PRIMA Section 2 - 2021, Thematic Area 1-Water management: Topic 2.1.1
"Alleviating Mediterranean water scarcity through adaptive water governance"

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PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

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Advancing non conventional water management for innovative climate-resilient water governance in the Mediterranean Area

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AG-WaMED 1 Masterclass

The role of Non Conventional Waters for Mediterranean Water Security: the AG-WaMED approach

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Outline

- **Water scarcity** and **Non Conventional Water Resource (NCW)** role
- **Limitations** to NCW use
- NCW in the **AG-WaMED project**

Water scarcity

- areas where there is **insufficient** water to simultaneously support both **human** and **ecosystem** water needs (White, 2014)

Physical water scarcity	as a result of a basic lack of **water**
Economic water scarcity	as result from a lack of **suitable infrastructure** to provide access to what might, otherwise, be considered ample available water resources

Physical water scarcity may occur as a result of both **natural phenomena** (e.g., aridity, drought) as well as from **human influences** (e.g., desertification, water storage; Pereira et al., 2009; White, 2014).

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Global distribution of regions affected by water scarcity

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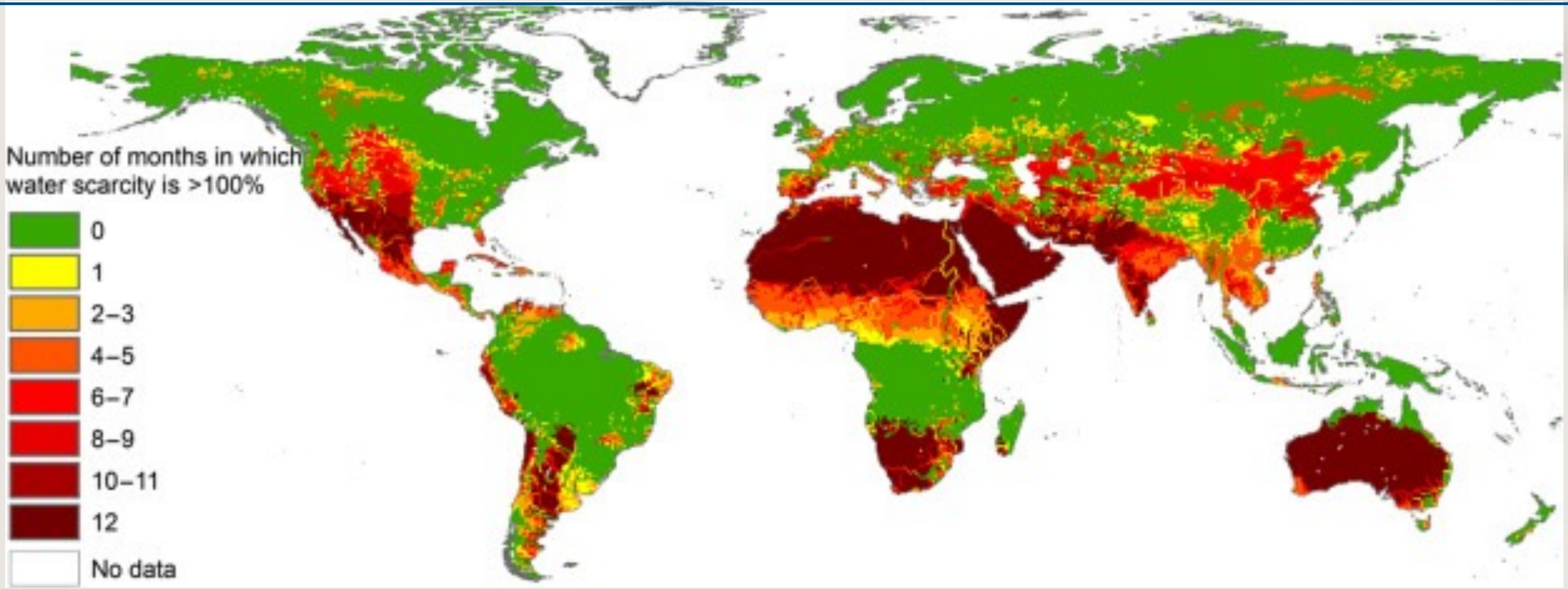

Reprinted from Mekonnen, M.M., Hoekstra, A.Y., 2016. Four billion people facing severe water scarcity. Sci. Adv. 2

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Water scarcity

- A key challenge to **sustainable development**
- A potential cause of social **unrest** and of **conflict** within and between countries
- Impact **traditional seasonal** human migration routes
- **60% of the global population** lives in areas of water stress where available supplies cannot sustainably meet demand for at least part of the year

Expected to intensify due to:

- increasing water demands,
- rapid urbanization,
- industrialization, and
- climate change (Kummu et al., 2010; Macedonio et al., 2012).

Karimidastenaei Z., Avellán T., Sadegh M., Kløve B., Haghighi A.T., 2022. Unconventional water resources: Global opportunities and challenges. Science of the Total Environment. Vol. 827, 154429. https://doi.org/10.1016/j.scitotenv.2022.154429

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Water scarcity and NCW

- Non Conventional Water Resources (NCW) can be an **alternative** water source and thus overcome water scarcity.

- Utilizing NCW is an emerging opportunity to **narrow the water demand-supply gap**

- Utilizing NCW is **increasingly growing** and can be especially useful in arid and semi-arid areas (Gosling and Arnell, 2016; Yazdandoost et al., 2021)

