REPUBLIC OF SLOVENIA
MINISTRY OF FOREIGN AFFAIRS

AII-FORA online Side-Event

"Saline intrusion: a potential risk for coastal aquifer management in a changing climate"

10th May 10:00 – 12:00

1st technical session – "Saline intrusion: a potential risk for coastal aquifer management in a changing climate"

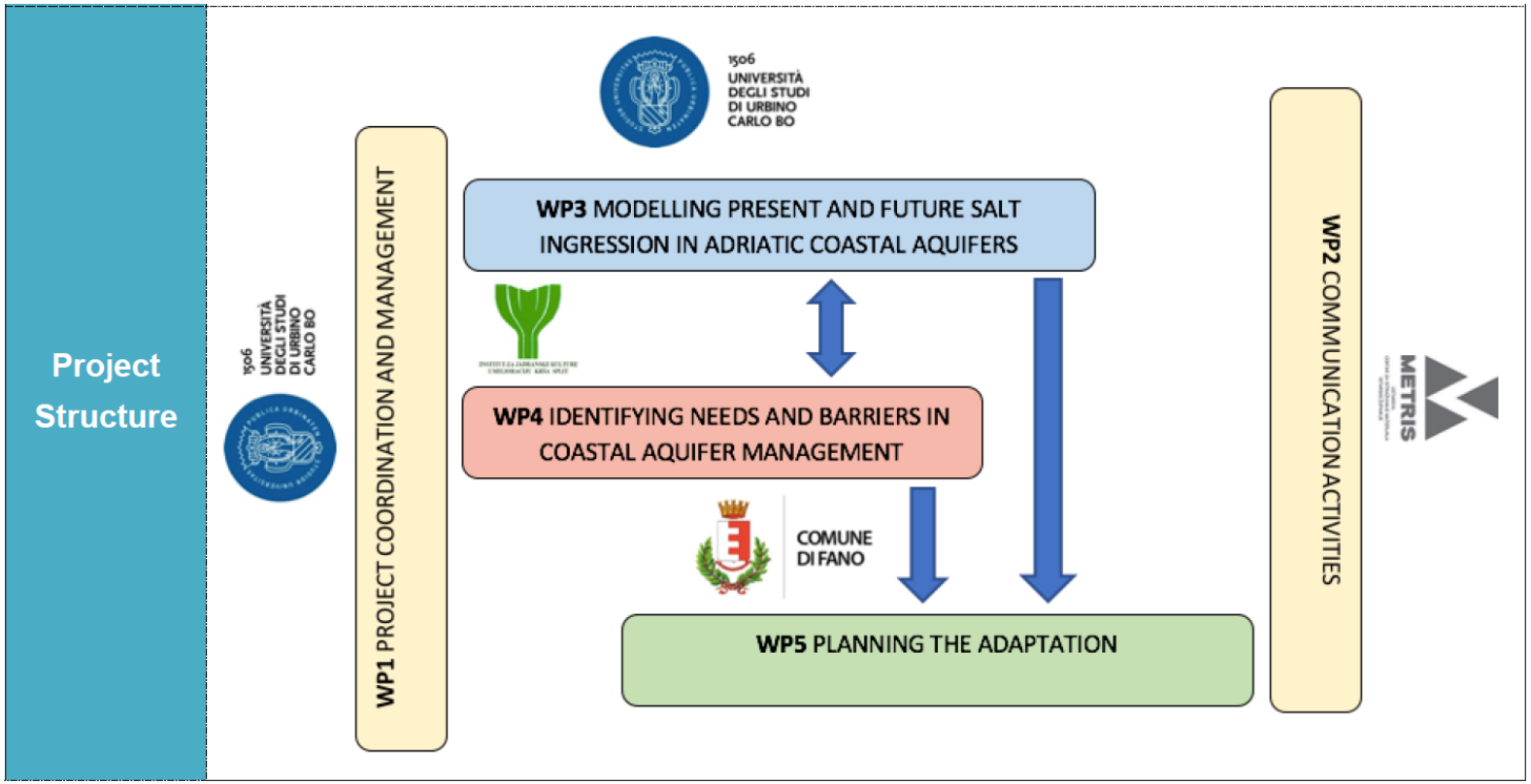
Nicola Quaranta, Elena Cogo (Geo engineering, Turin, Italy) hydrogeologist external expert – Municipalities of Fano (PU, IT)

REPUBLIC OF SLOVENIA
MINISTRY OF FOREIGN AFFAIRS

Short index

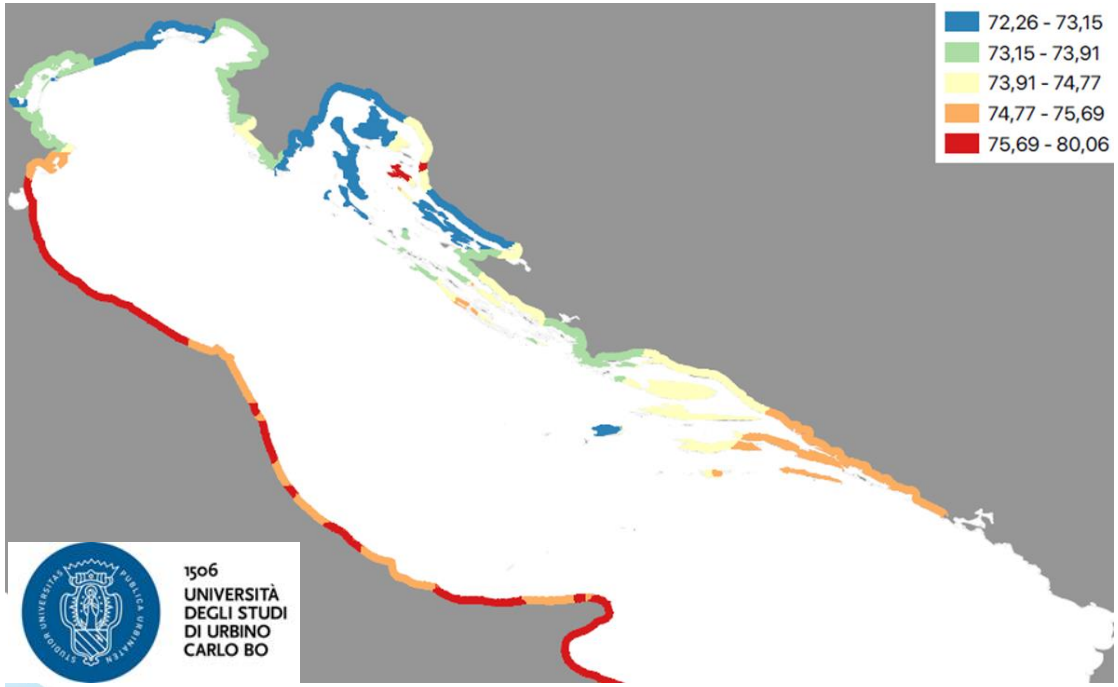
ASTERIS

Adaptation to **S**altwater in**T**rusion in s**E**a level **RI**se **S**cenarios



https://www.italy-croatia.eu/web/asteris

Regional high-resolution Maps of Sea-level (cm at 2100 above 2015 level)



Glacial Isostatic Adjustment

+

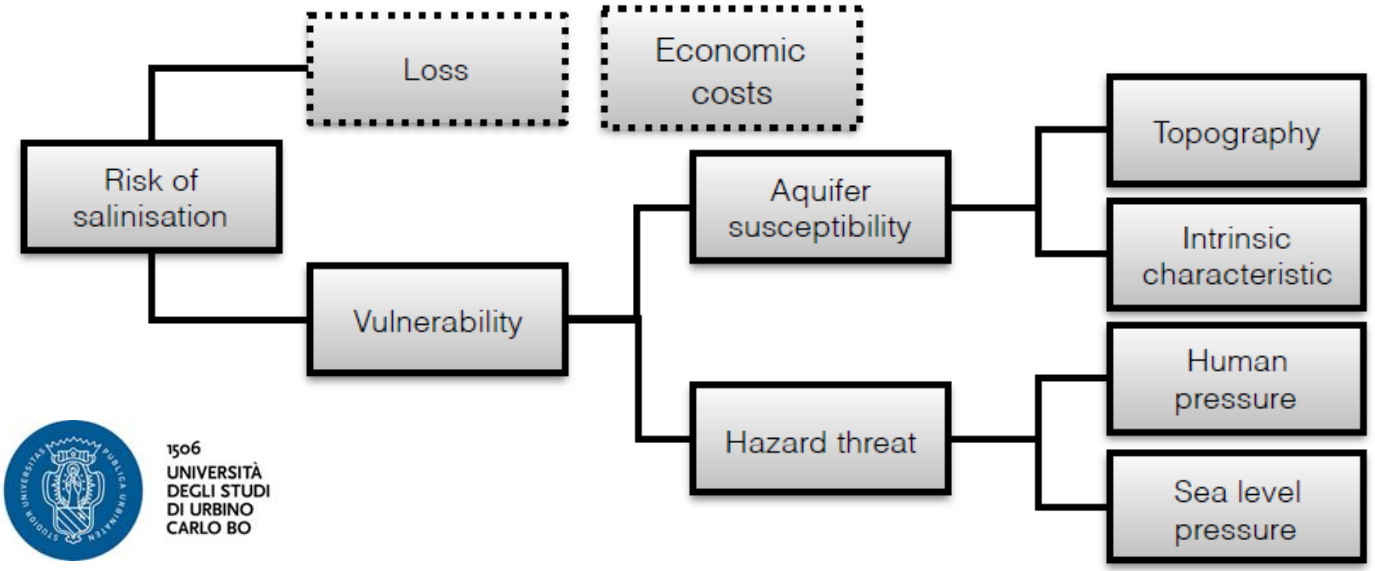
Current ice melting

+

Steric component
(thermo&halo)

$$Vulnerability\ (V_H) = Aquifer\ susceptibility\ (S_A) * hazard\ threat\ (T_H)$$

$$Risk\ (R_H) = Vulnerability\ (V_H) * Loss\ (L)$$

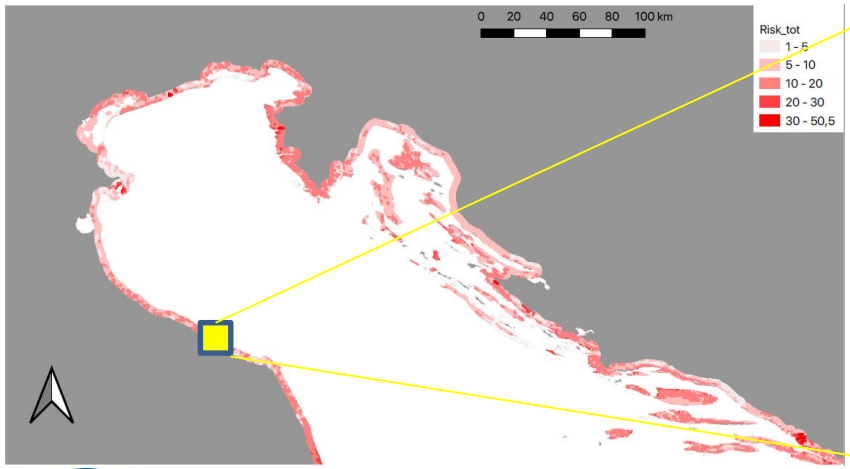


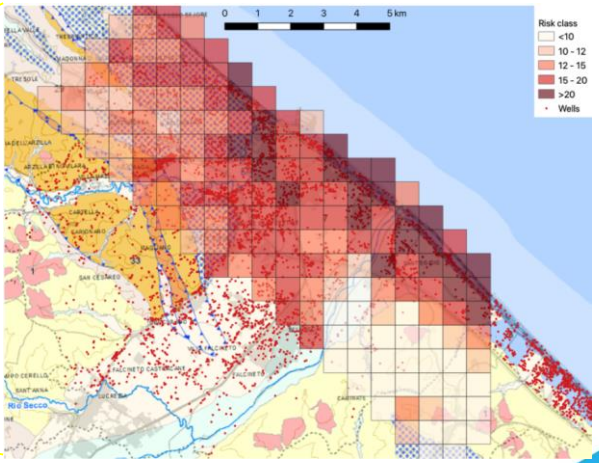
1506
UNIVERSITÀ DEGLI STUDI DI URBINO CARLO BO

Regional -> local approach

A map of vulnerability to coastal salinization at the macro regional scale (Adriatic) based on future scenarios for sea level rise and the hydrological cycle.

