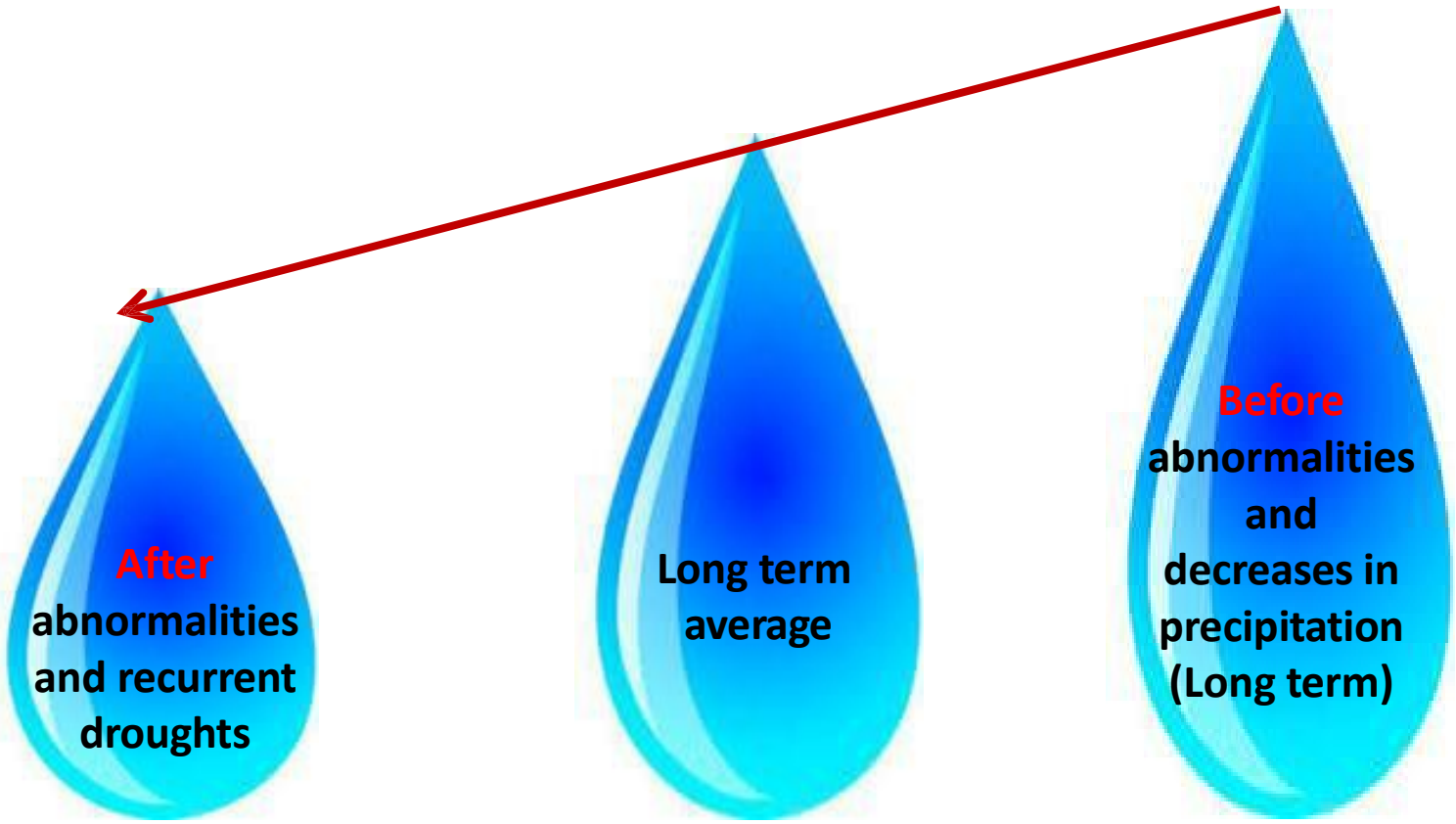
0.4 degrees Centigrade increase in Temperature in each decade