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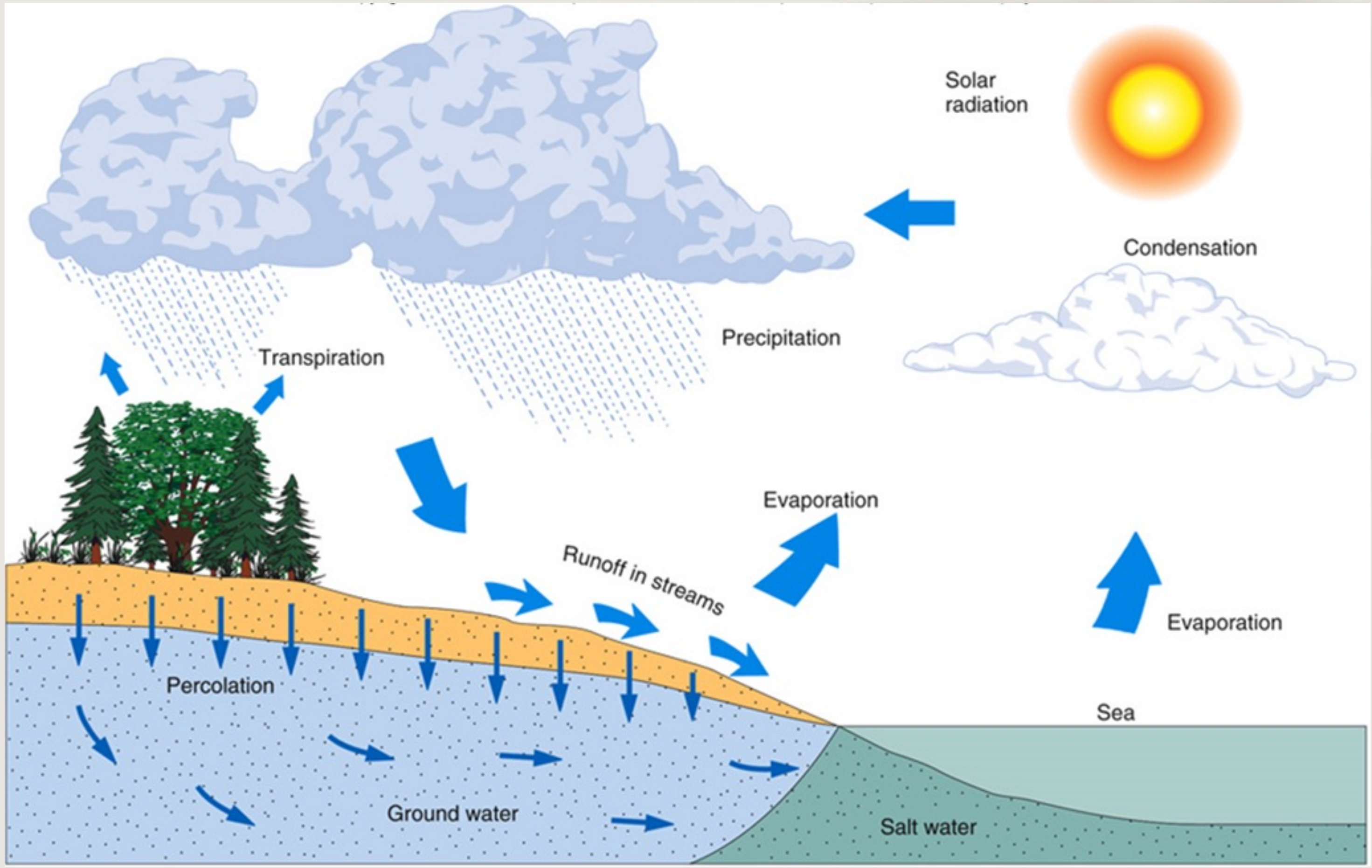
Conventional Water Resources

- Snowfall,
- Rainfall,
- river runoff, and
- easily accessible groundwater

are **overexploited** and **insufficient** to meet growing freshwater demand in water-scarce areas.



Non Conventional Water Resources

- Those sources of water which have **not** been **traditionally** used to meet existing water demands (Odendaal, 2009)

- Supplementary water sources requiring **specialized processes (**desalination, rainwater harvesting, iceberg towing, etc.) which may lead to applying appropriate strategies for a specified goal (Qadir et al., 2007).

- They are not accessible for consumers through conventional means, like surface water or groundwater (Indelicato et al., 1993; Haddad and Mizyed, 2004; Pereira et al., 2009).

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History of NCW definition

1985	Brewster and Buros	• not producing new water, but only **developing the potential for treating and using water sources that were previously considered unusable or unavailable**, such as saline water, wastewater, and inaccessible water resources. • rainwater harvesting and weather modification
1993	Indelicato et al.	• **water resources with specific features**, such as high organic matter and microorganism content, or high saline concentration needing treatment or similar processes before use
2000s	Jaber and Mohsen; Buchholz	• **rainwater harvesting was added to the list of NCW** (Jaber and Mohsen, 2001). Buchholz (2008) documented NCW as saline water, brackish water, agricultural drainage water, wastewater, and water obtained by fog capturing, weather modification, and rainwater harvesting
>2010	Ahmed; Negm et al.; Ji et al.,	• **any water resources, other than freshwater**, that **need new technologies** to make them useable as complimentary water sources (Ahmed, 2010; Negm et al., 2018; Ji et al., 2020)