Case study area of Fano: risk of salt ingression





1506 UNIVERSITÀ DEGLI STUDI DI URBINO CARLO BO

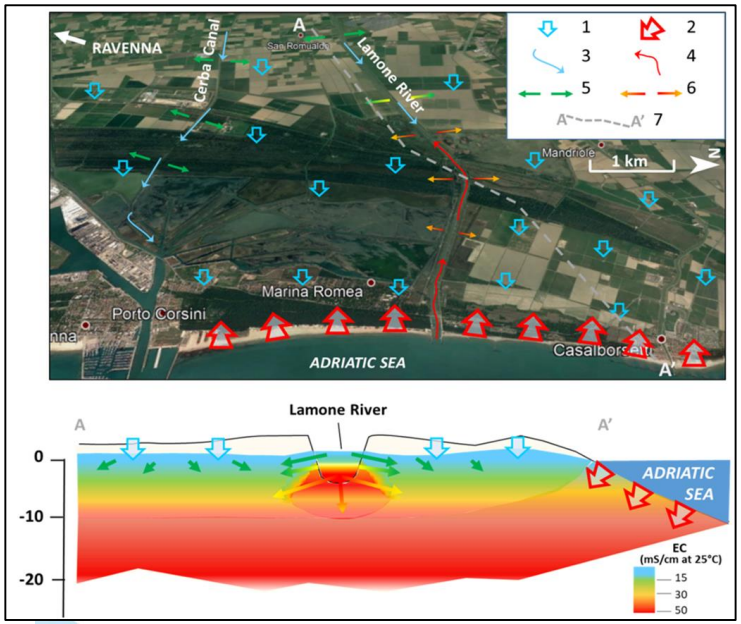
Modelling present and future salt ingression in Adriatic coastal aquifers

WP4 – MONITORING MANAGEMENT OF COASTAL AQUIFERS &CONCEPTUAL MODELS

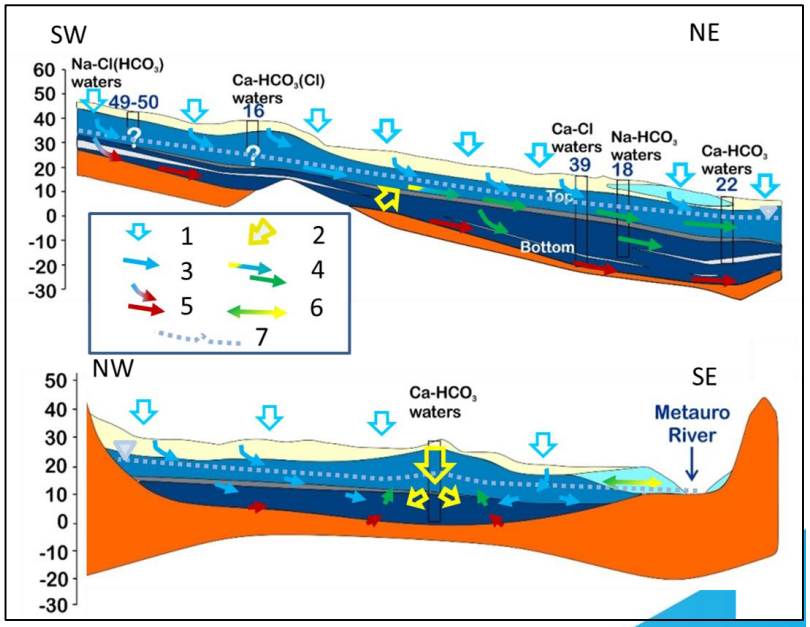
The understanding of the influences of sea level rise on salt ingression is not uniform at a local scale depending on a complex of factors for each site, including the hydrogeological setting, local rates of ground water extraction and hydrological regimes.

WP4 – MONITORING MANAGEMENT OF COASTAL AQUIFERS &CONCEPTUAL MODELS

Ravenna Case Study WP 4.1.2



Fano Case Study WP 4.1.2



WP5 – PLANNING THE ADAPTATION

Activity details WP 5.1

D.5.1.1 – Priority issues:

- **Physical (=> climate induced change on sea level & hydrology)**
- **Management (=> exploitation of resources)**

D.5.1.2 – Best practices

from Priority Issues to B.P.

Focus on case studies (or similar situations)

Activity details WP 5.2

D.5.2.1 – Guidelines for adaptation measure:

D.5.2.2 – Booklet on adaptation plans

One for each of the three case studies

Application of guidelines in different contexts

NB – actions selected by «low-CO_2 emission» criteria !

a. Knowledge heterogeneity (spatial&time-depending) of aquifer salinization "SWI" - WEB-GIS (National-Regional Environmental Agencies)

Making knowledge systematic and capillary-diffused

b. (over?)exploitation of groundwater bodies "with poor quantitative control"

Re-orienteering groundwater pumping

Facilitate deepening of interface zone

c. Climate change (temperature-rain => ETP/I distribution)

Facilitate infiltration and storage of surface runoff

d. Setback of the coast line

Active practices against shoreline erosion

e. Agricultural & Wet-zone coastal management

land use selection of plants/crops tolerant to salt limits

5.1.2.b) Re-orienteering groundwater pumping

Planning of methods, places and times of pumping:

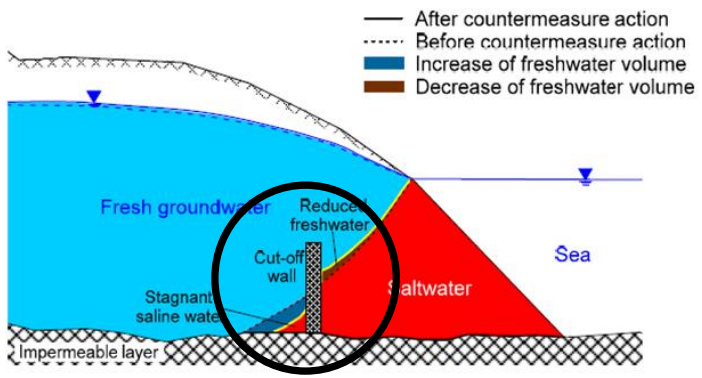
1. Limitation in the use of deep wells (revision of concessions - water saving). IT National Environmental Law D.Lgs. 152/99, art.96 "limitations to abstractions"
2. Relocation of wells / pumping centers (strategic planning: "PTA", Water Management Plan III cycle 2021-2027, IT District Authorities)
3. Preserve the use of fresh groundwater for valuable uses (IT-AATO)
4. Encourage alternative water supplies for less-valuable uses (agricultural and / or industrial) with joint use of surface and groundwater

5.1.2.b) Re-orienteering groundwater pumping

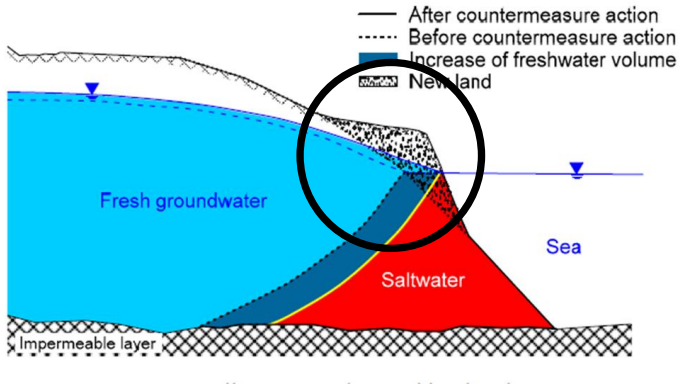
5. Reduce current irrigation needs by:
   - Use of farming techniques and irrigation water distribution with innovative and technologic plants (micro-irrigation systems capable of providing only the water necessary to maintain the soil-cultivation system to be irrigated at maximum production potential).
   - Management of irrigation networks with dedicated pipeline networks (upgrade/update Drainage & Irrigation Plans – IT Regional Level)
   - Promotion of photovoltaic power supply pumping system

5.1.2.b) Facilitate deepening of interface zone

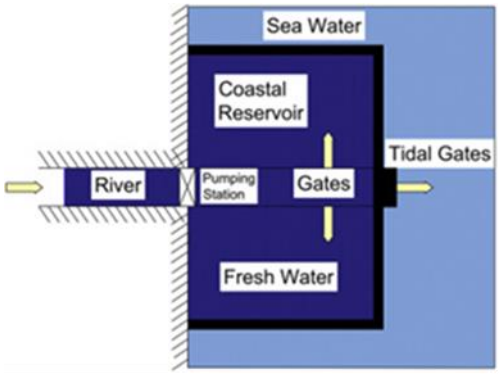
Physical barriers



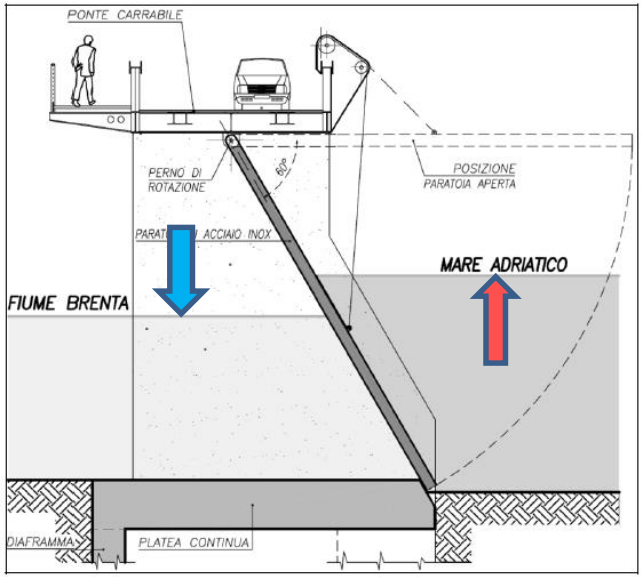
Subsurface Barriers



Land Reclamation



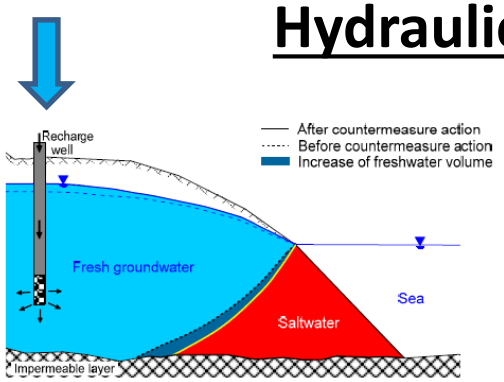
Surface barriers (river estuarine)