Renewable Water Resources availability in recent years



Renewable Water Resources changes in recent years

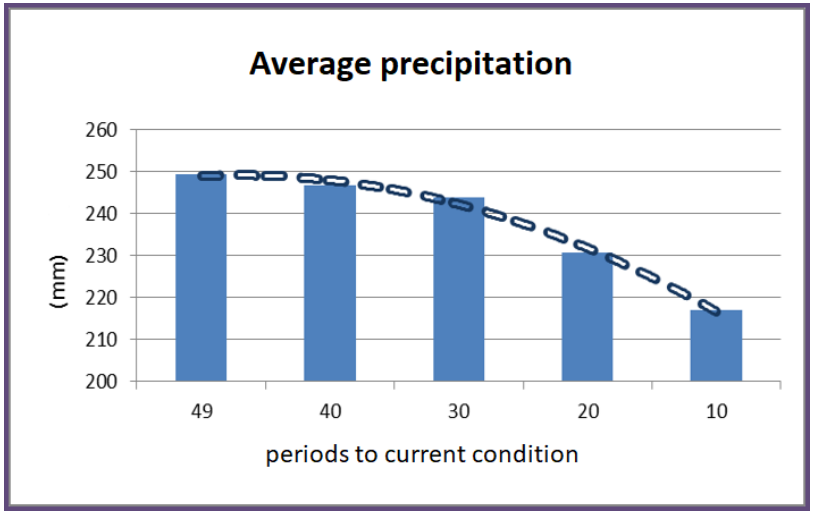


89 BCM

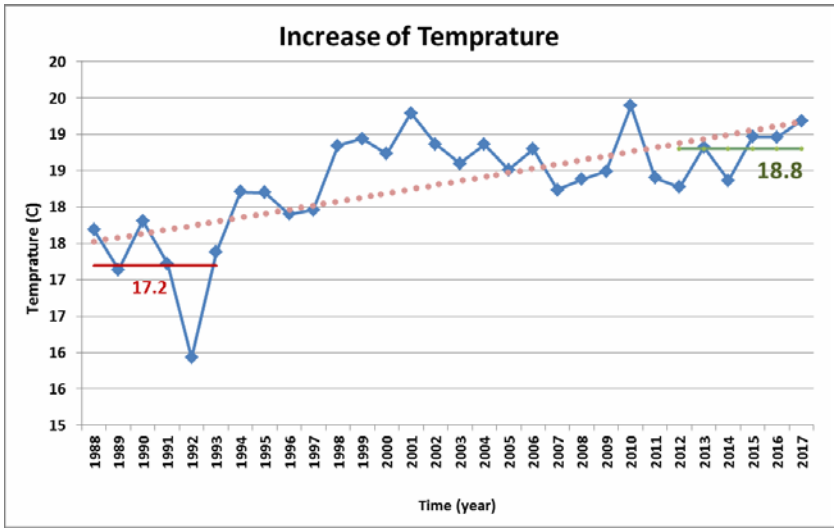
116 BCM

125 BCM

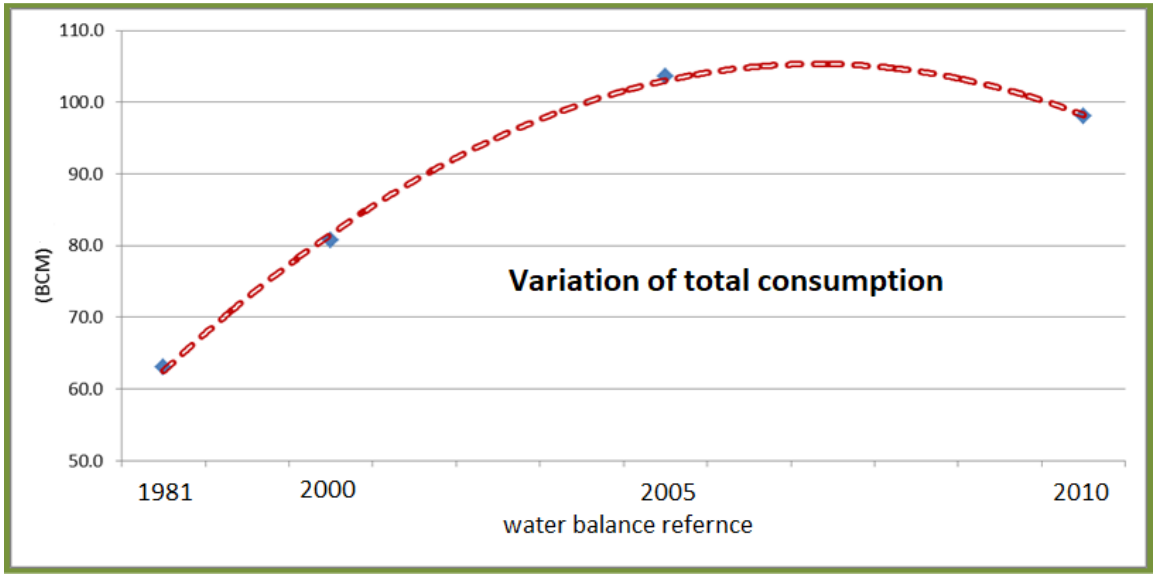
Decrease in Rainfall

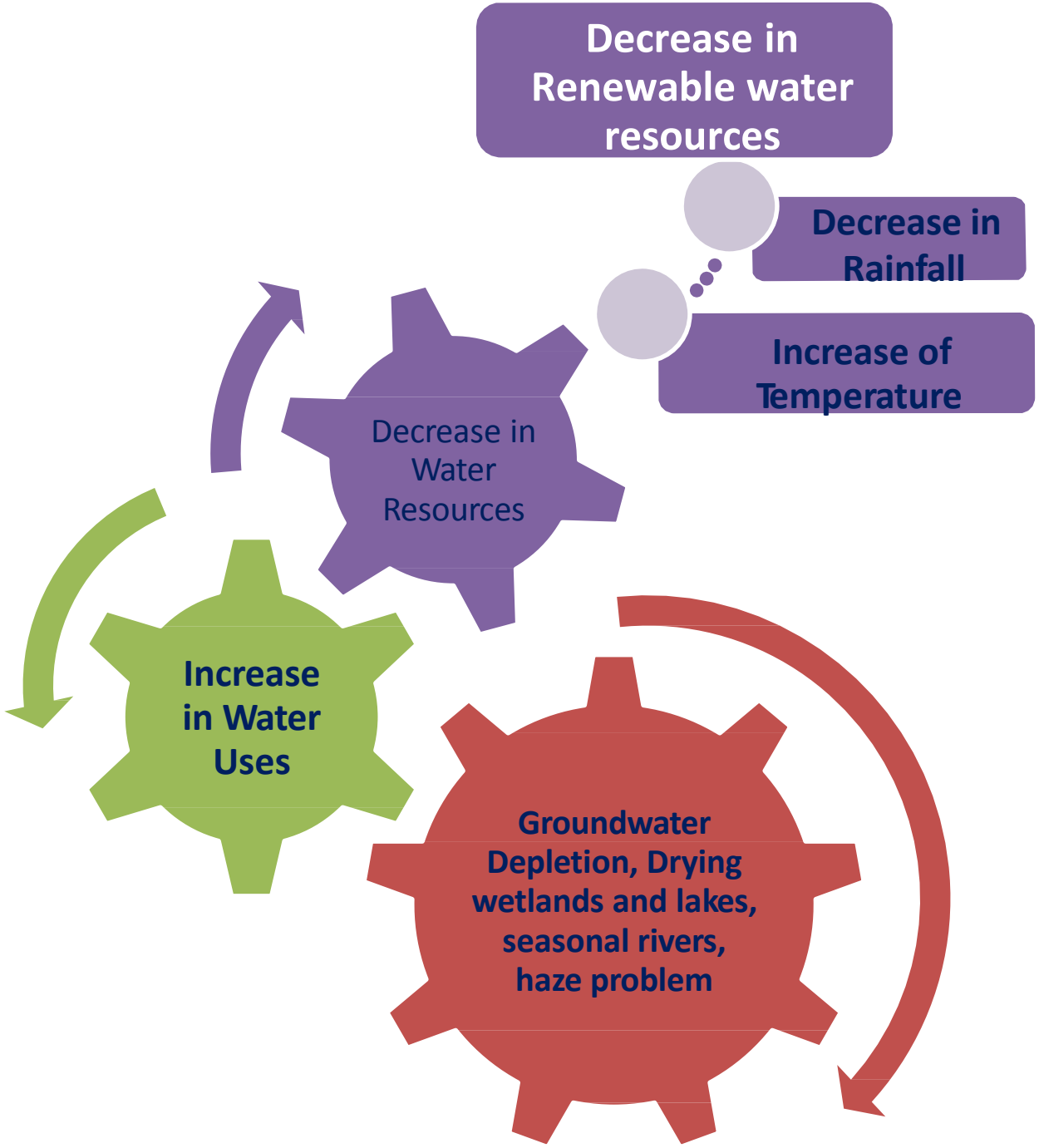


Water Resources Decreases & Water Uses Increases

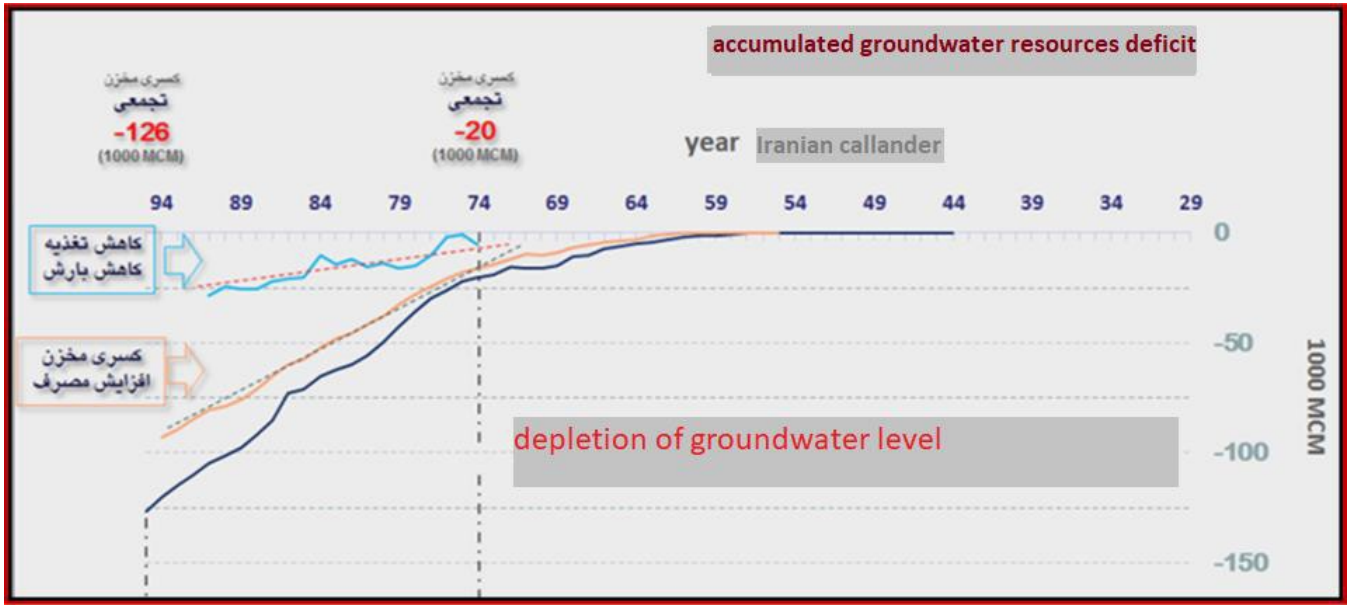


Increase in water uses




Decrease in Renewable water resources
Decrease in Rainfall
Increase of Temperature
Decrease in Water Resources
Increase in Water Uses
Groundwater Depletion, Drying wetlands and lakes, seasonal rivers, haze problem