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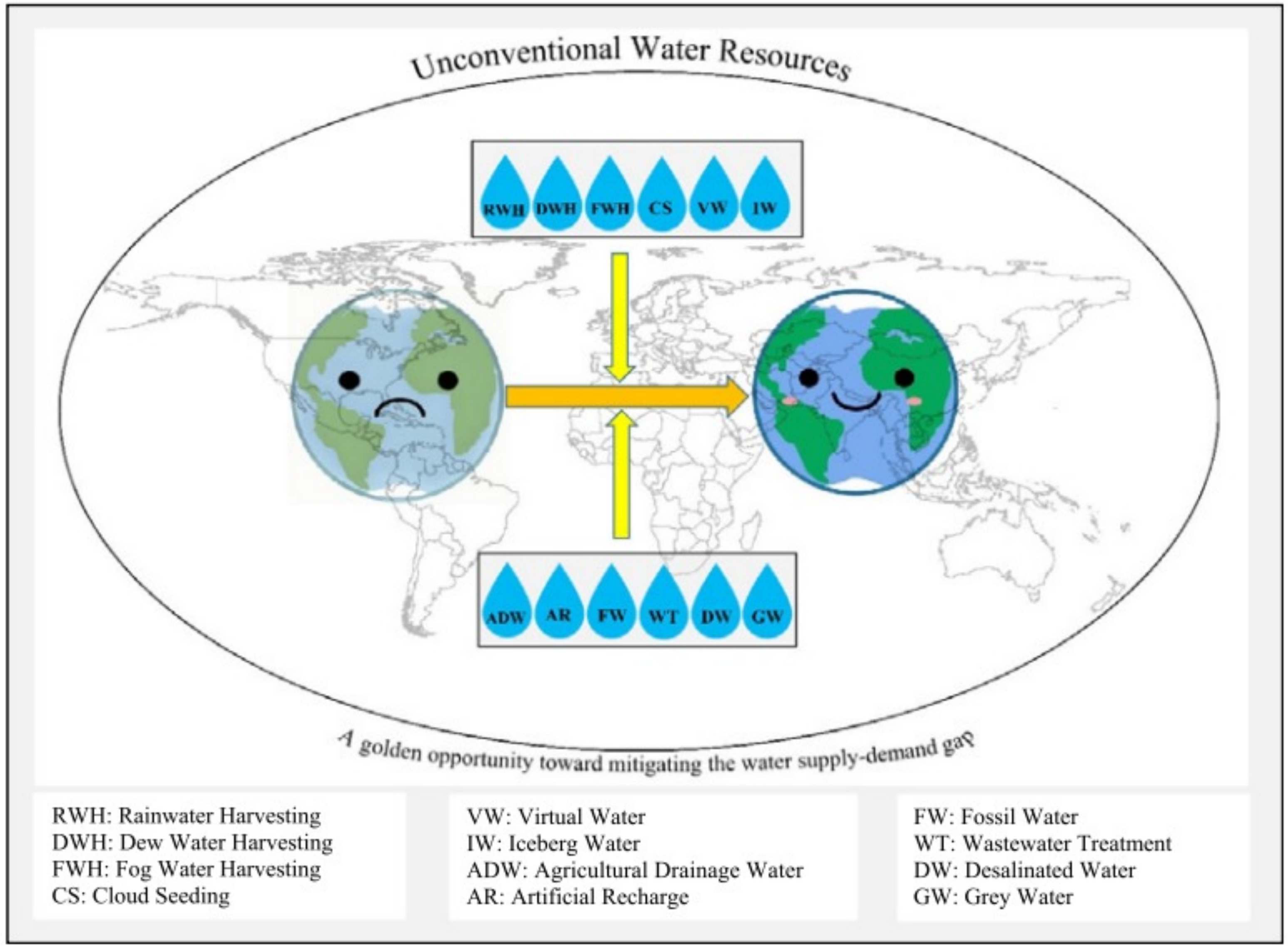

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NCW map

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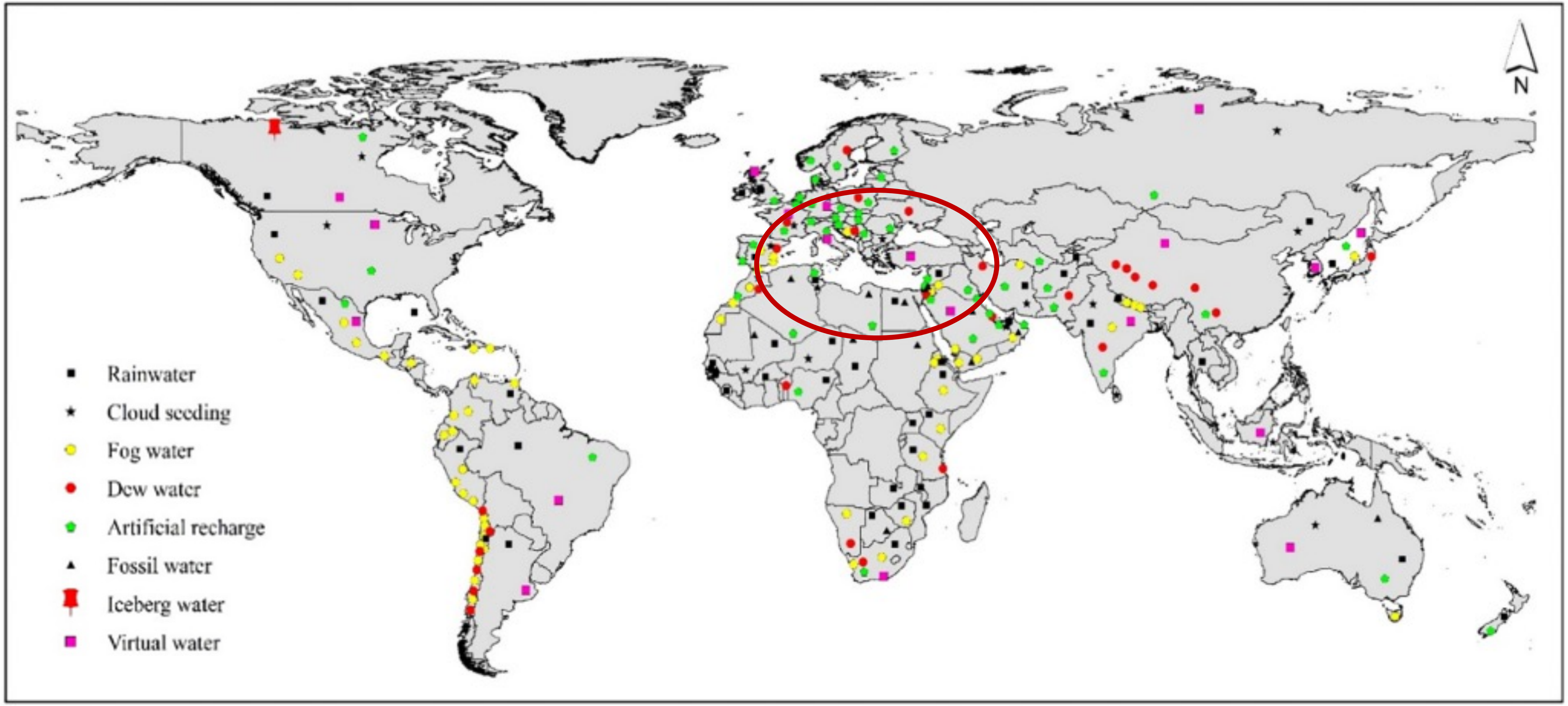

Fig. 3. Map with locations marked for artificial recharge, fossil water, iceberg melted water utilization, virtual water, fog water harvesting, dew water harvesting, rainwater harvesting and cloud seeding (extracted from the literature review presented in Table 2 and Appendix B).