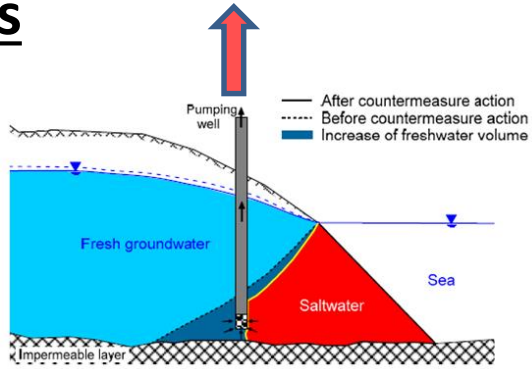
Bridges with mobile weir (against river salt wedge)

5.1.2.b) Facilitate deepening of interface zone

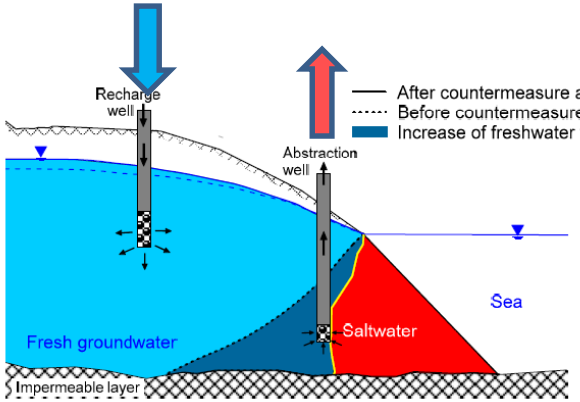
Hydraulic barriers



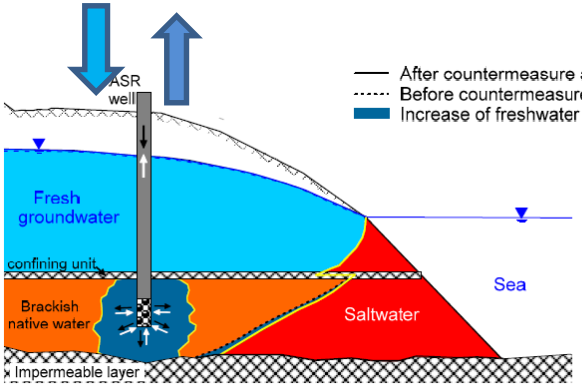
Recharge wells



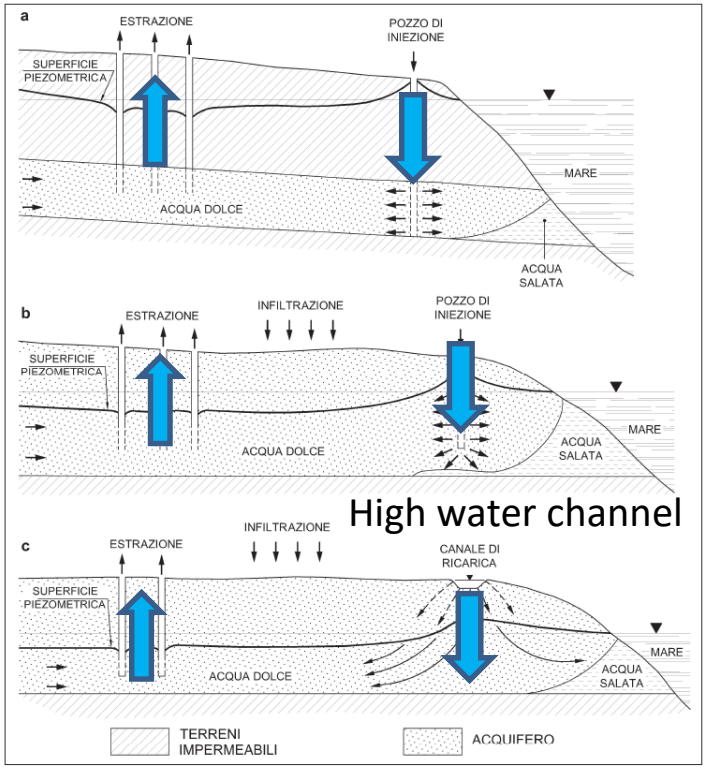
Extraction wells (salt water)



Mixed system



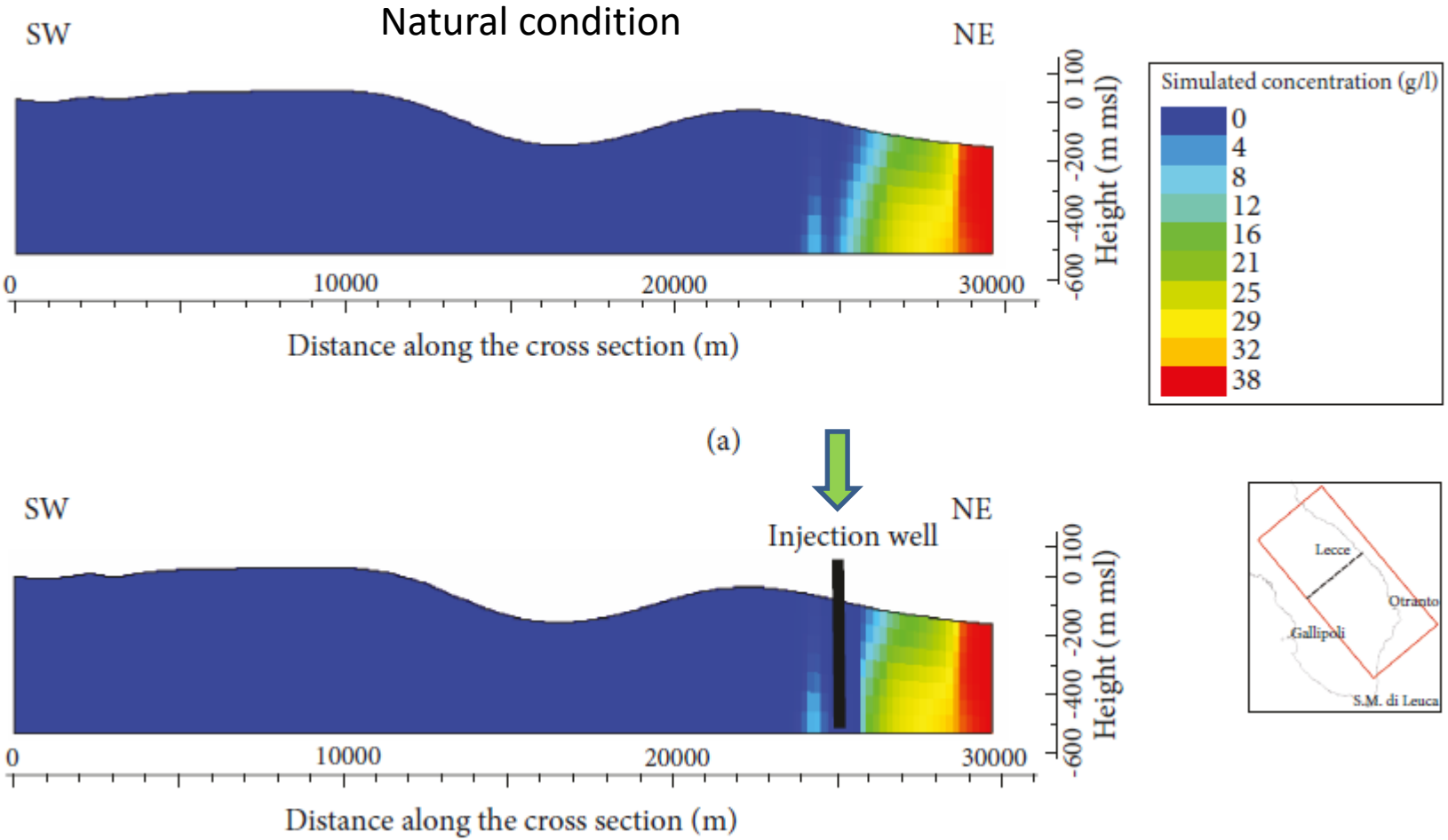
Cyclic Recharge (wet season) & abstraction well (dry season). COP % water suitable use



High water channel

5.1.2.b) Facilitate deepening of interface zone

Hydraulic barriers – Case study Salento (Puglia, IT)

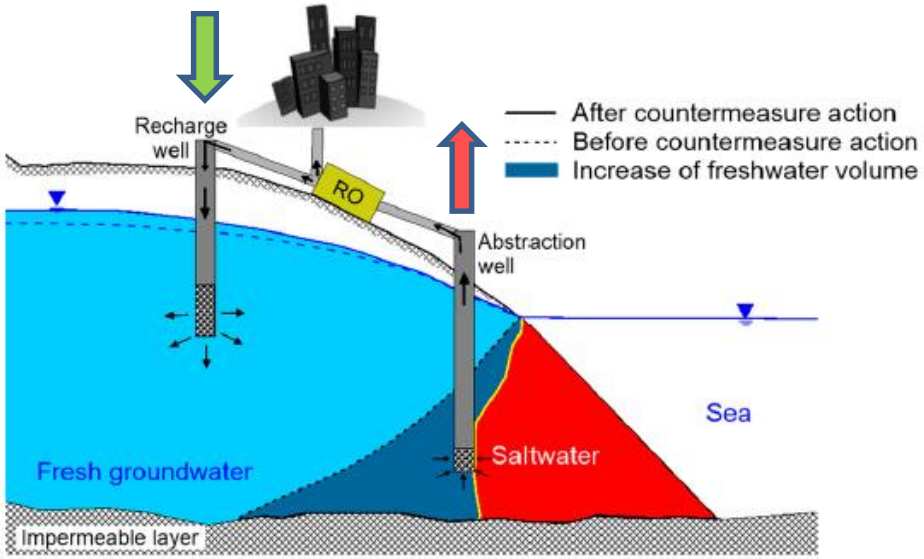


Project condition: injection wells of treated waste-water (Lecce)