Effects of Water Resources Decreases and Water Consumption Increases



Groundwater Depletion

Drying Lakes

Haze problem

The role of groundwater resources in supplying water demands

Total GW abstraction

54 BCM

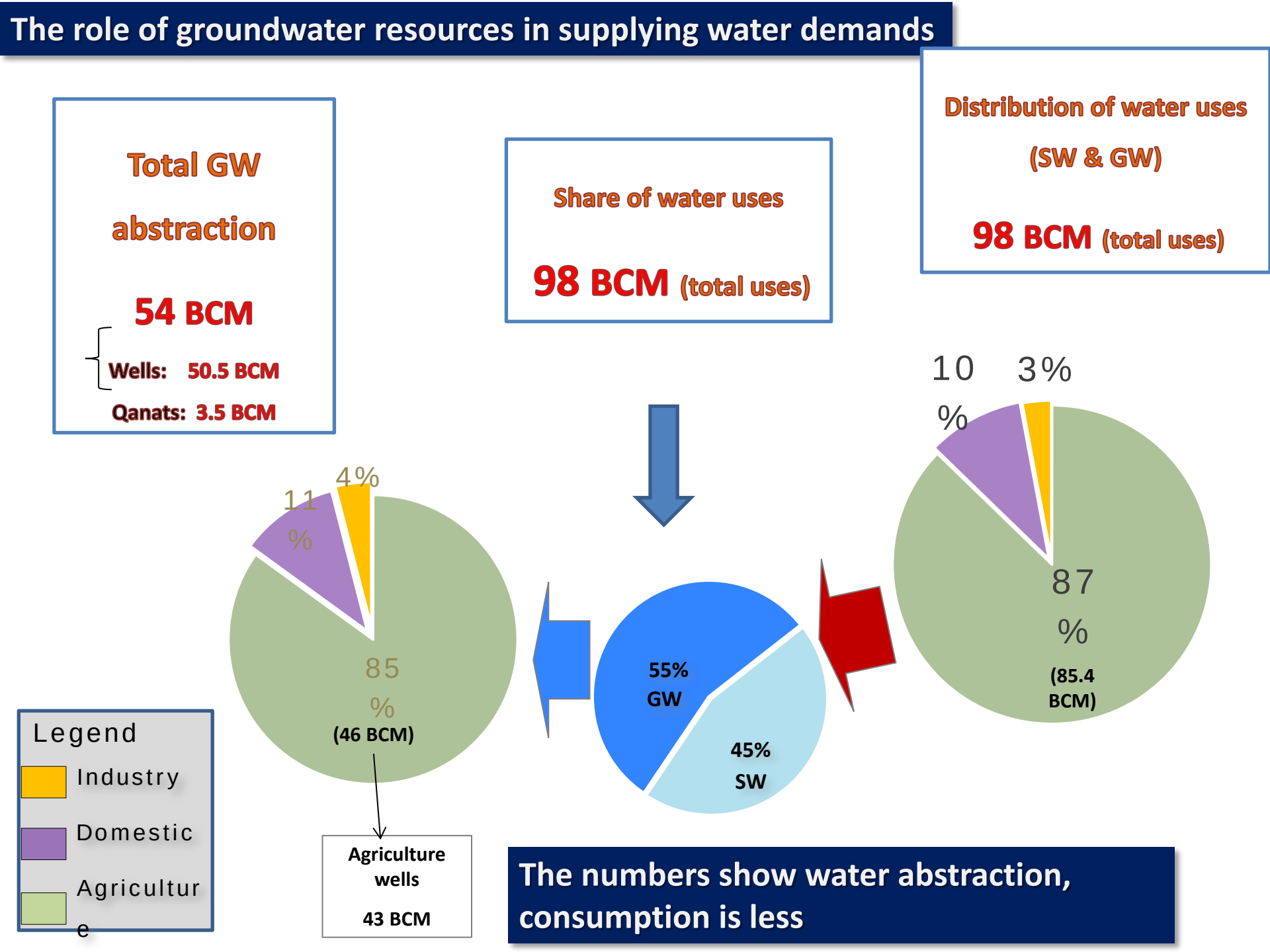
- Wells: 50.5 BCM
- Qanats: 3.5 BCM

Share of water uses

98 BCM (total uses)

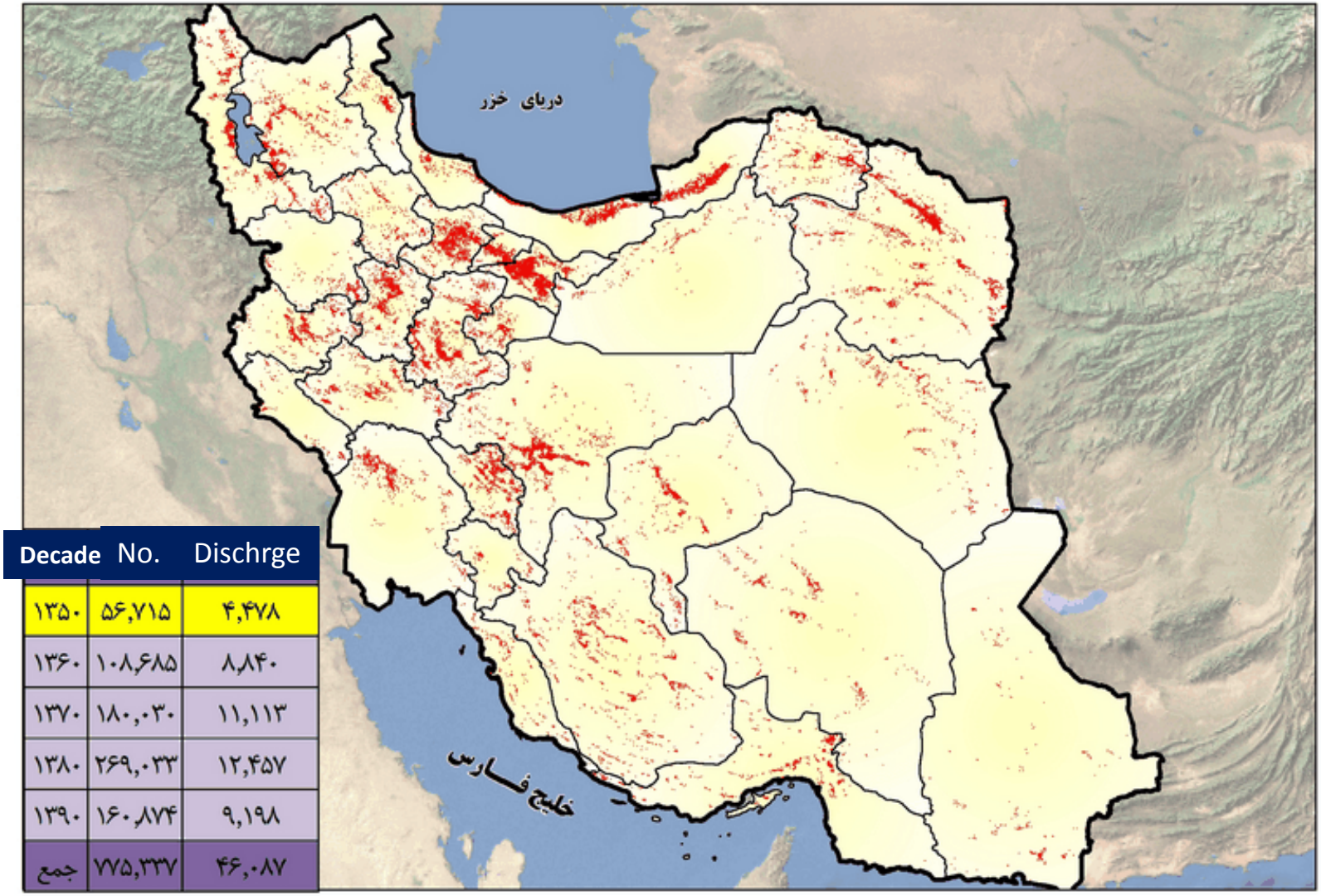
Distribution of water uses (SW & GW)