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NCW use limitations

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- Some NCW have clear **geographic limitations** (fog and/or dew harvesting, iceberg or fossil water, and desalinization can only occur where the proper geographic conditions are present)

- Some NCW **overlap in their geographic distribution** (fog and dew harvesting overlap in the Pacific Coast of South America, Southern Africa, and parts of Southeast Asia

- Some are practiced only in certain contexts, and

- Managed aquifer recharge, cloud seeding, and wastewater use **demand certain legislative frameworks since their unskilled implementation may cause significant harm** to the environment, both regionally and across borders

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NCW use increasing

- There are **growing examples** of using NCW resources worldwide to boost water supplies to address water scarcity (Smakhtin et al., 2001; Qadir et al., 2007; Djuma et al., 2014).
- Despite demonstrated benefits, the **potential** of most NCW is vastly under-explored due to the lack of consolidated information on the significance of such water resources.
- There are **multiple barriers** to harnessing the potential of these water resources that need to be addressed through supportive **policies** and **institutions**, **science-based actions and tools**, and **innovative financing**.

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Project duration: 36 months 09/2022 – 08/2025

Funding: PRIMA Consortium Section 2 – 2021 Call

Total Budget: 1,274,071.00 Euro

Coordinator: UNIFI-DAGRI Prof. Elena Bresci

Countries: Italy, Algeria-Tunisia, Spain, Egypt

- Aims at providing innovative, evidence-based participatory **management solutions** to water scarcity governance that can be scaled at the Mediterranean level.

- The project will apply a transdisciplinary approach, integrating the state of the art of land, water and agronomic modelling to support evidence-based water management in **four Living Labs (LLs)** located in Mediterranean watersheds (including a transboundary case).

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Participant No *	PI name	Organisation	Country
1 **(Coordinator)**	Elena Bresci	Università degli Studi di Firenze (UNIFI)	Italy
2 **Partner 1**	Maria Cristina Rulli	Politecnico di Milano (POLIMI)	Italy
3 **Partner 2**	Luis Garrote	Universidad Politécnica de Madrid (UPM)	Spain
4 **Partner 3**	Mohamed Ouessar	Institut des Régions Arides (IRA)	Tunisia
5 **Partner 4**	Mohamed Bahnassy	Alexandria University (ALEXU)	Egypt
6 **Partner 5**	Athanasios Ragkos	Hellenic Agricultural Organization ELGO-DIMITRA, Agricultural Economics Research Institute (AGRERI)	Greece
7 **Partner 6**	Layachi Gouaidia	Université Larbi Tebessi de Tébessa (UTEBESSA)	Algeria
8 **Partner 7**	Jampel Dell'Angelo	Vrije Universiteit Amsterdam (VUA)	The Netherlands (in kind)