https://doi.org/10.1155/2019/5714535

5.1.2.b) Facilitate deepening of interface zone

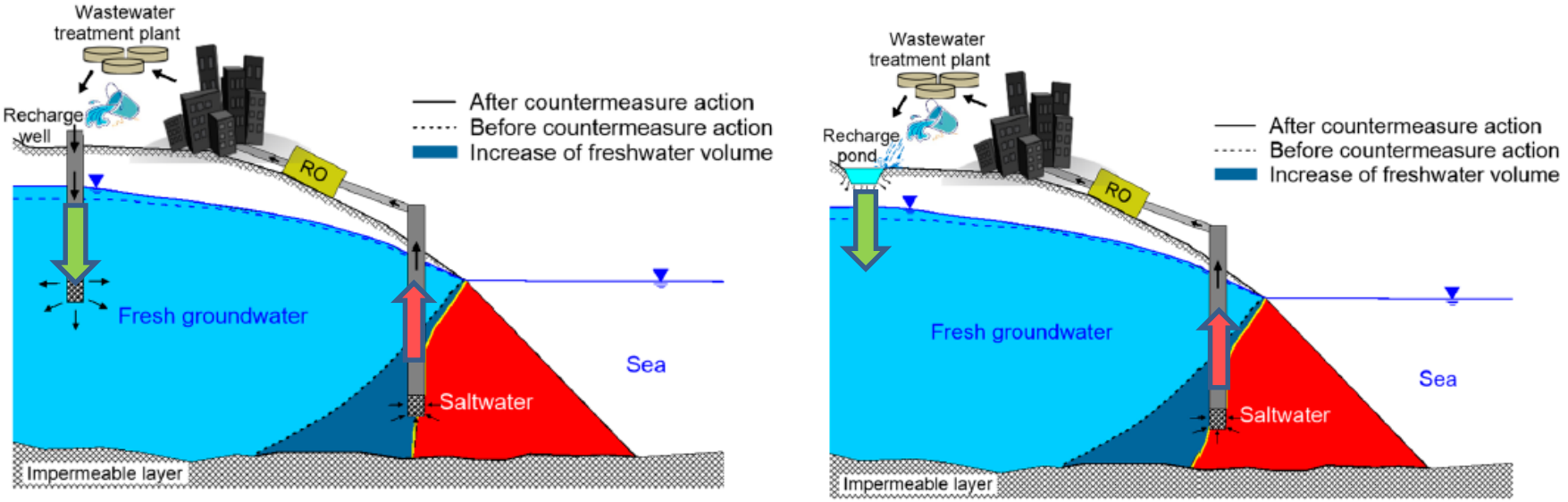
Mixed systems: Abstraction, Desalination, and Recharge



- ✓ Continuos abstraction of saltwater
- ✓ Desalination (Reverse Osmosis plant)
- ✓ Partial re-use of desalinized water for artificial recharge

5.1.2.b) Facilitate deepening of interface zone

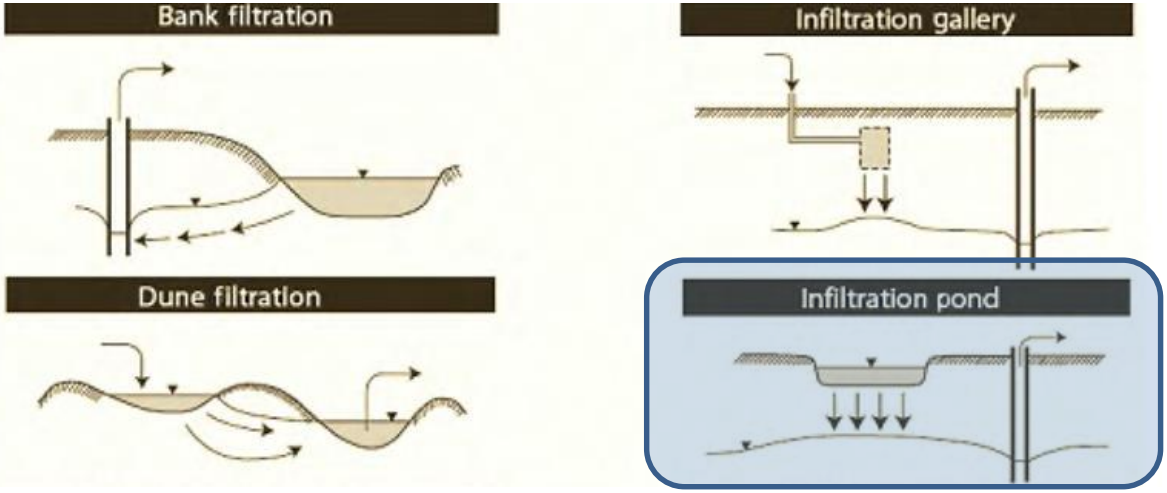
Mixed systems: abstraction, desalination, and recharge by treated wastewater (direct/undirect)

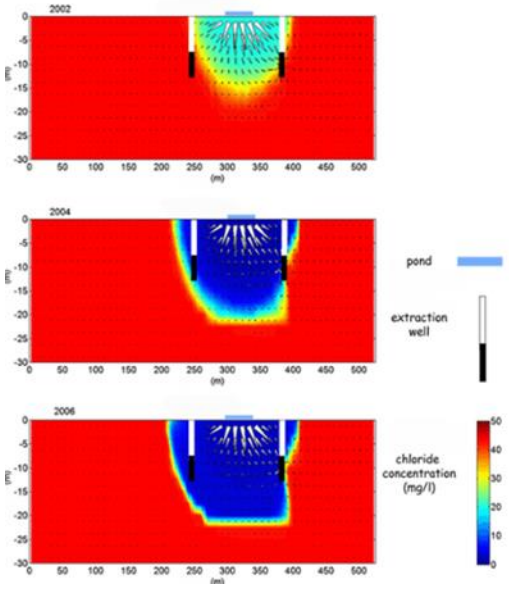


- ✓ Continuos abstraction of saltwater
- ✓ Desalination (reverse osmosis plant)
- ✓ Use of treated waters for low-valuable purpose
- ✓ Waste-water treatment
- ✓ Artificial recharge (direct by injection wells or recharge pond)

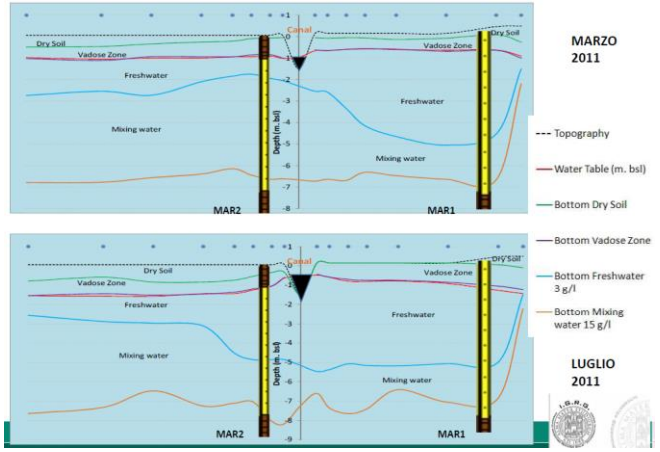
5.1.2.c) Facilitate infiltration and storage of surface runoff

Shallow aquifer

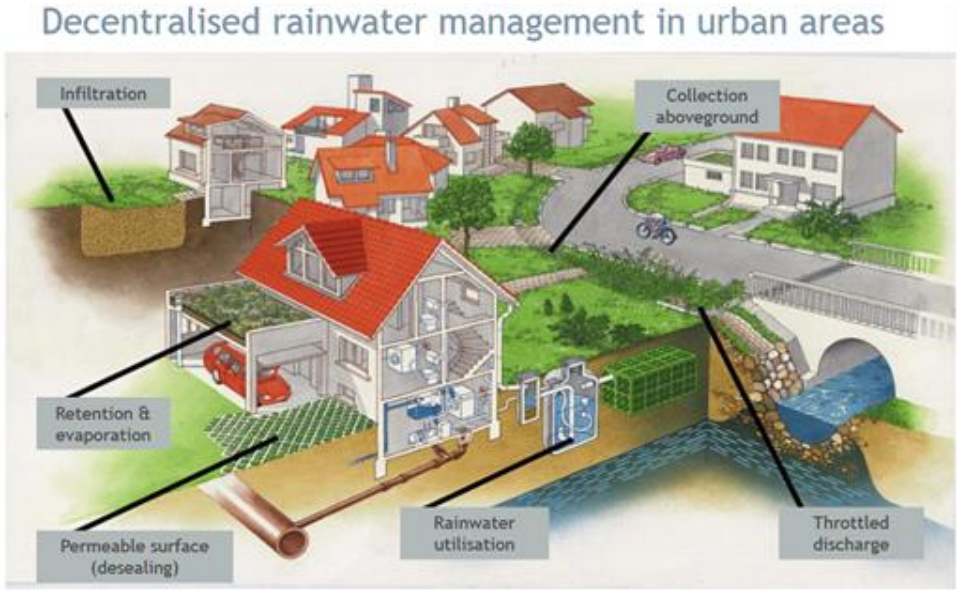


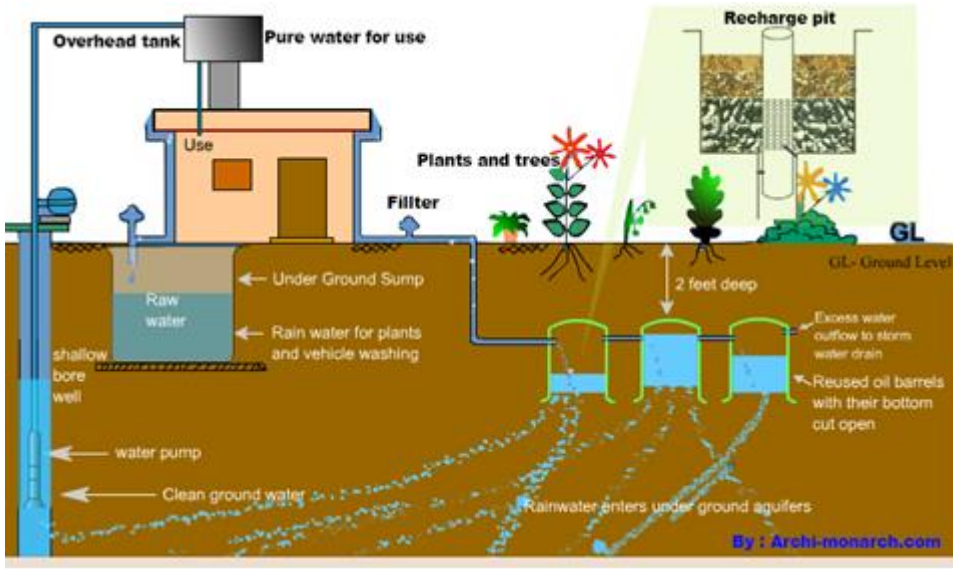


Lido di Dante Test Area (Ravenna), 2011. N. Greggio



5.1.2.c) Facilitate infiltration and storage of surface runoff





5.1.2.d) Active practices against shoreline erosion

Realization of:

- soft type works
- rigid type works
- semi-rigid works
- Measures based on innovative techniques and / or materials:
  - ✓ renaturalization and reconstruction of the dune bars,
  - ✓ construction of naturalistic engineering works (walkways for access management)
  - ✓ construction of windbreak barriers
  - ✓ planting of pioneer species, which stabilize the dune and retain the sand

upgrade/update Coast Defense Plane – IT Regional Level

5.1.2.d) Active practices against shoreline erosion

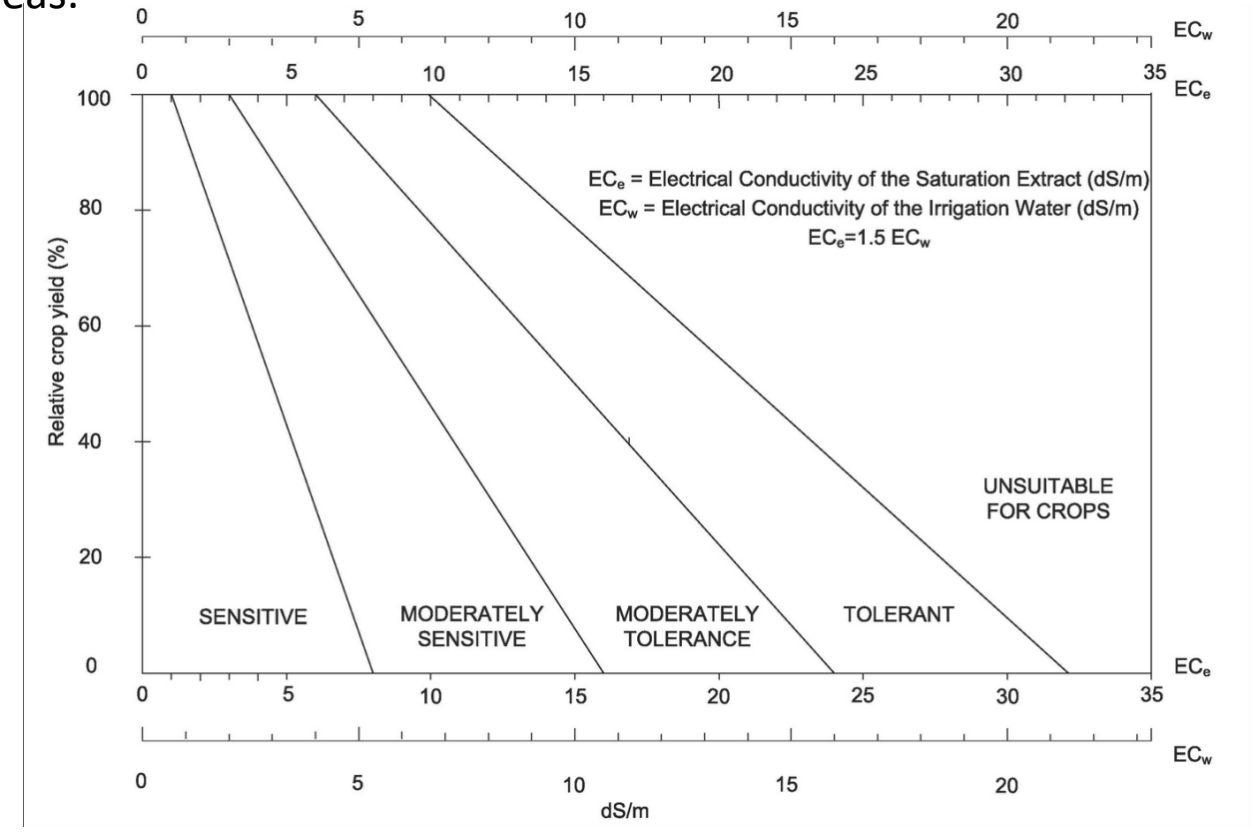
Fano (PU), Ponte Alto

5.1.2.e) Land use selection of plants/crops tolerant to salt limits

Apply measure to **adapt salt intrusion** with an **appropriate land use planning**:

- reasonable shifts in agricultural practices;
- selection of plants and crops which can be tolerant to various salt limits;
- applying advanced cultivation techniques;
- project hard-engineered structures for salt prevention and freshwater conveyance in freshwater-scarce areas.

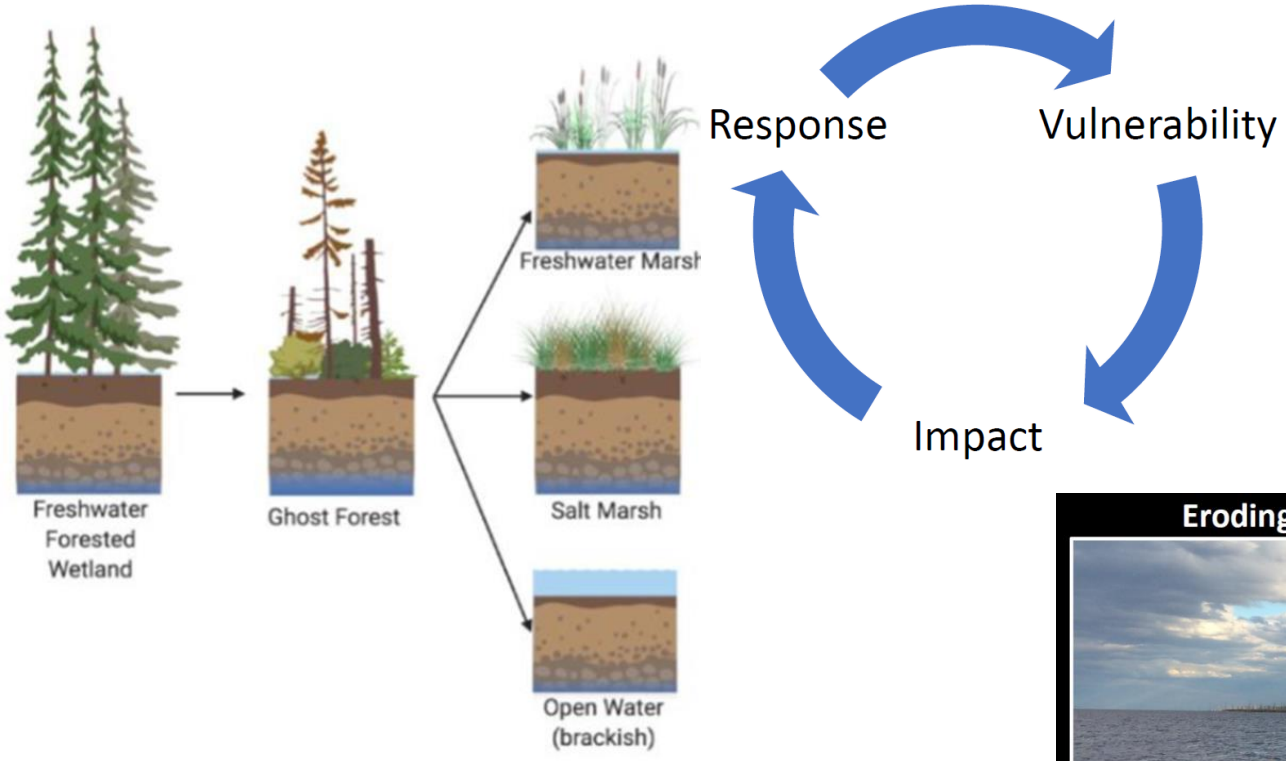
Salt tolerance of crops is described by a graph of the relationship between crop yield and salinity values



5.1.2.e) Land use selection of plants/crops tolerant to salt limits

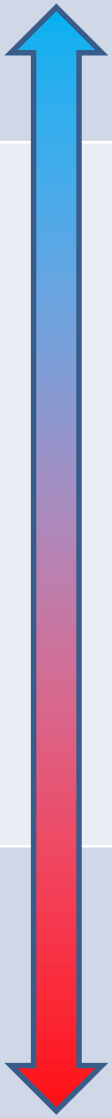
CASE STUDIES (USA)

Gradual Sea Level Rise + Episodic Salt Water Intrusion



Eroding coastal margins already obvious

VULNERABILITY CLASS	MITIGATION AND ADAPTATION MEASURES
1 - **FRESHWATER**	**Monitoring and prevent** Re-orienteering groundwater pumping, improve media communication of good practices
2 – **MIXING ZONE**	**Water Control**: groundwater abstraction limitations; water control infrastructure such as hydraulical barriers and storage of surface runoff; **Irrigation Methods:** leaching soils with freshwater can reduce salinity in well-drained soils and conditions where the groundwater table is not close to the surface. **Land use planning**: 1. reasonable shifts in agricultural practices; 2. selection of plants and crops which can be tolerant to various salt limits; 3. advanced cultivation techniques such as less water irrigation practices of alternate wetting and drying and salt tolerance enhancement
3 – **SALTWATER**	**Water Control:** hard-engineered structures (physical barriers such as flood gates, dikes, levees, and valves) **Land use planning:** cultivated salt-tolerant grass and plants species **Active practices against shoreline erosion**



D.5.2.2 – Booklet on adaptation plans
Application of guidelines in different contexts

i. Why an adaptation plan to salt intrusion in coastal aquifer ?

ii. Involving of stakeholders: which roles (and rules) ?

iii. Check list of actions & priority

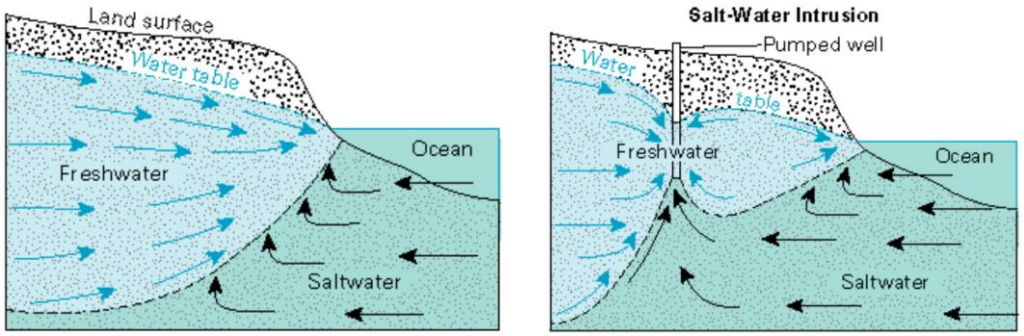
iv. Test-sites, pilot areas: where, when & why ?

v. Monitoring, evaluating and optimizing of adaptation plan: how to improve ?

vi. Extensive run of adaptation plans: what's the goal ?

i. Introduction – why an adaptation plan ? Wrap-up questions

<u>What is salt intrusion in coastal aquifer ?</u> (graphic/design comparing present situation and future scenario)



<u>What are the potential impacts to communities and the resources they depend on??</u> (synthesis in technical & non-technical language of WP3 – scenarios and WP4 – risk mapping)

<u>Why should communities care about it and get involved? What can communities do to prepare for and adapt to salt intrusion in coastal aquifer ?</u>

- ✓ Protection of the beach from sea level rise and storm surge frequency
- ✓ Protection of ground water resources for different uses (drinking, irrigation, industrial, domestic)
- ✓ Maintenance of underground infrastructures (technological networks, sewers etc.) and buildings (underground rooms, foundations etc.)
- ✓ Coastal bio-diversity protection (where applicable / sensitive)

ii. Involving of stakeholders: which roles (and rules) ?

