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FLOWERED

H2020

Italian Chapter

CONSIGLIO NAZIONALE DEI GEOLOGI

Acquiferaonlus

COMUNE DI FIRENZE

REGIONE TOSCANA

1° Workshop su:

Uso delle risorse idriche sotterranee in periodi siccitosi. Esperienze dalla Toscana al resto del mondo.

Alla ricerca dell'acqua in Africa: esperienze scientifiche di cooperazione

Proff.i Stefania Da Pelo e Giorgio Ghiglieri

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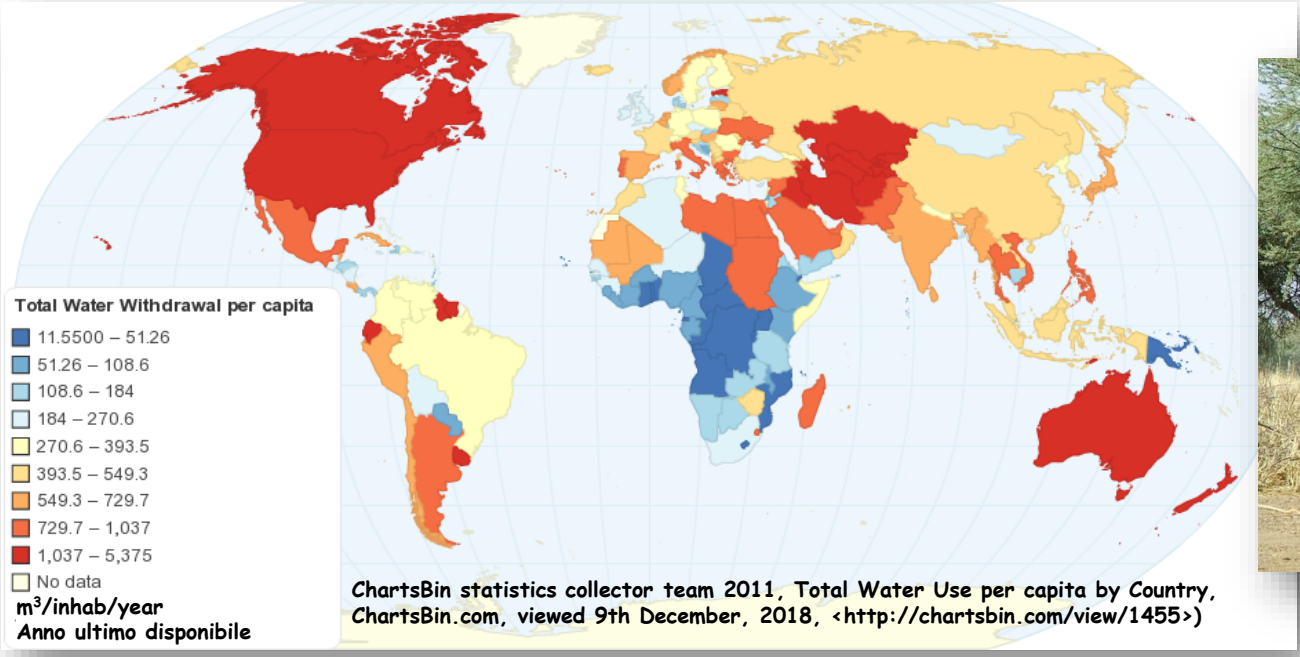
IL CONSUMO D'ACQUA NEI PAESI INDUSTRIALIZZATI E'ALMENO 6 VOLTE MAGGIORE RISPETTO A QUELLO DEL TERZO MONDO

Total water withdrawal per capita (Fonte FAO)