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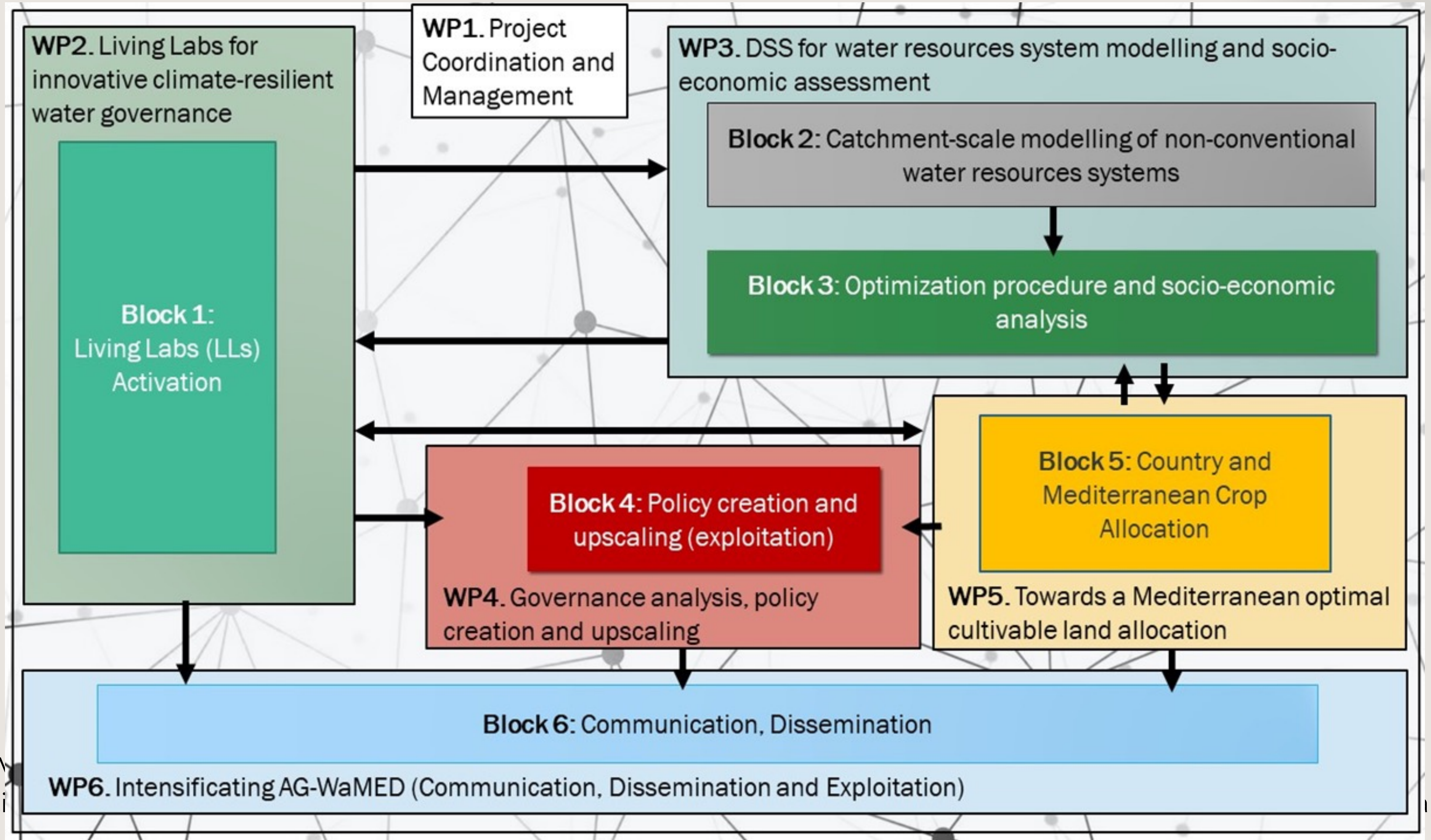
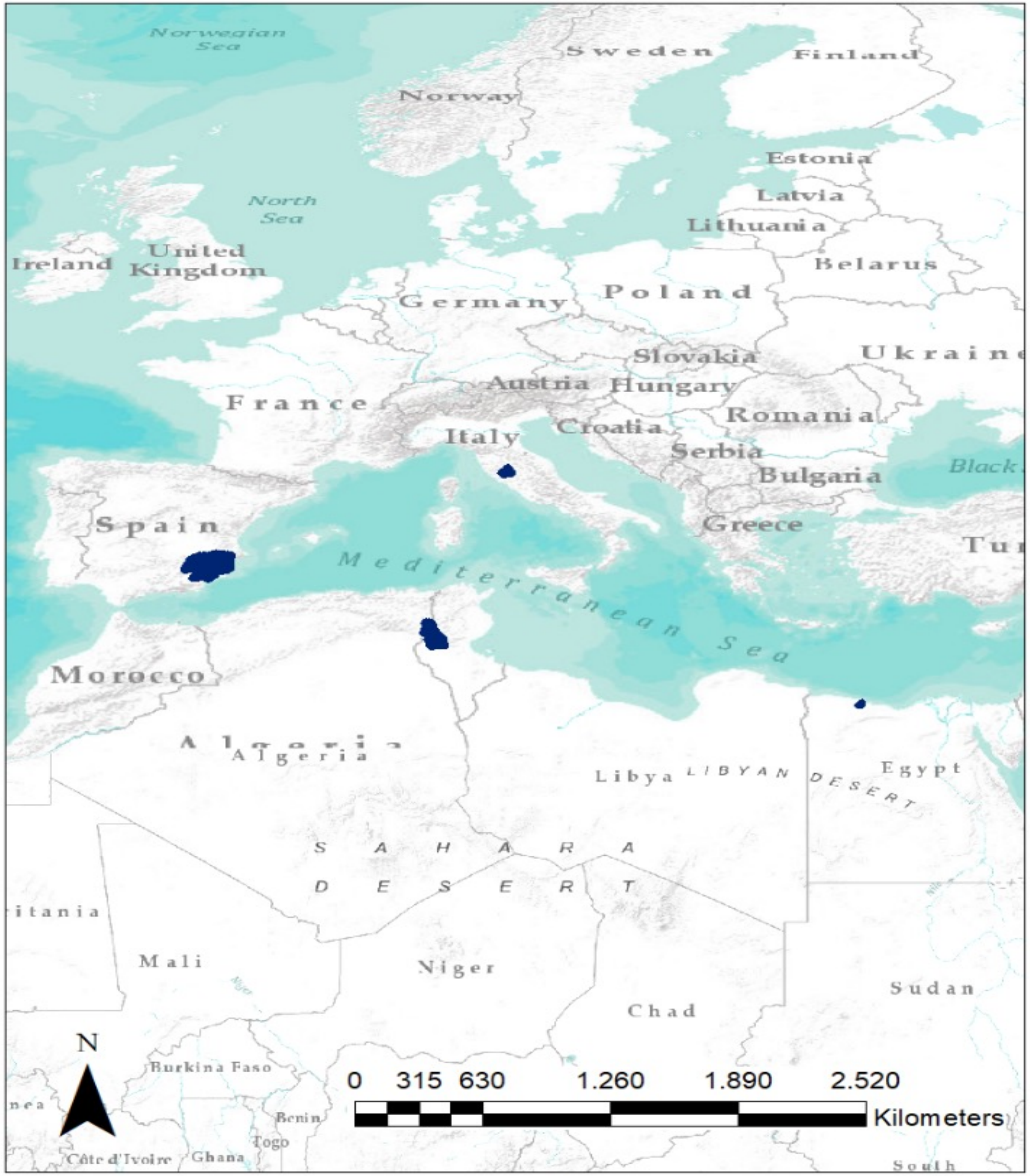
AG-WaMED methodology



T3.1 Modelling NCW at watershed scale
Task Leader POLIMI
Participants: UNIFI, UPM, IRA, ALEXU, AGRERI, UTEBESSA [M1-M32]

- **Model application for water availability analysis** with a particular attention to the contribution of NCW.
- A set of **indicators** used for deriving scenarios of optimal water allocation among crops under different environments and challenges.
- Models running for reproducing the current situations within each LLs, and then to propose sets of possible crop alternatives
- **Model results** to be discussed within the LL

LLs country	Model
Italy	SWAT
Spain	WAAPA
Tunisia	SWAT
Egypt	SWAT



Localization of AG-WaMED **Living Labs** (LLs), in the Mediterranean area

LLs country	NCW
Italy	**Managed Aquifer Recharge, Water Harvesting**
Spain	Wastewater use and Managed Aquifer Recharge
Tunisia	Managed Aquifer Recharge
Egypt	Wastewater use and desalination

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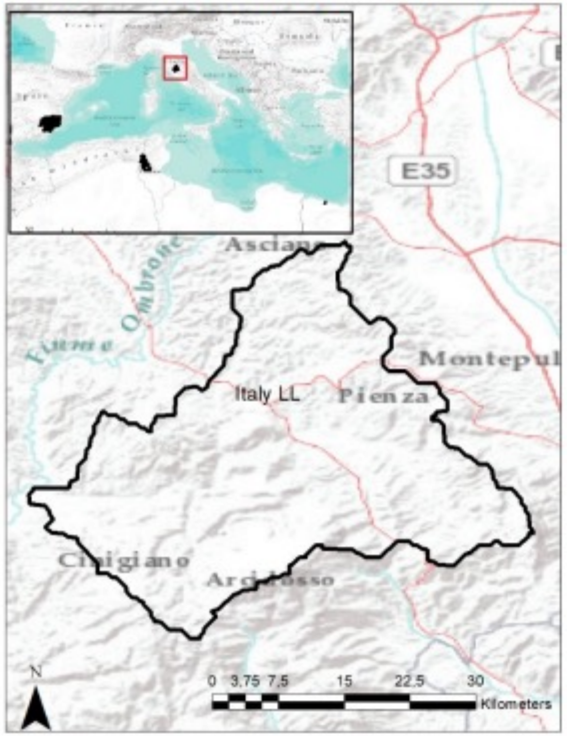
LL in Italy