PRIVATE

National level

Trade associations

Industry, agriculture associations (promoters of water saving devices)

Regional & Provincial Level

Managers of integrated water cycle (use of groundwater for human purposes)

Irrigation and Drainage Consortium; Industry & farmer associations (groundwater users)

Drilling companies (aquifer exploitation)

Municipal level

Environmental groups (knowledge dissemination)

Social media (awareness diffusion)

Foundations (financing)

….. (others)

PUBLIC/INSTITUTIONS

National level

District basin authority (management plan of water resources - 2000/60/CE)

Universities/Research centers (technology development and its applications)

Regional & Provincial Level

Environmental Protection Agencies (groundwater monitoring network)

Policy-makers and environmental planners

Regional Parks, Manager of Natura 2000 sites, SIC/ZPS (environmental and coast protection)

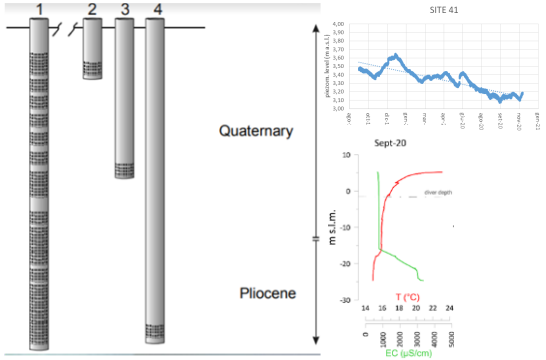
Municipal level

Environmental services (direction and coordination)

Strategic planners (land-use modifications)

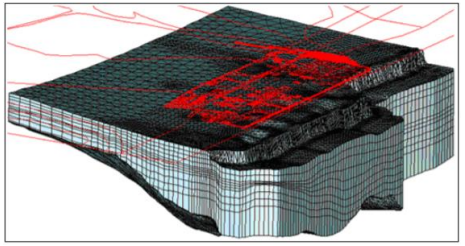
Urban planners (application of guidelines)

iii. Check (priority) list = local action plane



CONTROL ROOM

Monitoring coastal aquifer
Numerical simulation models
GW nowcasting & forecasting



WATER RESOURCE MANAGER

Planning sustainable water use
Control of abstraction rates
Relocation of wells / pumping centers
Reuse of purified waste water
Desalinization

URBAN ENVIRONMENT

Freshwater storage & ponding/infiltration
Active practices against shoreline erosion / coastal design & buffer zones
Hydraulic barriers (MAR)
Physical barriers
Adaptation of underground structures e infrastructures
Progradation of the coastline

AGRICULTURE & IRRIGATION

Adapting current irrigation techniques & needs
Enhancing salt tolerance of plants and crops
Freshwater storage & ponding

iii. Check (priority) list = local action plane

Zoning

inland

300-400 m

100 m

shoreline

300-400 m

Hydrogeological effects

- Sustainable groundwater yield
- Optimization of withdrawal from wells
- Facilitate deepening of interface zone
- Disruption of interface zone progression
- Moving interface seaward

Check list of actions

Planning sustainable water use
Control of abstraction rates

Relocation of wells / pumping centers

Adapting current irrigation techniques & needs
Enhancing salt tolerance of plants and crops
Reuse of purified waste water

Freshwater storage & ponding

Adaptation of underground structures and infrastructures

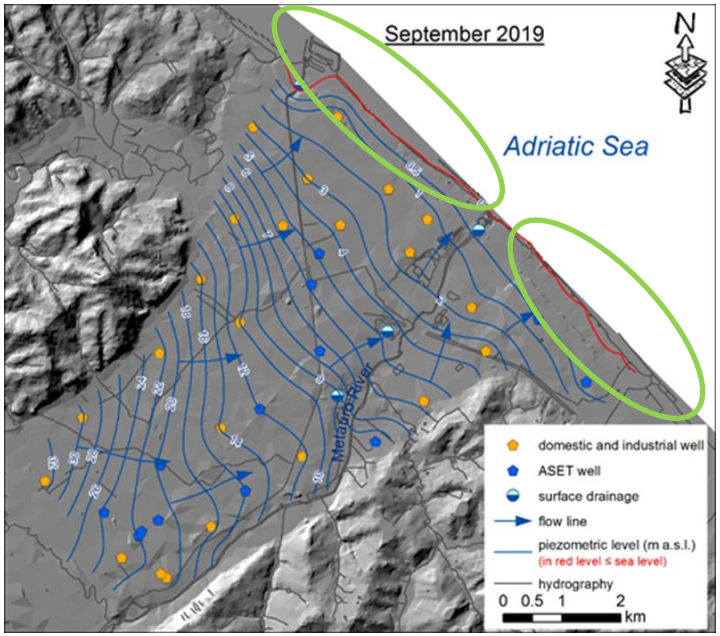
Hydraulic barriers (MAR)
Physical barriers

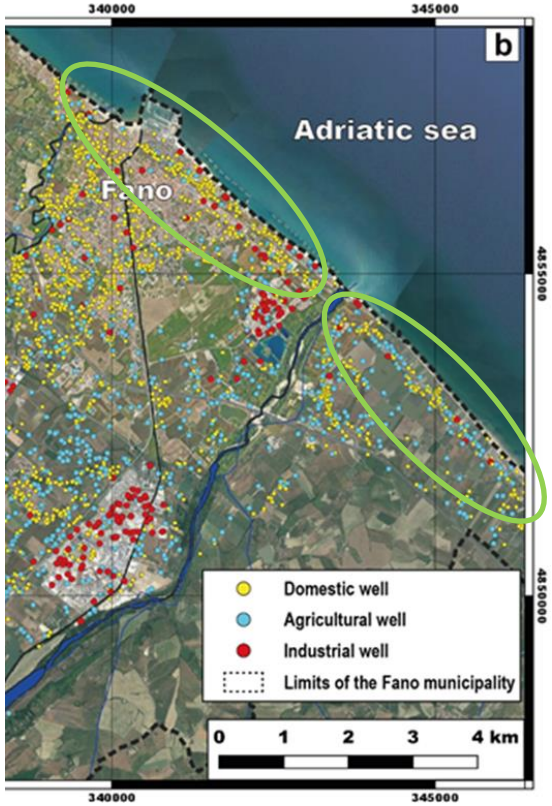
Desalinization

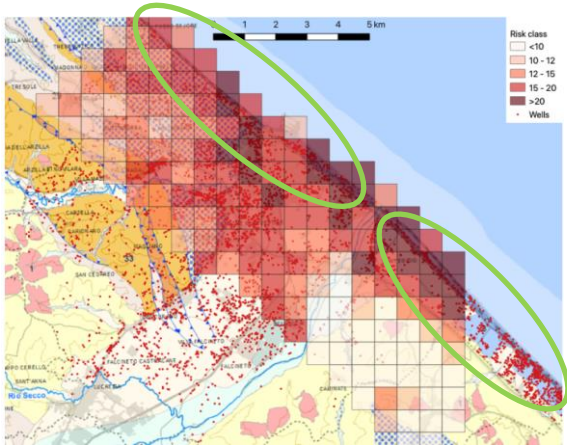
Active practices against shoreline erosion / coastal design & buffer zones

Progradation of the coastline

iv. Test-sites, pilot areas: where & why ?







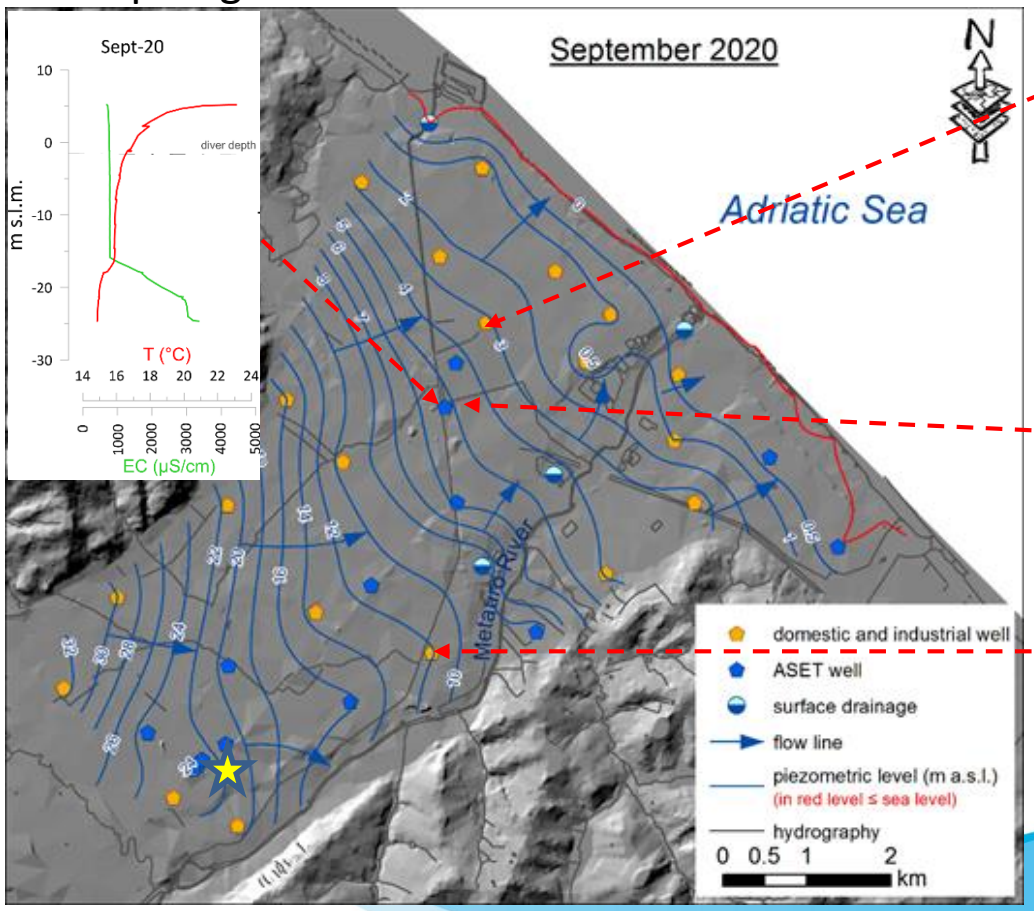
Preparation of integrated monitoring devices of coastal water resources, headed by coordinated control bodies, with continuous instruments that combine (along transects – reference IT ISPRA-SNPA Manuals & Guidelines 15.5.2017 Doc-8)

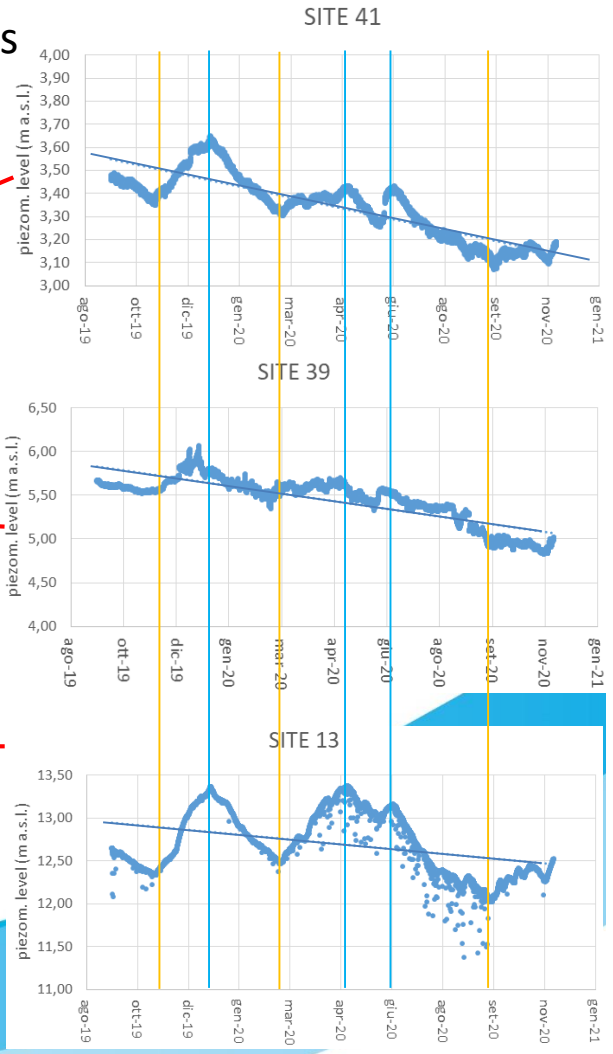
- Aquifer phreatimetry / pressure
- Salinity
- Hydro-chemical and physical characteristics of water (isotopes, age, temperature)
- Tidal measurements
- Rainfall
- Geophysical measurements

iv. Test-sites, pilot areas: where & why ?