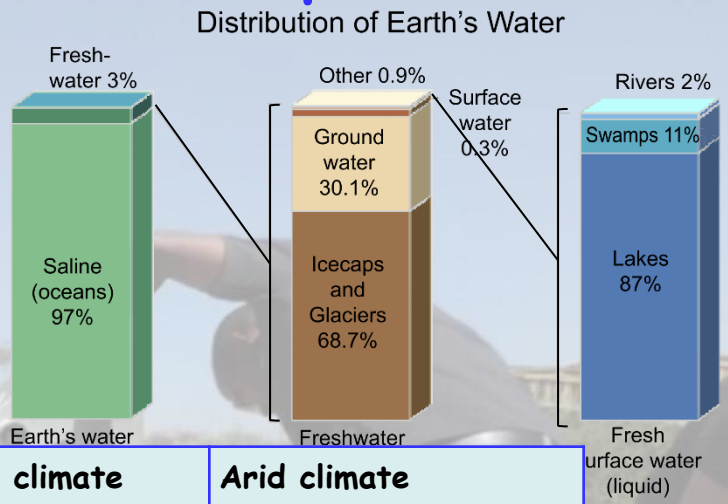
Continent	n. of countries	Mean	Min	Max
		L/inhab/day		
Africa	54	512	31	2638
Americas	36	1616	213	5896
Asia	48	2162	47	15762
Europe	46	1159	208	3589
Oceania	16	1825	279	3211



ChartsBin statistics collector team 2011, Total Water Use per capita by Country, ChartsBin.com, viewed 9th December, 2018, <http://chartsbin.com/view/1455>)

Da cosa dipende la scarsità d'acqua?

- Meno del 3% delle acque terrestri sono acque dolci
- Disponibilità della risorsa non equamente distribuita (contesto climatico, geologico e idrogeologico)



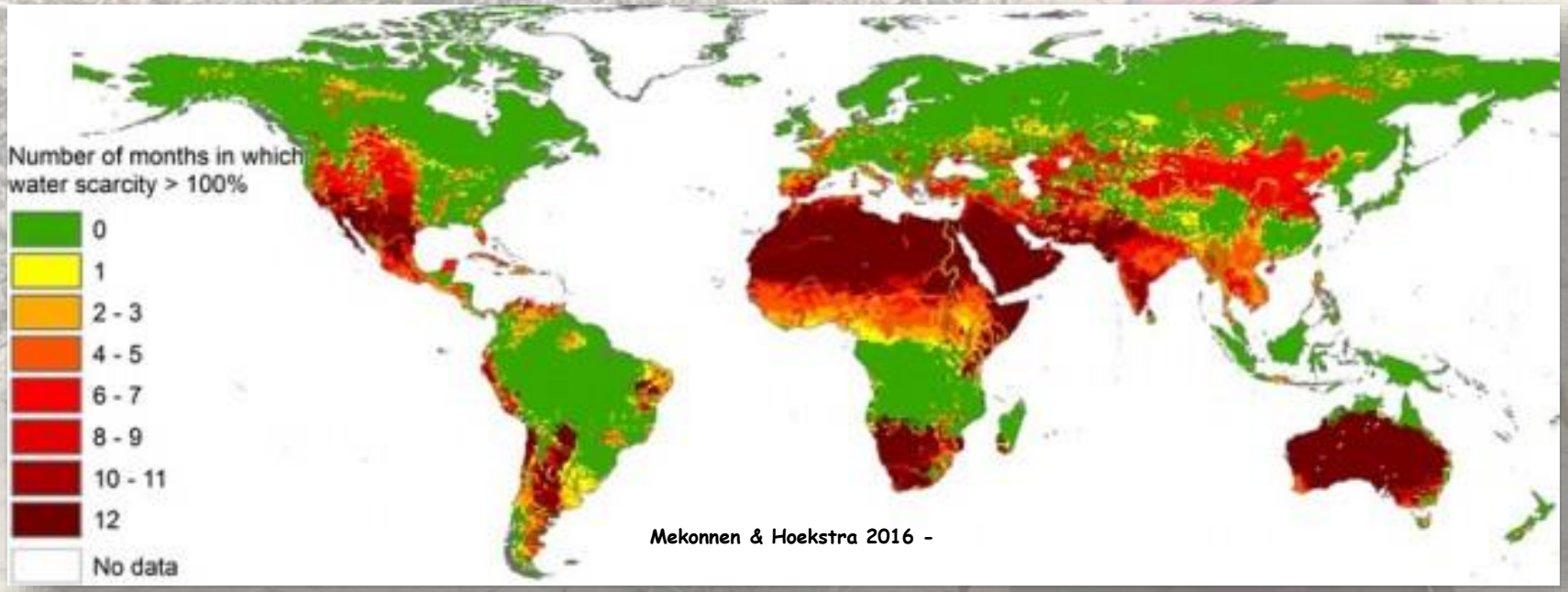
	Temperate climate		Semi-arid climate		Arid climate	
	%	mm	%	mm	%	mm
Total precipitation	100	500–1,500	100	200–500	100	0–200
Evaporation /Evapotranspiration	~ 33	160–500	~ 50	100–250	~ 70	0–140
Groundwater recharge	~ 33	160–500	~ 20	40–100	~ 1	0–2