LL No. 1	Country: Italy	Leader: UNIFI	Watershed: Orcia watershed



NCW technology in place	***Water harvesting (small agricultural reservoirs)***
NCW technologies to be tested	Managed Aquifer Recharge,
Watershed size (km²)	748
Precipitation (mm/y)	715
Main crops	Wheat, Grapes, Olives
Type of irrigation	Drip irrigation 96%, Sprinkler 2%, Surface 2%
Climate (Koppen Geiger)	CSa, BSh, BSk
Governance Challenges	Maximize the benefits of the high number of existing small reservoirs
Water conflicts	Use of water storage vs environmental flows

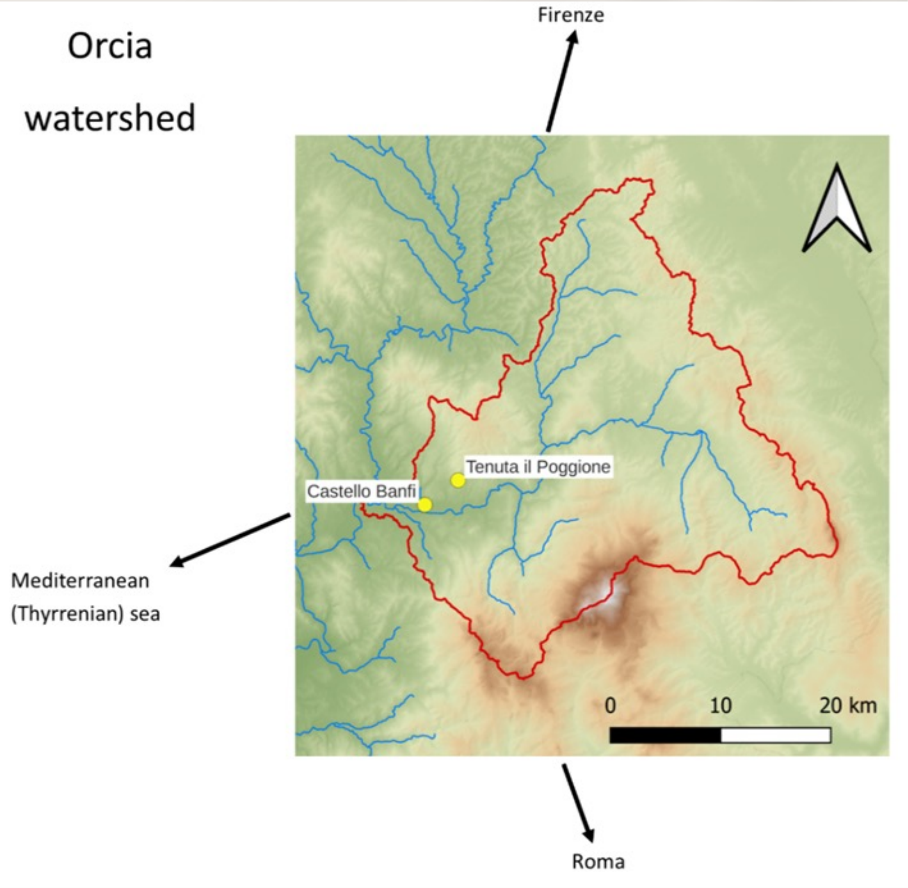
Case study description

The Orcia watershed is situated in Tuscany, Central Italy. It is morphologically characterized by a succession of hills composed of Pliocene clay, characterized by deep incisions of the courses of gullies and erosive formations typically associated with clay substrates. The soil is intensely cultivated in wide agricultural parcels characterized by simple arable land with sporadic tree crops (olive groves and vineyards) on the highest areas and near the major settlements. Winter durum wheat is considered an important quality production and is the most common type of cultivation. Wine production is also an important asset of the territory with several excellence productions. However, due to the extensive agricultural practices, the semi-natural vegetation is reduced to a few rare patches of woodland in the tributaries, to sparse herbaceous and shrub formations and to more extensive woodland coverings in the higher elevations.

NCW technology in place description	The area is mainly characterized by non-irrigated agriculture but, in the last decades, farmers resorted to emergency irrigation during summer. Only few direct abstraction points from Orcia river are present in the area while groundwater is mainly used for geothermal purposes. Therefore, a fundamental reserve of water is represented by multiple small agricultural lakes spread in the area.
Stakeholders	***Involved with support Letter (5):*** Reclamation Consortium "Toscana Sud", River Basin District Authority of Northern Apennines, CIA Toscana (farmers union), ConfAgricoltura Siena (farmers union), LaMMA (research center) ***Others:*** civil society, agricultural services providers, smart enterprises, NGOs
Model to be used	SWAT (Napoli et al. 2014)