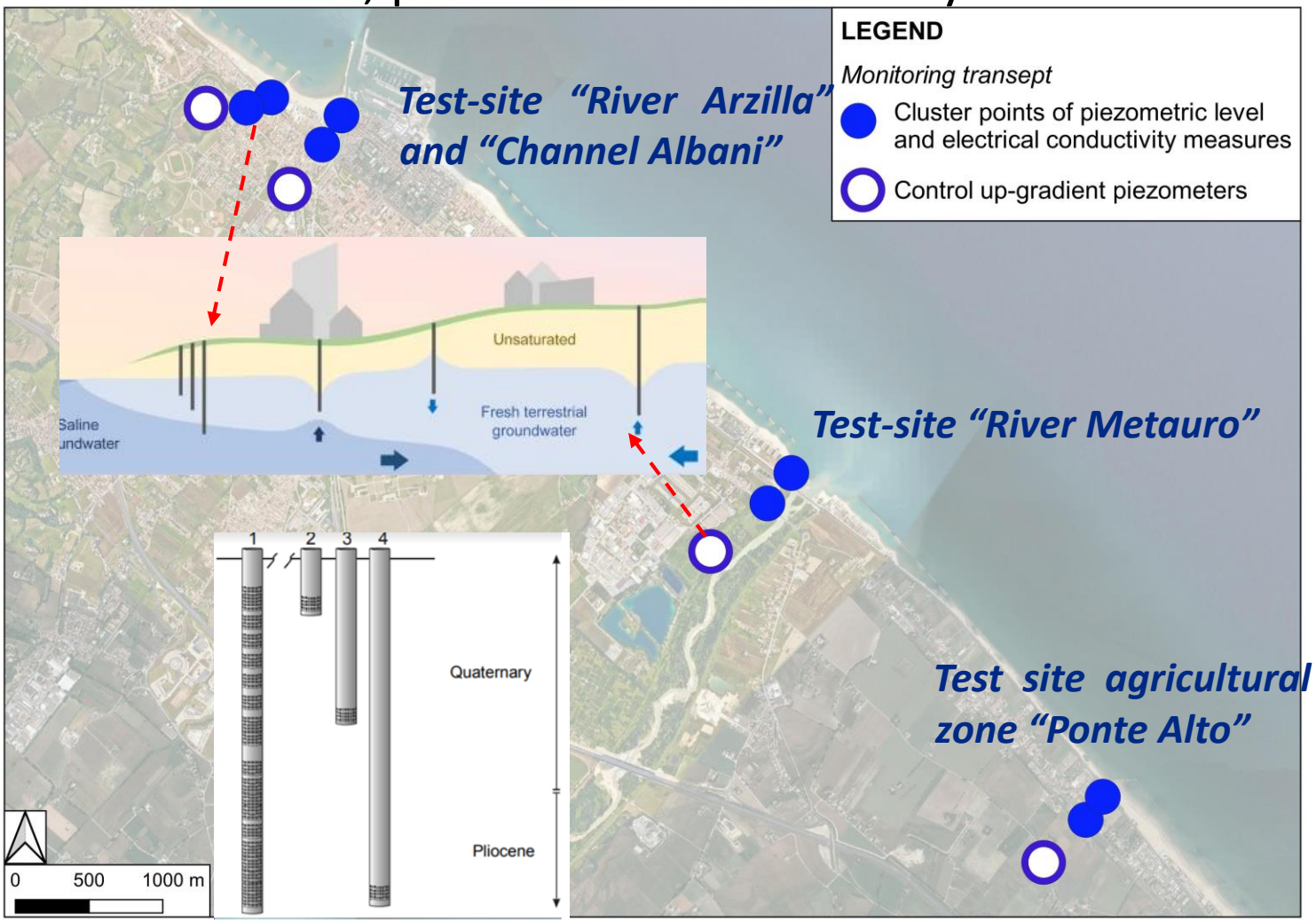
Saline waters of deep origin

Piezometric level trends





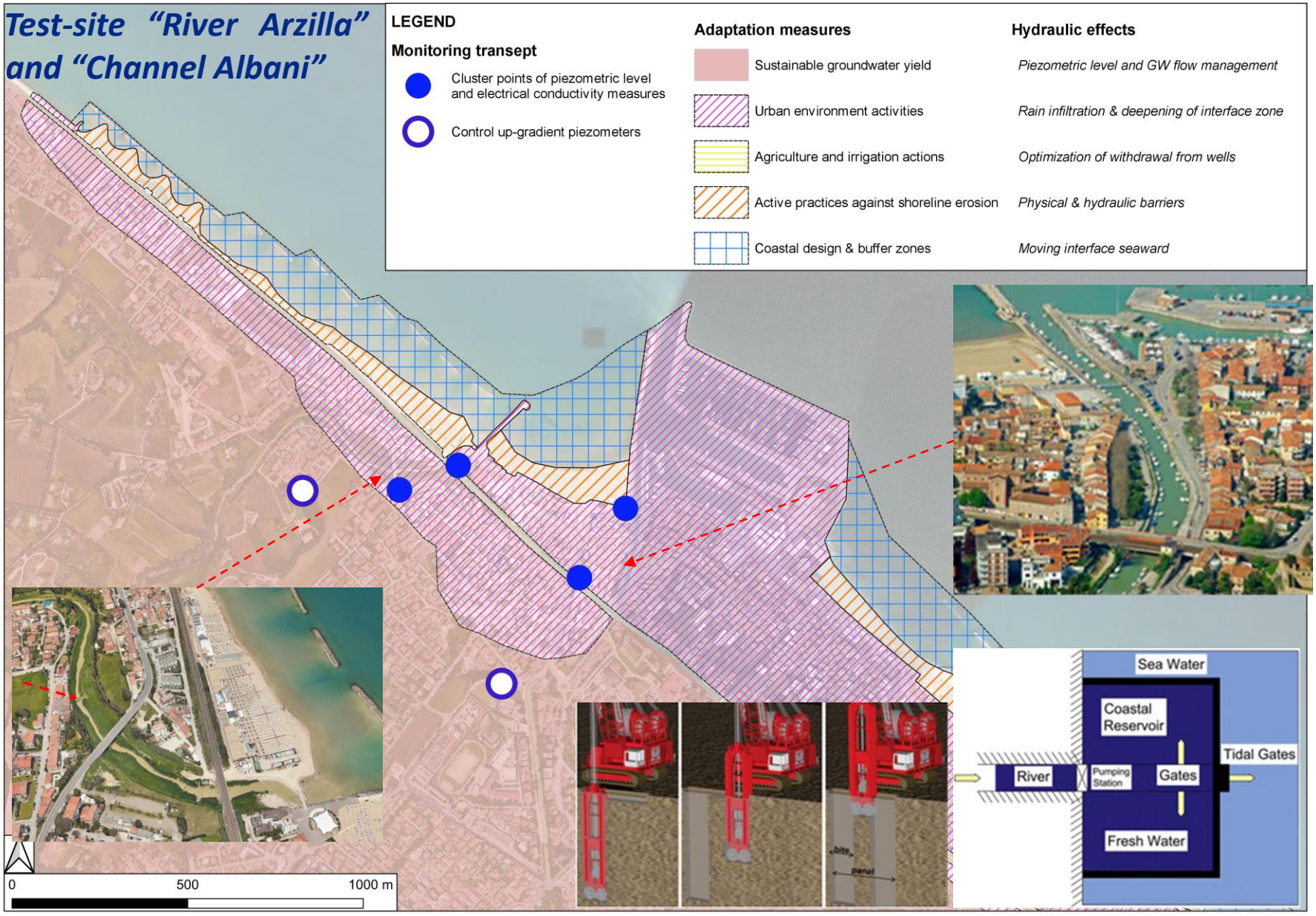
iv. Test-sites, pilot areas: where & why ?



Purposes:

- Verify the mineralization of aquifer levels at increasing depths, discriminate the nature and origin of saline waters with isotope (and age) analysis;
- Monitoring the evolution of the interface and intrusion following the implementation of "Best practices" (increase or decrease of salinization).

iv. Test-sites, pilot areas: where, when & why ?



iv. Test-sites, pilot areas: where, when & why ?