Source: UNESCO: The United Nations World Water Development Report 2

- Rinnovabilità della risorsa (acque superficiali, sotterranee)
- Crescita della domanda (popolazione in continuo aumento e modifica degli stili di vita)
- Processi antropici di degradazione della risorsa
- Naturale qualità della risorsa
- Non corrispondenza temporale fra la domanda e la disponibilità della risorsa

Almeno il 44% della popolazione dell'Africa Sub-Sahariana (circa 320 milioni di persone) non hanno accesso ad acqua di accettabile qualità (JMP, 2004; MacDonald et al., 2008).

Circa l'85% di questi vivono nelle aree rurali dove povertà,scarsa qualità della vita e malattie interessano soprattutto donne e bambini (JMP, 2004; MacDonald et al., 2008).



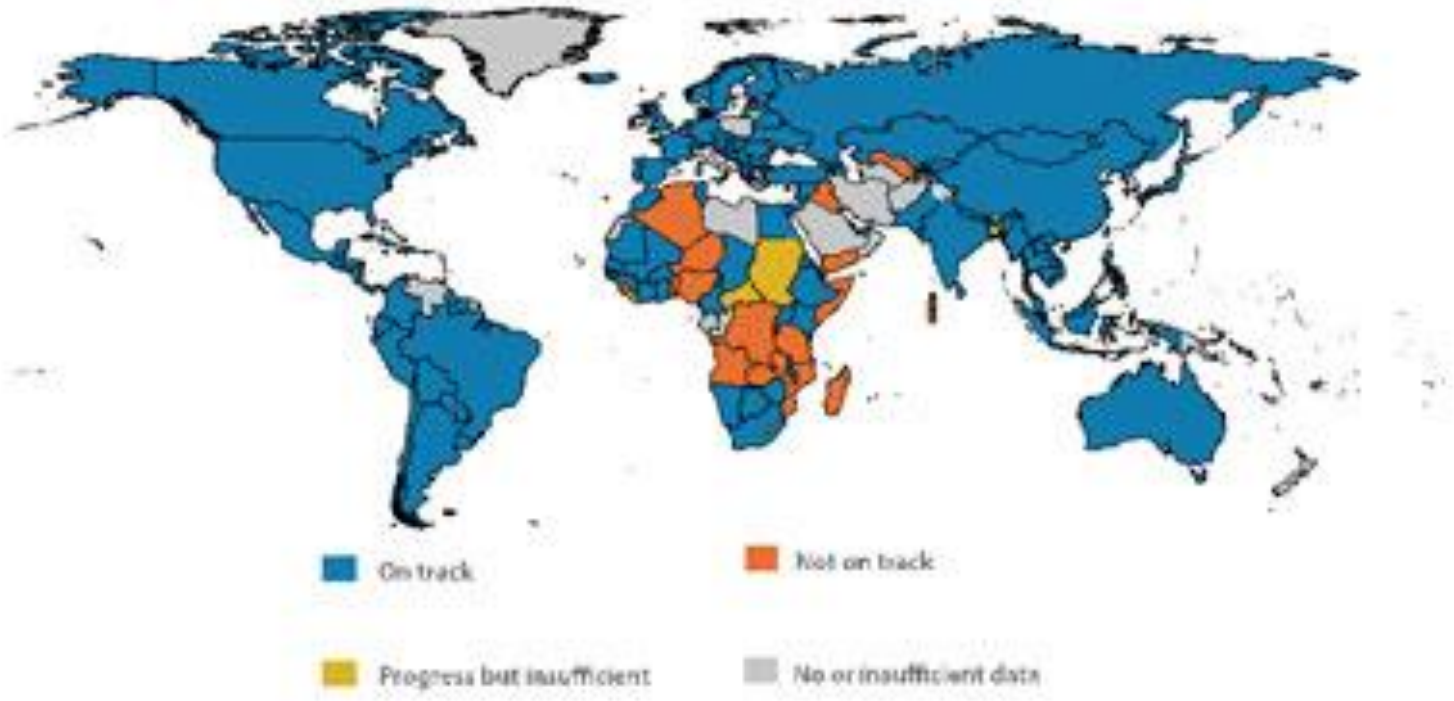
Millennium Development Goals (MDGs)