98 BCM (total uses)



The numbers show water abstraction, consumption is less

Total number of wells since 1971



Decade	No.	Dischrge
۱۳۵۰	۵۶,۷۱۵	۴,۴۷۸
۱۳۶۰	۱۰۸,۶۸۵	۸,۸۴۰
۱۳۷۰	۱۸۰,۰۳۰	۱۱,۱۱۳
۱۳۸۰	۲۶۹,۰۳۳	۱۲,۴۵۷
۱۳۹۰	۱۶۰,۸۷۴	۹,۱۹۸
جمع	۷۷۵,۳۳۷	۴۶,۰۸۷

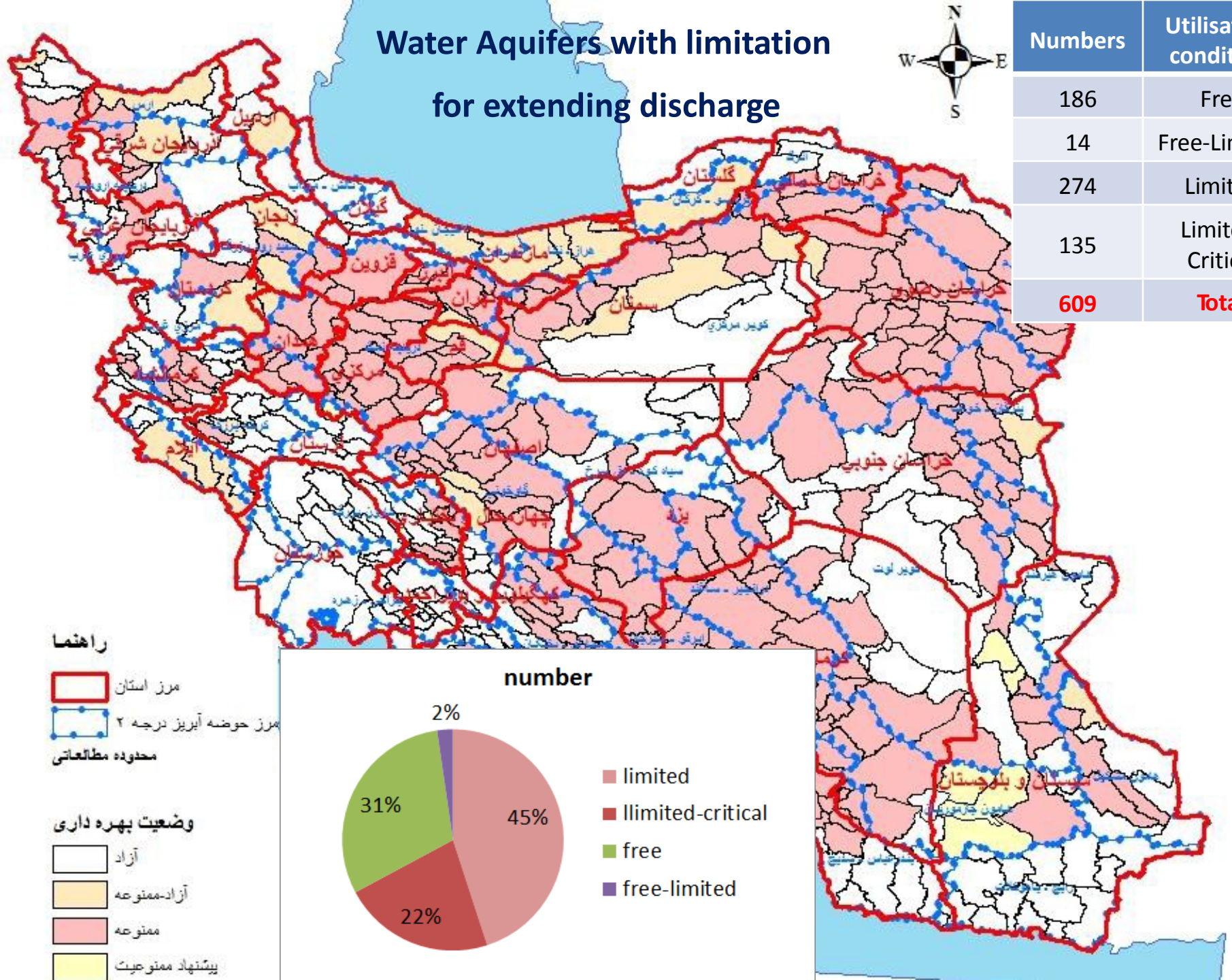
Land Subsidence

Maximum land subsidence (cm/year)

- No-data
- < 5
- 5-15
- 15-25
- > 25

Water Aquifers with limitation for extending discharge

Numbers	Utilisation condition
186	Free
14	Free-Limited
274	Limited
135	Limited-Critical
609	Total



Water Aquifers with limitation for extending discharge

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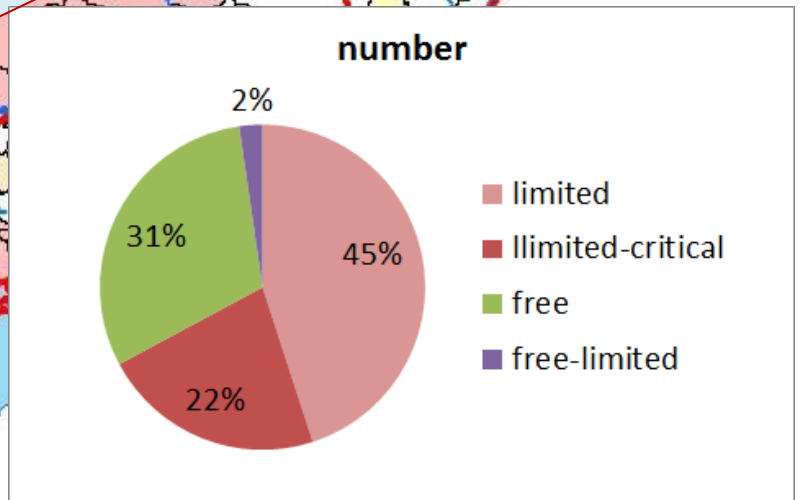
More than 60% of aquifers have Outflow more than Inflow