LEGEND

Adaptation measures

- Sustainable groundwater yield
- Urban environment activities
- Agriculture and irrigation actions
- Active practices against shoreline erosion
- Coastal design & buffer zones

Hydraulic effects

- *Piezometric level and GW flow management*
- *Rain infiltration & deepening of interface zone*
- *Optimization of withdrawal from wells*
- *Physical & hydraulic barriers*
- *Moving interface seaward*

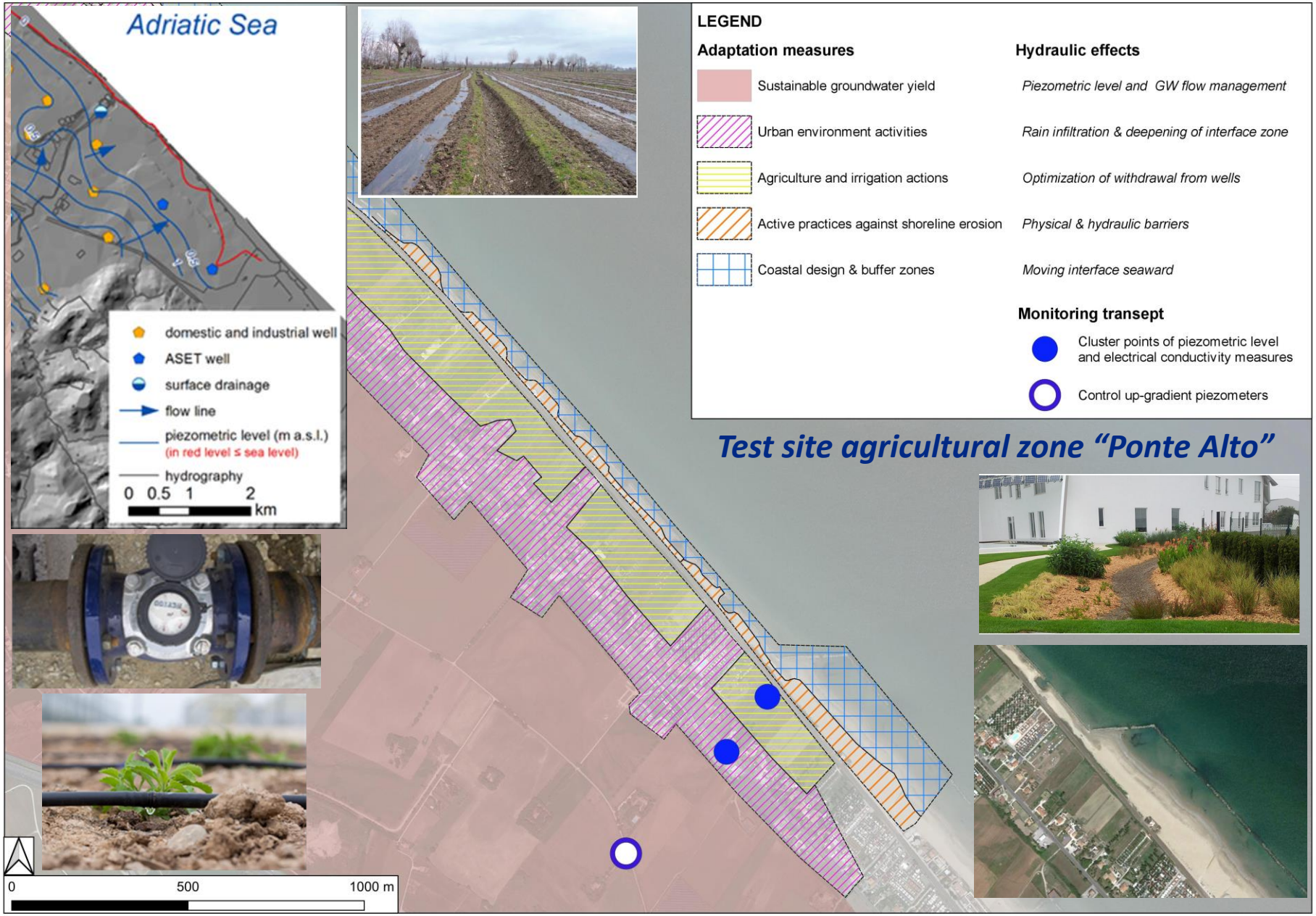
Monitoring transept

- Cluster points of piezometric level and electrical conductivity measures
- Control up-gradient piezometers

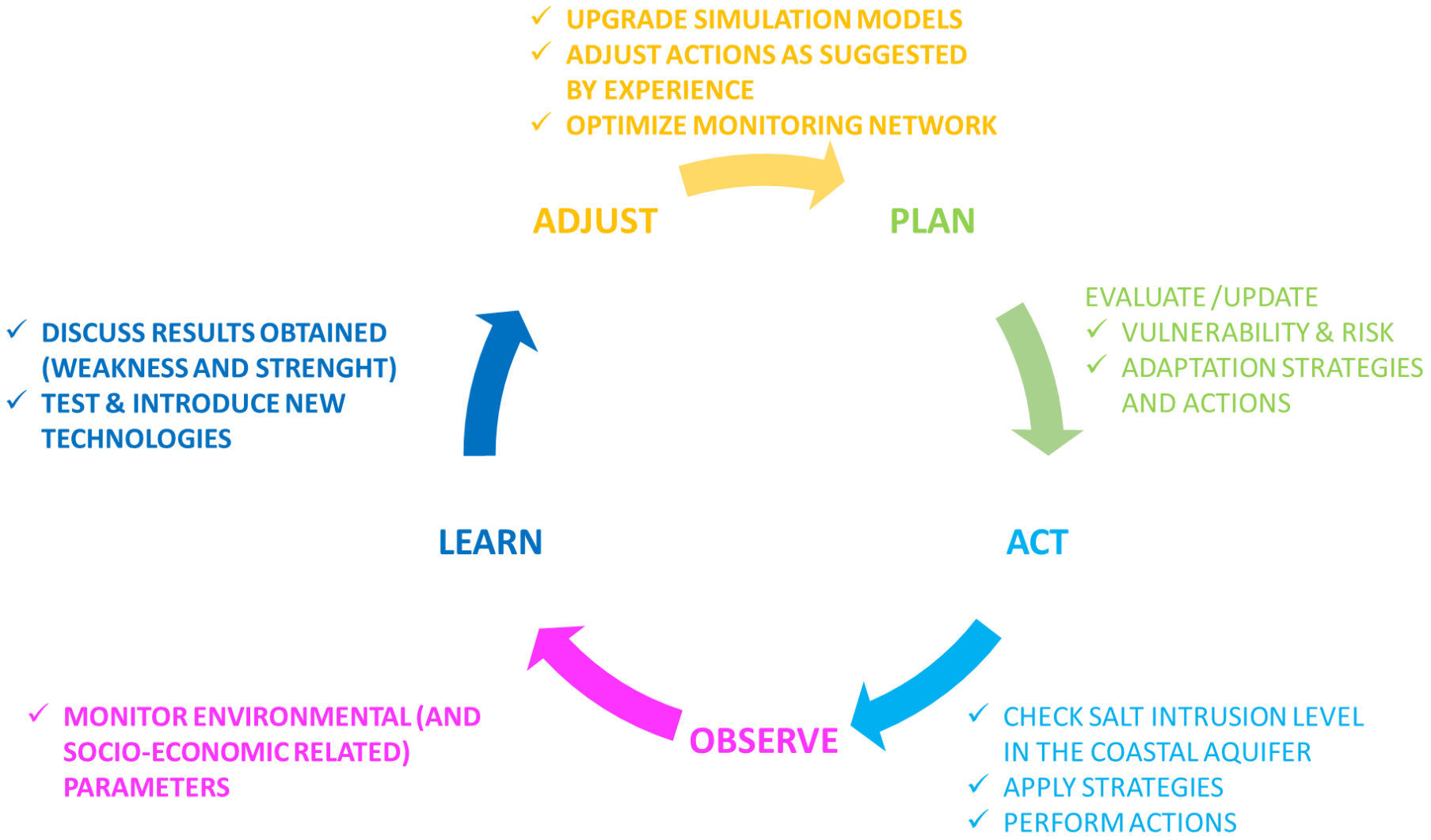
Test-site "River Metauro"

0 500 1000 m

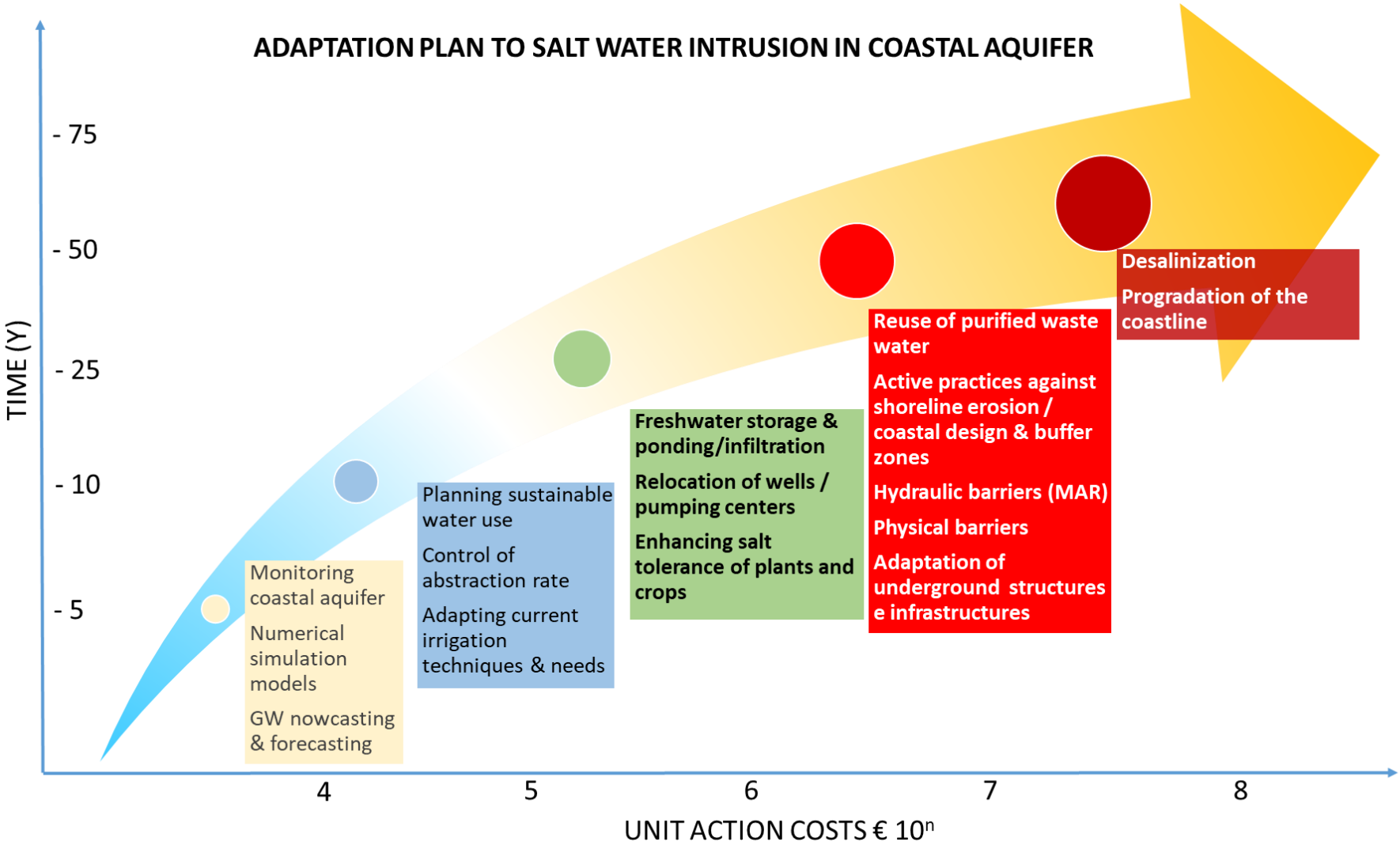
iv. Test-sites, pilot areas: where, when & why ?



v. Monitoring, evaluating and optimizing of adaptation plan: how to improve ?



vi. Extensive run of adaptation plans: what's the goal ?



CONCLUSIONS

SWI – Salt water intrusion

i. Predictable

ii. Detectable

iii. Can be mitigated with a progression of actions

iv. The local experiences of MAR (managed aquifer recharge) can be decisive for the prevention / reduction of the phenomenon

GOOD WORK AND THANKS FOR YOUR ATTENTION