impegnano i paesi facenti capo alle Nazioni Unite a dimezzare la percentuale di persone che non sono in grado di raggiungere, o permettersi, acqua potabile sicura entro l'anno 2015 (Nazioni Unite, 2000).

2005-2015

Decennio internazionale per l'azione "**Water for Life**" il cui obiettivo è riuscire a fornire almeno 20 L/giorno/abit alle popolazioni delle aree che non ne hanno accesso

Some progress for drinking water:
If the current trend continues, sub-Saharan Africa will not reach MDG water target



Progress towards the MDG drinking water target, 2006
UNICEF/WHO JMP '08

United Nations Educational, Scientific and Cultural Organization

WorldWater

UN WATER

Perché le acque sotterranee?

In gran parte dell'Africa, le acque sotterranee rappresentano l'unica opzione realistica di approvvigionamento idrico per soddisfare la domanda dei villaggi rurali dispersi.

- Le risorse idriche alternative possono essere inaffidabili e difficili o costose da sviluppare: le acque superficiali sono soggette a contaminazione, spesso stagionale, e devono essere convogliate verso il punto di prelievo;
- la raccolta dell'acqua piovana è costosa e richiede buone precipitazioni durante tutto l'anno.
- Le risorse idriche sotterranee (RIS) sono spesso resistenti alla siccità.
- Le RIS sono naturalmente più protette dalla contaminazione che non quelle superficiali
- Le RIS possono generalmente essere trovate vicino al punto di domanda (necessaria conoscenza e competenza adeguata).

Conoscenze inadeguate e dati non facilmente disponibili Lacune critiche (di ricerca)

Spesso, molti progetti di approvvigionamento idrico rurale sono visti solo in termini di problemi di ingegneria: ad es. perforazione, installazione di pompe, serbatoi e rubinetti. Soffrono invece della mancanza di input idrogeologici adeguati (Davies, 2008).

Consapevolezza dei rischi inerenti allo sfruttamento intensivo delle RIS senza un approccio scientifico e una gestione sostenibile delle stesse (Davies, 2008).

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de - FLuoridation technologies for imprOving quality of WatEr and agRo - animal products along the East African Rift Valley in the context of aDaptation to climate change *(Grant agreement no. 690378 -Topic: WATER-5c-2015 Type of action: RIA)*

An interdisciplinary approach for groundwater management in areas contaminated by fluoride in East African Rift System

S. Da Pelo*, *M.T. Melis, Dessì F., Pistis M., Soler Gil A., Barbieri M., Pittalis D., Biddau R. Cidu R., Haile T., Azagegn T., Abebe B., Tesfaw B., La Mantia C., Loddo P., Deflorio A.M., Ucakunwu E., Conti P., Guastaldi E., Colonna T., Funedda A., Oggiano O., Carletti A., &* ***Ghiglieri G.***