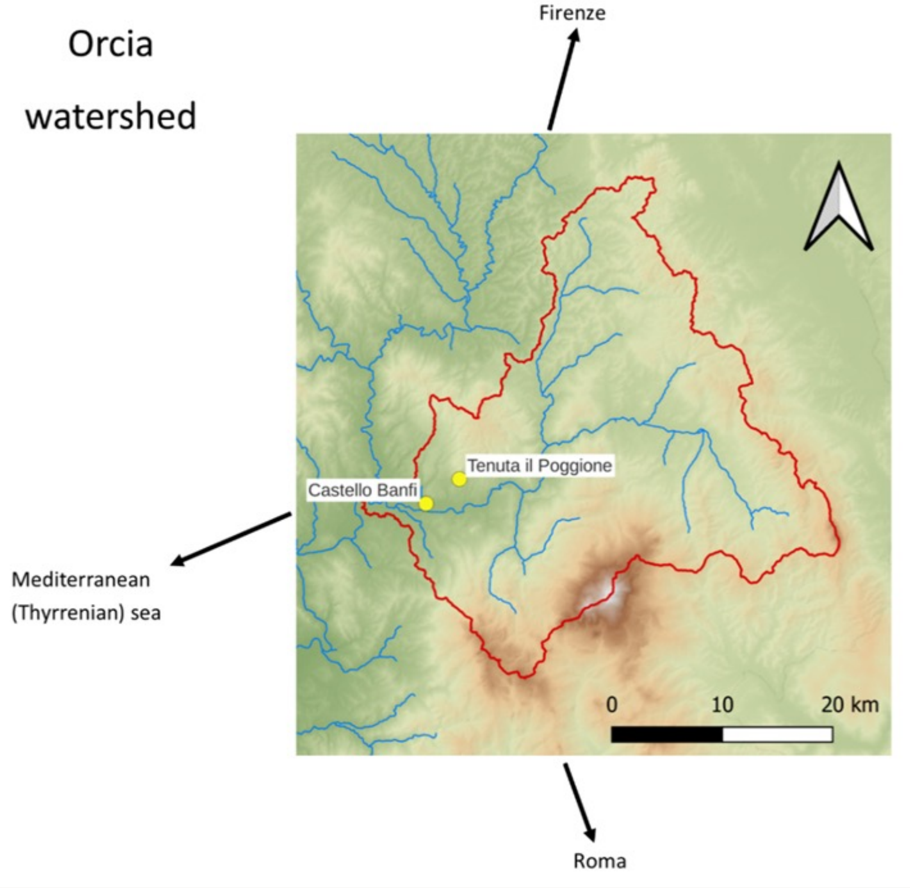
Field visit to LL in Italy 07/12/2022

Castello Banfi



- **Castello Banfi** is a winery founded in 1978 located in Montalcino (SI).
- It is 2,830 ha wide, with one third of the land being **vineyards** while the remaining part is divided between **forests, truffle production, olive groves, wheat and (susine) orchards**.
- The farm's soil is heterogeneous and well-structured.
- The winery has its own **five** water reservoirs.

Il Poggione



- **Tenuta il Poggione** was founded at the end of 1800 located in Sant'Angelo in Colle, 10 km South of Montalcino (SI).
- Its vineyards lie at an elevation ranging from 150 and 450 m a.s.l.
- it is 600 ha wide, 150 of which are dedicated to **vineyards**, 70 to **olive orchards**, and the remaining divided between cropland and woods.
- The farm has solar panels and **two water reservoirs** to increase its sustainability.

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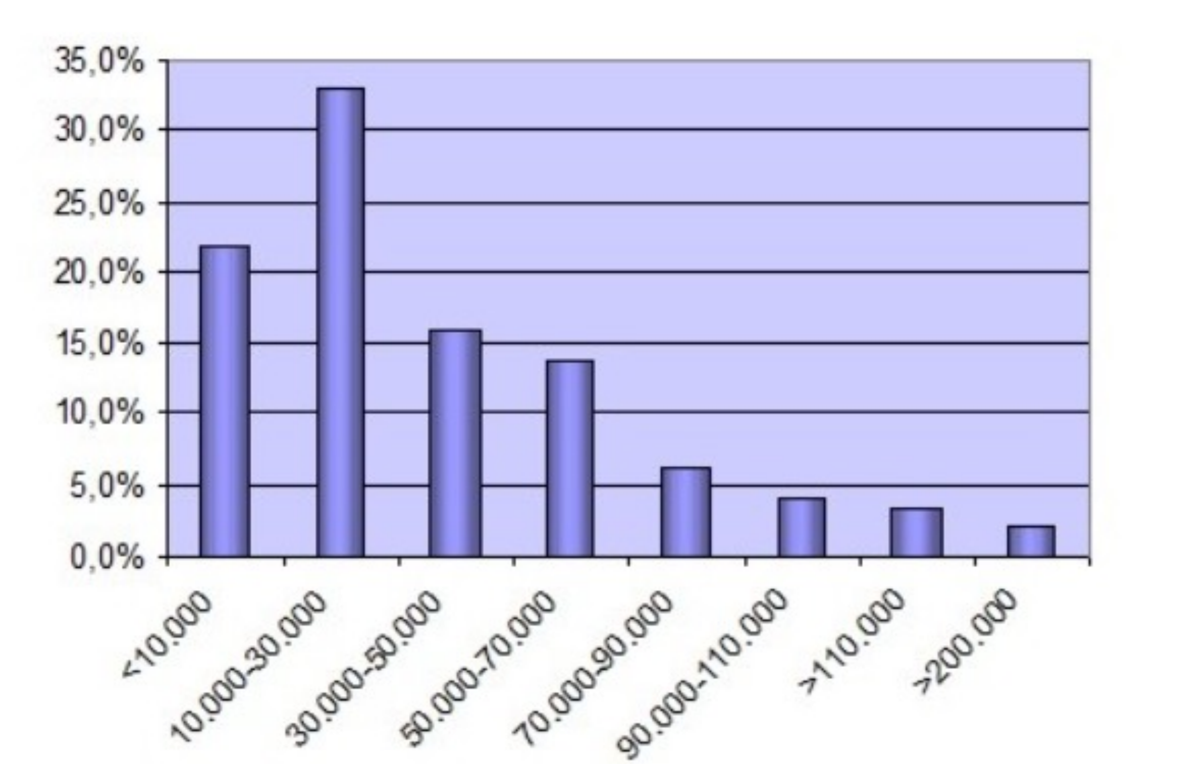
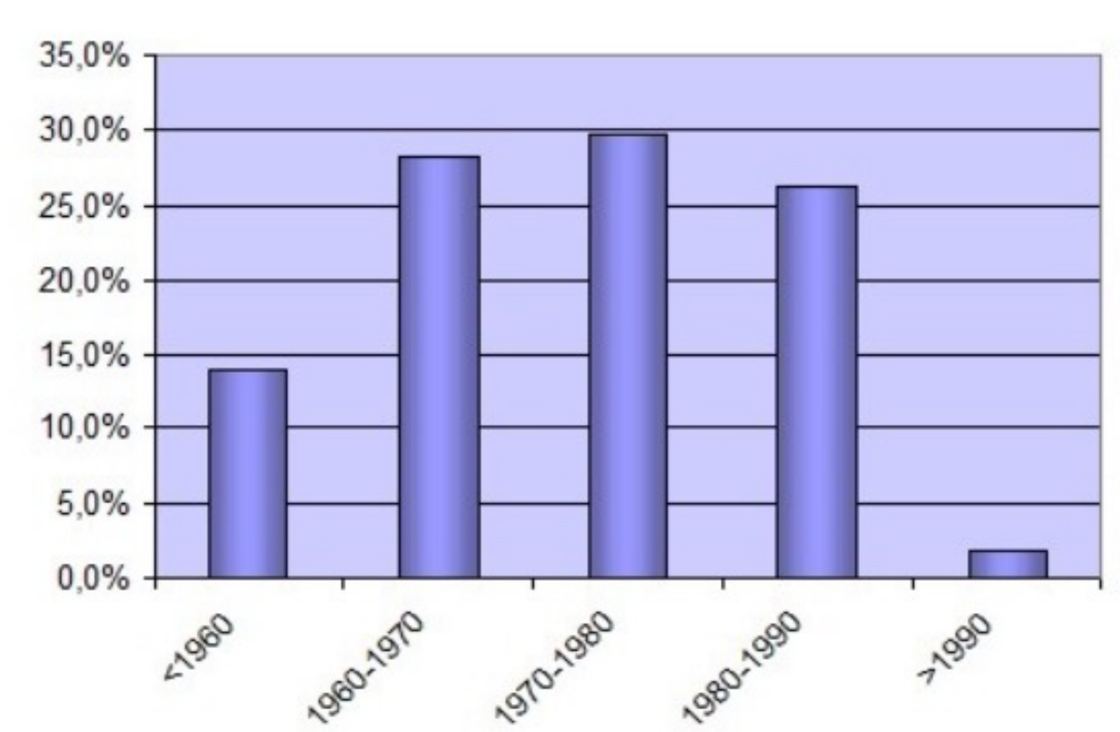
Small reservoirs in Italy (L.D. 507/1994)