Water Aquifers with limitation for extending discharge

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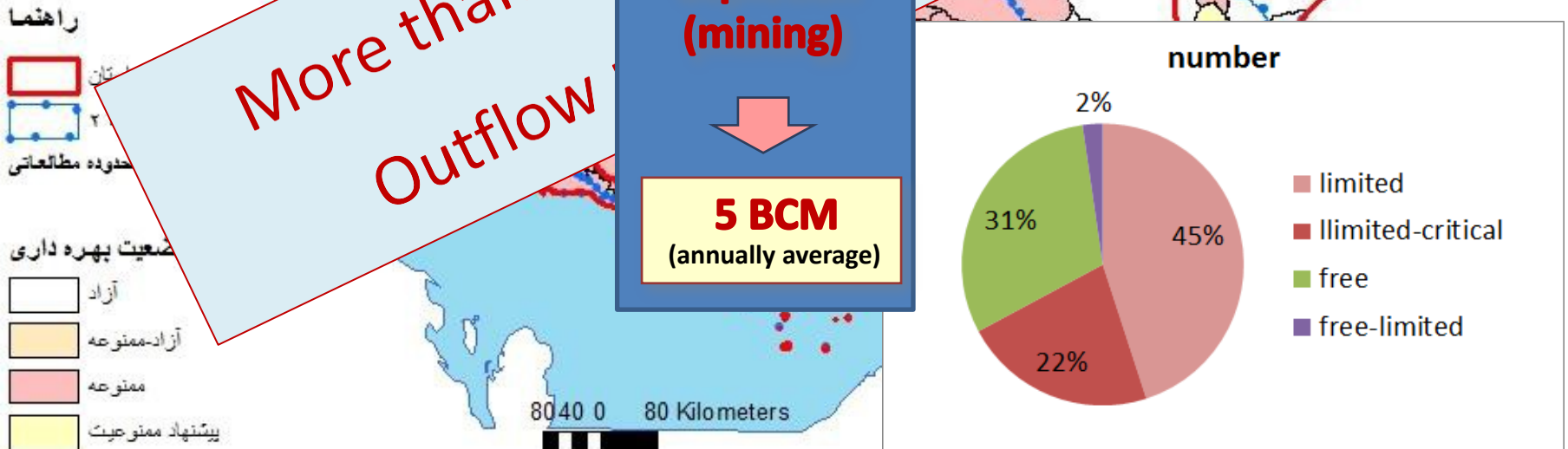
GW level declining

0.4 m
(annually average)

Aquifer depletion (mining)

5 BCM
(annually average)

More than 60 … rs have
Outflow … nflow



Accomplished Actions and Future Plans

September 2011

The Supreme Leader has demanded to find solutions for the water resources challenges; including the groundwater

Relying on the capacities of the Supreme Water Council was recommended

September 2014

15th meeting of the Supreme Water Council:

It was resolved to implement the "Project of reclamation and balancing of the country's Groundwater"

Fifteen projects were defined under three main targets:

- Monitoring and observation by installations instruments
- Water demand management and water market
- Reliable data and information and water balance estimates

Ministry of Energy

- Announce of Water share for different uses/ provinces/ watersheds and aquifers
- Filling unauthorized wells
- Controlling the abstraction from authorized wells

Ministry of Agricultural Jihad

- Declaring the optimum crop patterns
- Declaring the irrigation improving plans

Use of Technologies in Monitoring

- Smart volumetric meters
- Remote sensing

Methods to estimate and measure the wells abstraction

Direct Measurements

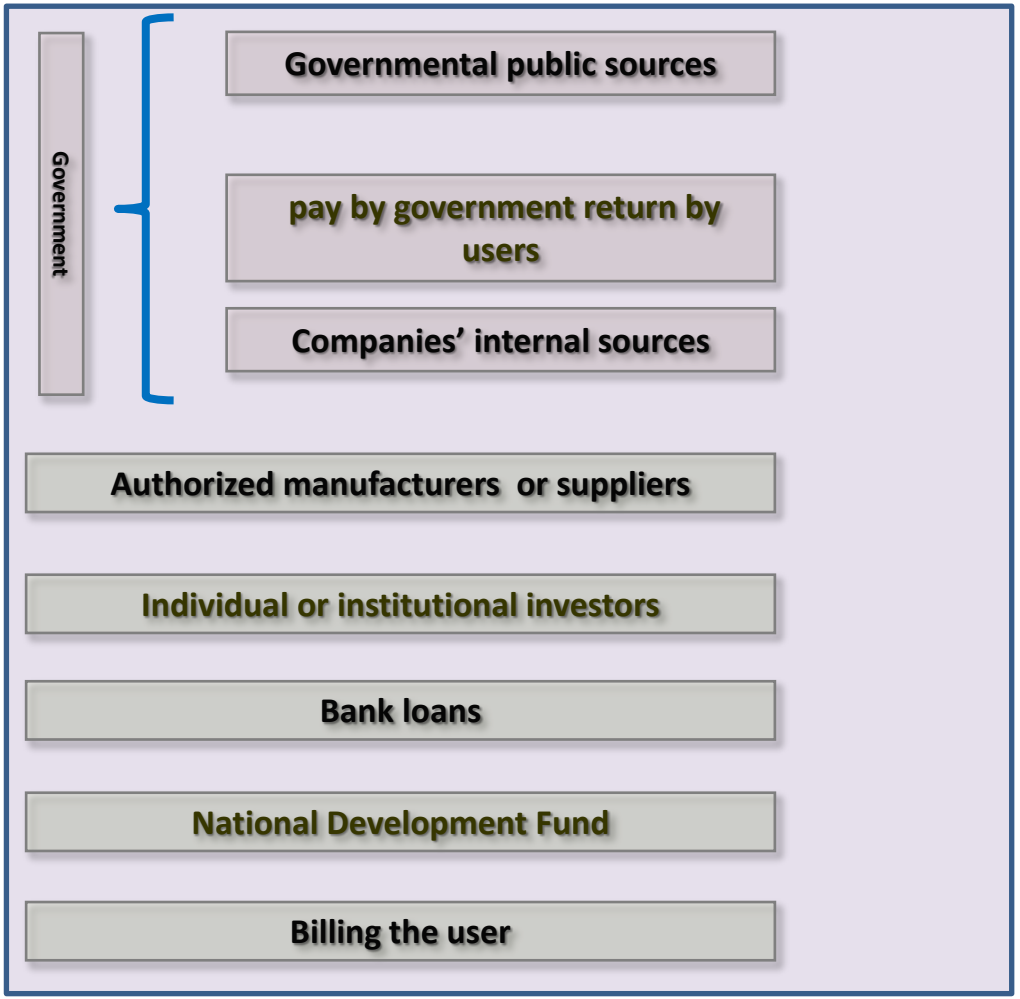
- Normal and smart volumetric meters

Indirect Measurements

Based on;

- Well's active time and flow
- Well's electricity use
- Well's fuel use
- Geostatistics and satellite images

Financing for purchase and installing of meters

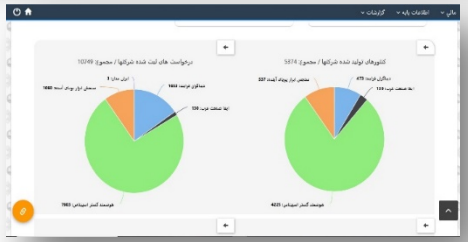


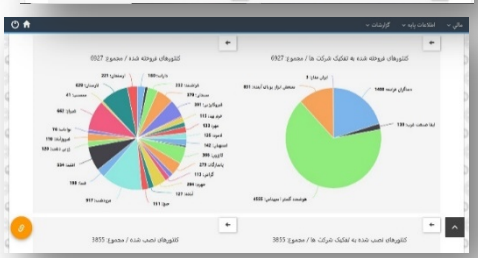
Designing the system for purchase, installation and maintenance of Meters

Specifications:

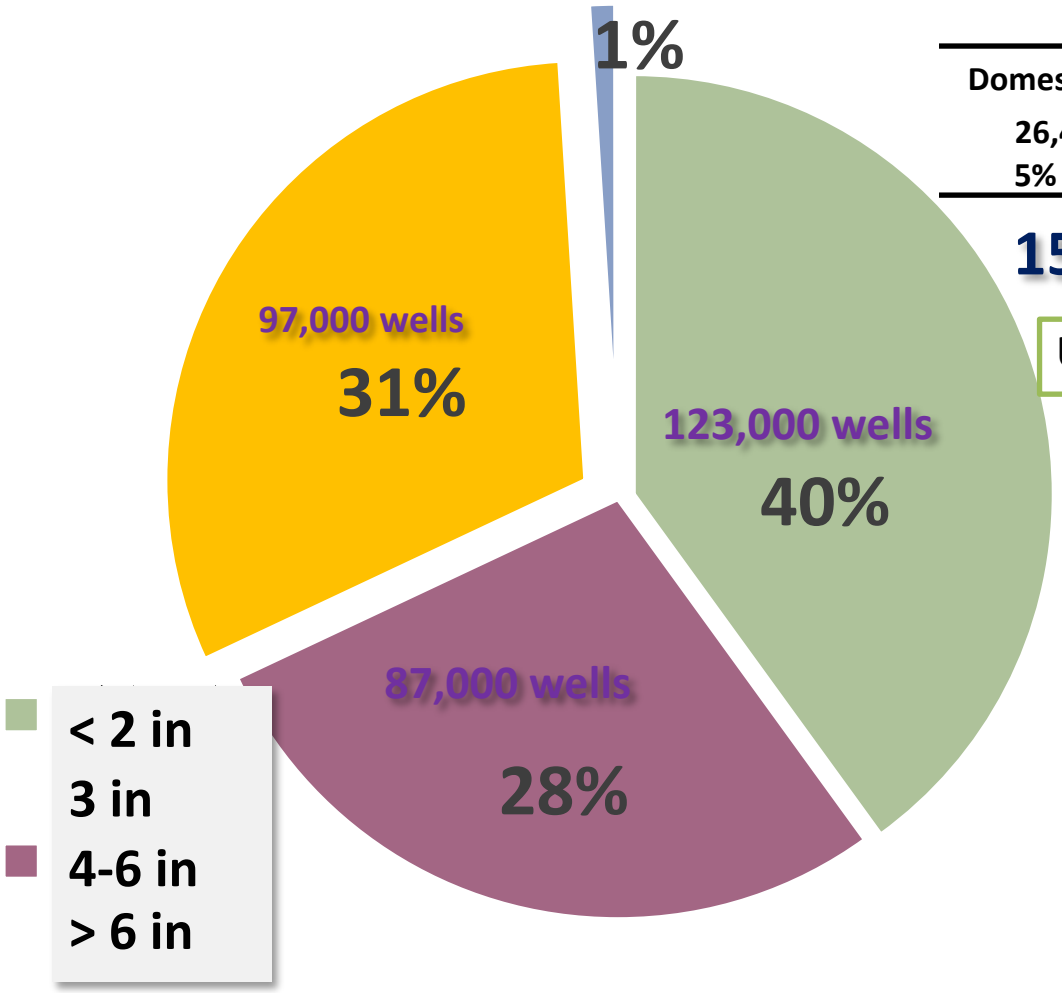
- Data and history on purchased, installed, or stocked meters
- Ordering process
- Integrated follow-ups on purchasing, manufacturing, delivering, installing and test operation
- Reporting performances (Province and County)
- Authentication process
- Cost management on purchasing and installing

Integrated Information System on Water measures





Authorizd wells in Iran



Domestic	Industry	Agriculture	Total
26,422	51,677	415,867	493,966
5%	10%	84%	
15%	29%	21%	With Installed Meters

Unmetered; 413,000 wells

Ignoring shallow Wells
(Mostly in Gilan and Mazandaran Provinces)

311,000 Wells are prioritized

Challenges and obstacles in purchasing and installing smart volumetric meters

- Low capacity and restrictions in manufacturing meters which meet the standards of the Ministry of Energy
- Dependency on foreign supply and finance
- Users not willing to monitor the abstraction
- Lack of coordination among different governmental stakeholders involved in manufacturing, standardization, financing and operation
- Lack of financial and technical capacities and expertise in manufacturing, operation and maintenance of meters

Monitoring Device; Smart Meters

Most of the installed meters in the country are categorized in one of the two following categories:

Volumetric Smart Meters

Function: direct measurement of water discharge

Advantages:

- Not sensitive to climate conditions

Disadvantages:

- Dependency on imported parts
- Requires expert operators for reading, operation and maintenance

Water and Energy Smart Meters

Function: based on the consumed electricity and field discharge metering in several periods and recording in meters – the discharge and volume is calculated over the period

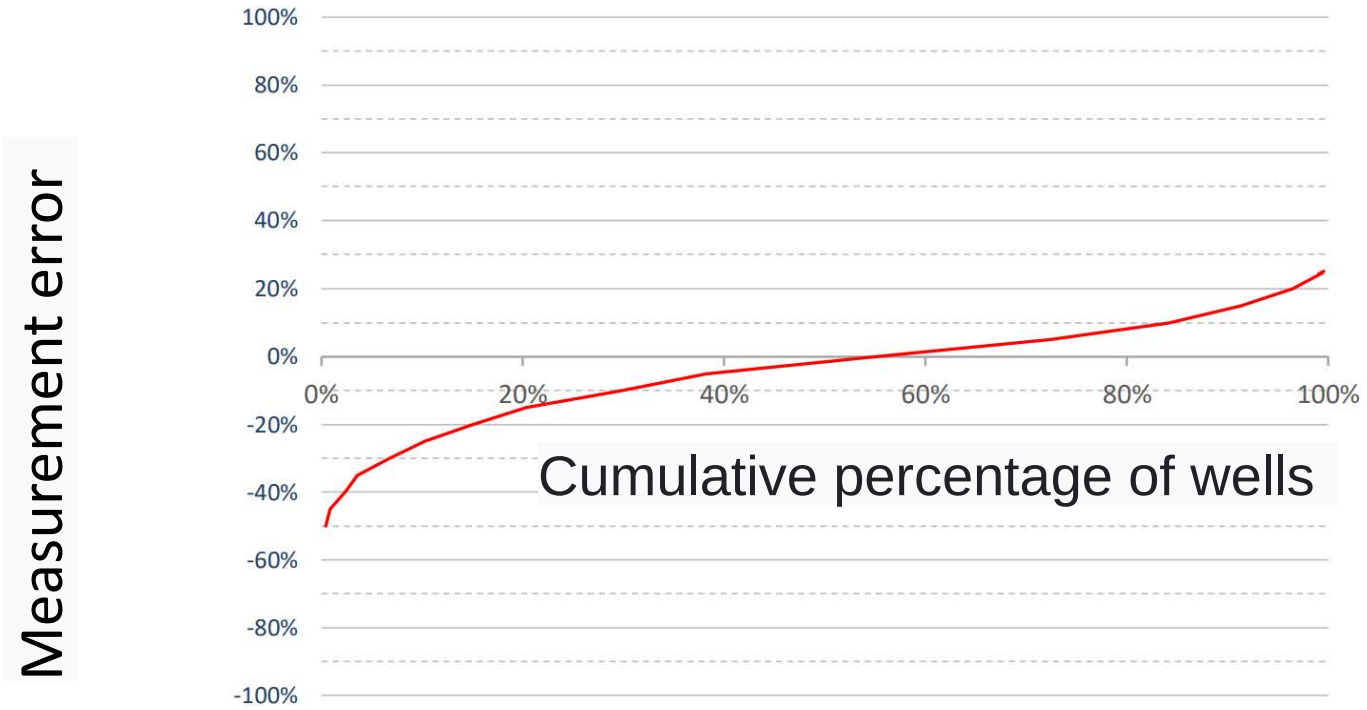
Advantages:

- It is possible to disconnect the electricity in case of water over-abstraction

Disadvantages:

- High calibration costs
- Different performance in diverse climates of Iran (very hot regions)

Assess accuracy estimates of installed smart meters.



The error rate is less than 20% in 80% of cases

The error rate is less than 10% in 60% of cases

Cause of defect

- Low efficiency of electric pump
- Lack of calibration

Experience on Using Remote Sensing Data in Water Resources Management

Ground based data specifications

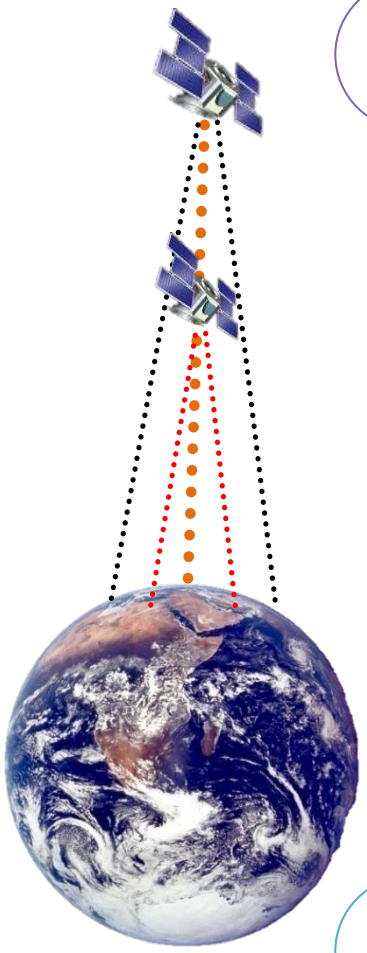
Limitations:

- Lack of direct measurement of some important water related parameters for water resources management (e.g., Evapotranspiration)
- small number of meteorological and hydrometric stations
- Point data collection (in comparison to continuous data collection)
- Lake of an appropriate data in high elevation mountain areas
- Low accuracy of data collected in stations
- The data of some stations are not up to date

Solutions:

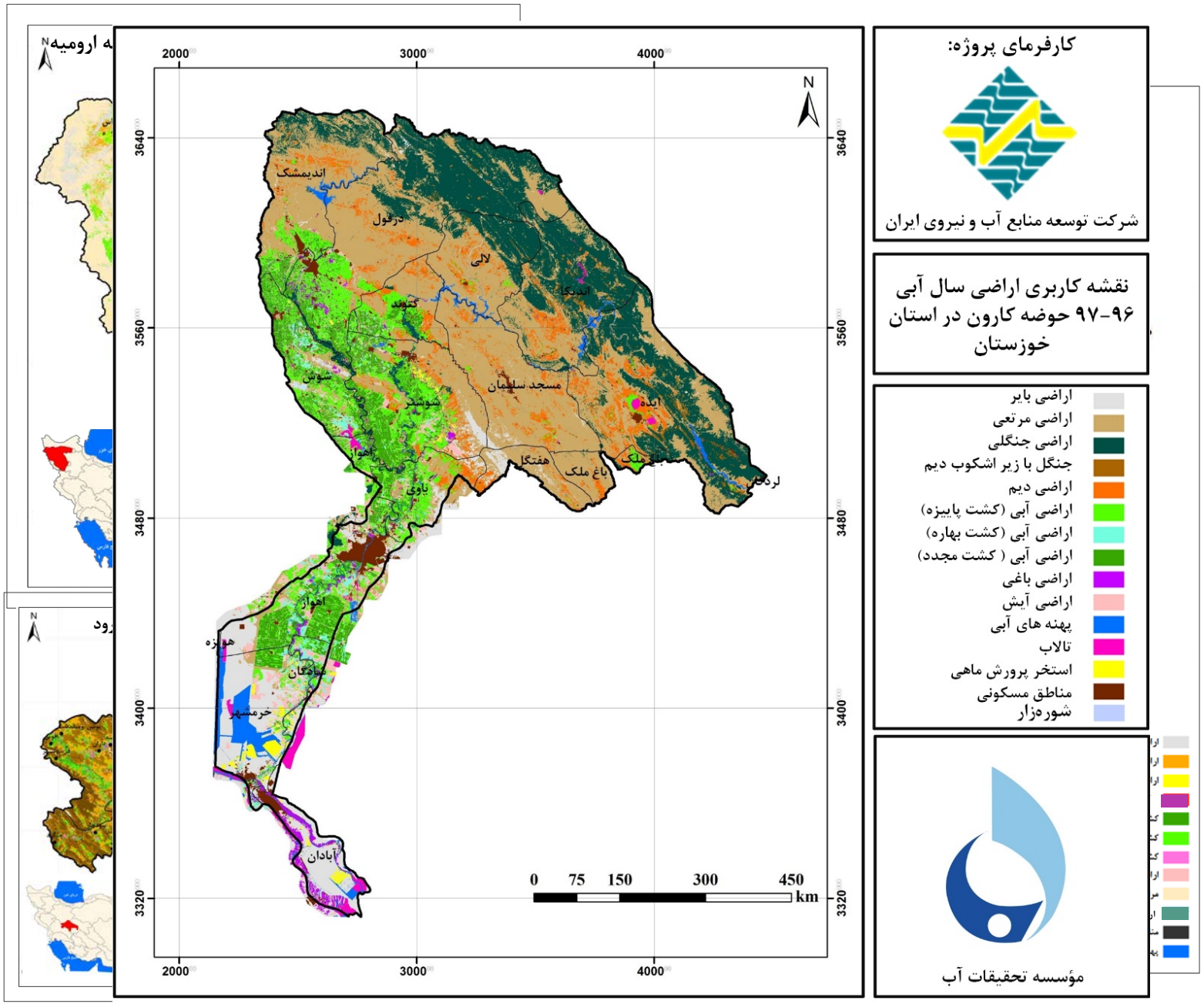
- Increasing the quantity and quality of ground stations
- Using Remote Sensing data