H< 15 m
V< 10^6 m^3

- In the **1960s and 1970s , thousands of small reservoirs built for increasing water availability for agricultural uses**, thanks to agricultural policy offering financing
- Maintenance activities **represented a big issue for farmers**, and their restoration is not economically viable, leading to their abandonment
- In 1998: **8288 small reservoirs**
- Actual estimation: 12 000 and 14 000 (ITCOLD, 2017).

Small reservoirs in Tuscany are 2469, in the provinces of Grosseto, Arezzo, Firenze e Siena. (Lusini S., 2013)





- Mean water volumes: 20000 - 30000 m^3
- 22% with volumes < 10.000 m^3
- Totale estimated volumes 60 Mm^3 (not considering sedimentation)

Degli Innocenti E., 2022. Modellazione con HEC-HMS dell'effetto del cambiamento di uso del suolo sull'accumulo di sedimenti negli invasi collinari. Tesi di laurea.

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LL Participatory workshop 21/04/2023

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Strengths

1. Val d'Orcia plays **a fundamental role for agriculture and tourism** with high quality products
2. Farmers **are aware of climate change** and are starting implementing adaptation measures
3. Farmers are **willing to collaborate** with research and institutions to experiment soil and water conservation techniques and water harvesting
4. Farmers are organized **in associations to exchange knowledge and share resources**
5. **Water management institutions** are present and collaborate with farmers

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LL Participatory workshop 21/04/2023

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Weaknesses

1. **Complex regulation** to build and restore existing irrigation ponds
2. Water reservoirs management has been **neglected for almost 40 years**
3. Restoring water reservoirs is very expensive
4. **No existing policies on common irrigation**
5. Groundwater monitoring should be improved
6. **Small farms might not have the financial resources** and space to create new reservoirs
7. Need to increase water availability in the area
8. **Difficulties in siting** new water structures
9. New concession are often refused while existing ones are renewed
10. Lack of long-term planning

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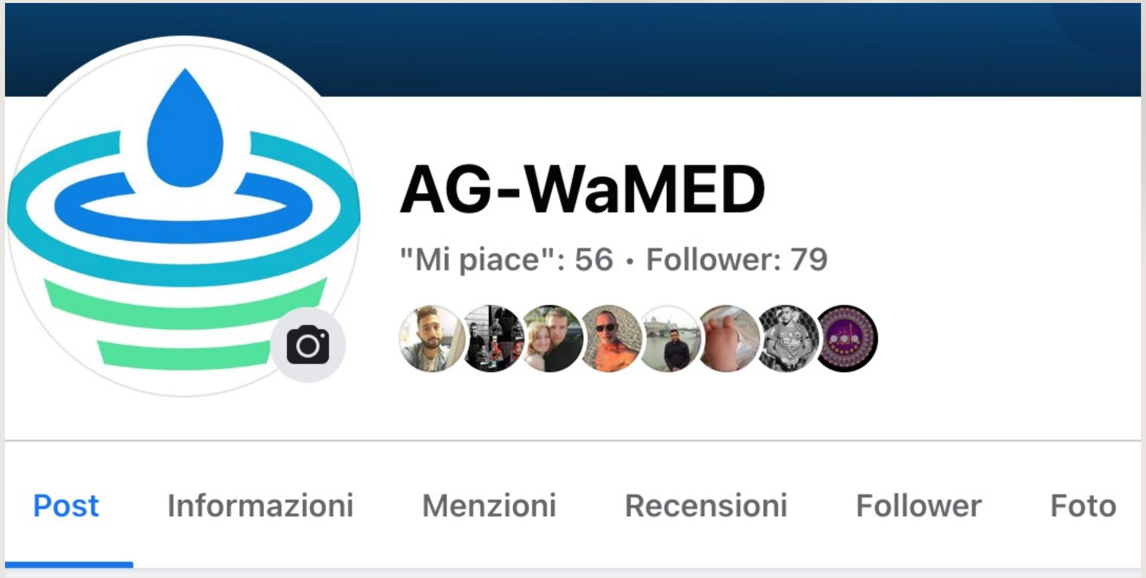

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