Advantage of Remote Sensing Data in Water Resource Management

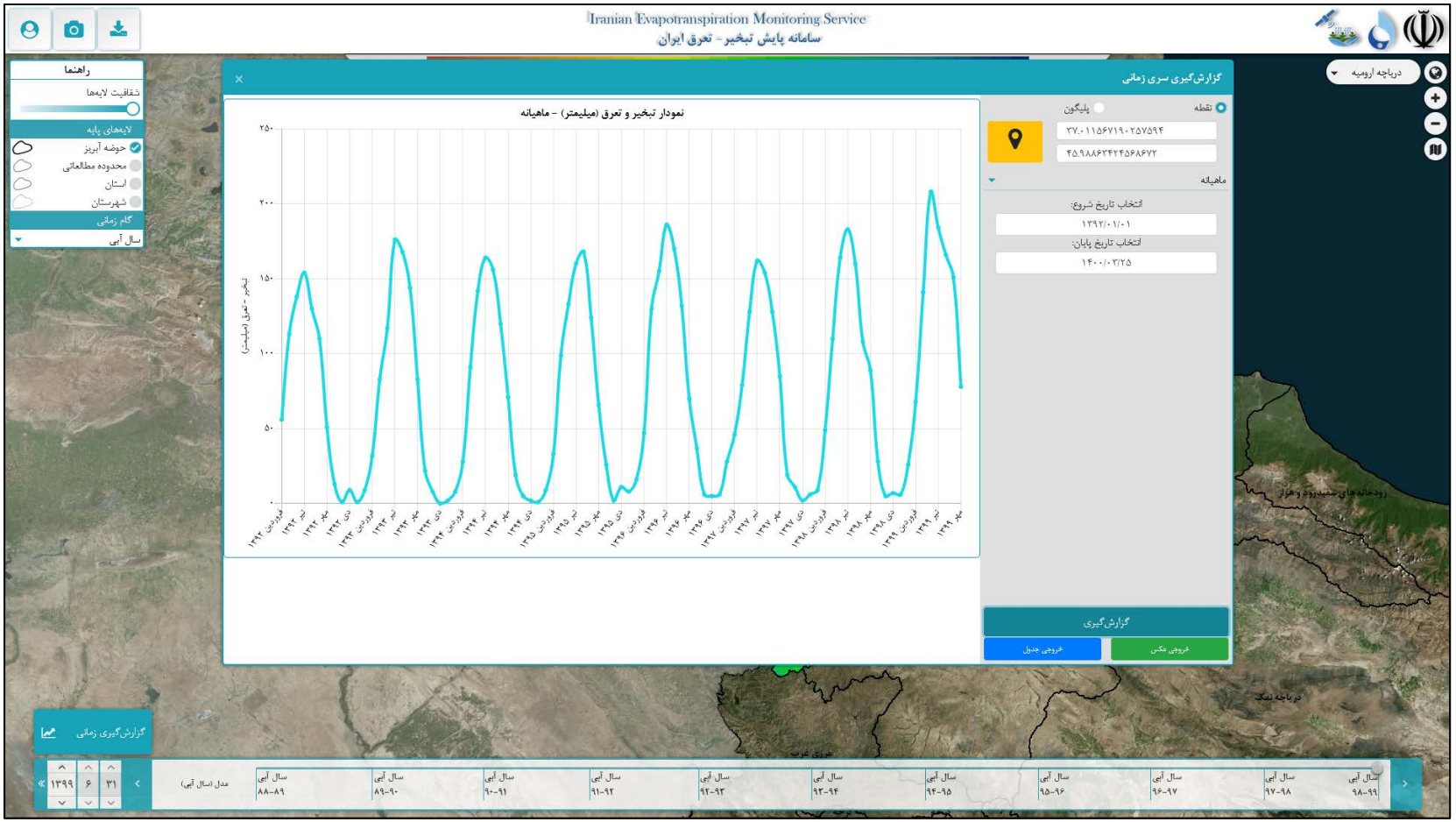


- Ability to continuous monitoring (Spatially and temporally)
- Access to long-term archives of data
- Ability to estimate the parameters required for water resource management studies
- Low cost of preparing and processing satellite images
- Near real time data base generation
- Availability of multispectral, hyper spectral and multi temporal data

Samples of LULC Maps



Samples of ET maps and data

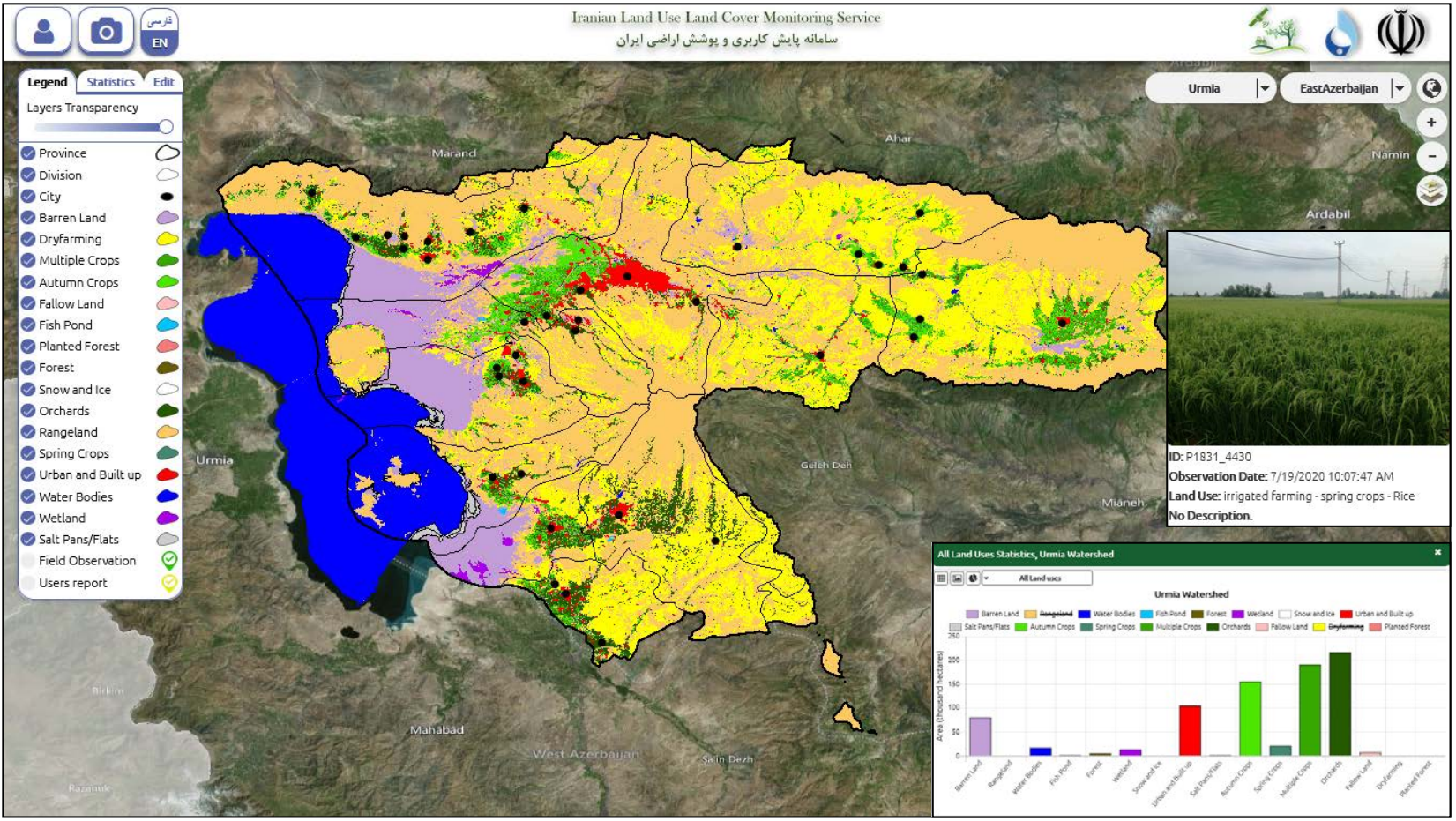


Challenges

- Requires a large dataset of satellite images (more than 100TB of raw data for LULC mapping and ET calculation)
- Computationally intensive
- Requires extensive ground data at a very large spatial extent (country wide)
- Interact with a wide range of stakeholders in the process of studying and utilization of the results

Dealing with stakeholders

Developing online data portals for LULC and ET for easy sharing of data and reports with stakeholders



Ground data gathering for LULC: Tools

Developing a customized smartphone app for easy ground data gathering with connection to the online database and intelligent basic quality control of data (without SIM card)

Ground data gathering for LULC: Implementation

Participation of more than 200 people from the governmental sector, NGOs and individual volunteers to collect land use information in more than 35,000 locations across the country

Ground data gathering for ET

Using Scintillometer for collection of ground data for validation and calibration of ET estimation by RS methods in different land types