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HORIZON 2020

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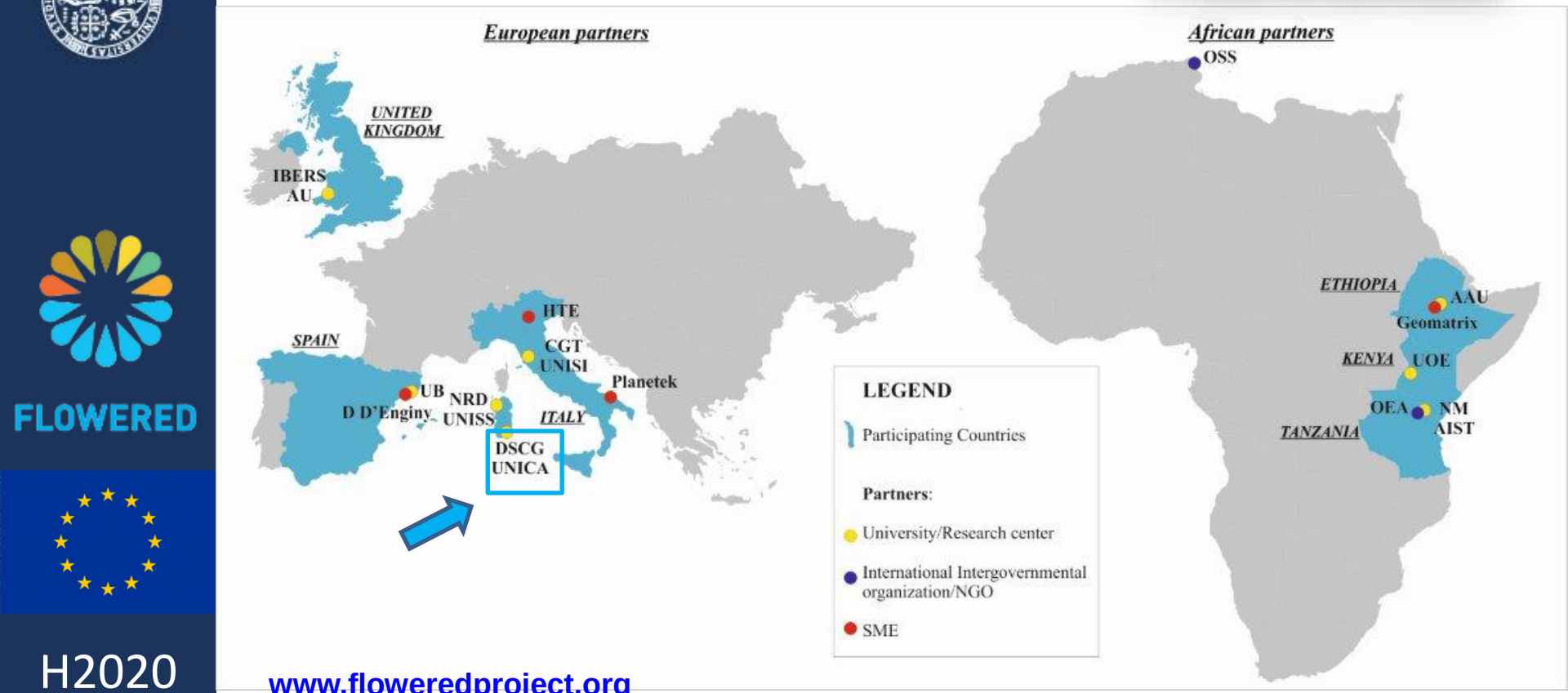
Consortium as a whole

Project Coordination → UNICA

Giorgio Ghiglieri



www.floweredproject.org

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EXCELLENCE

The overall objective of the project is to contribute to the development of a sustainable water management system in areas affected by fluoride contamination in water, soils and food with the aim of improving the living standards of local population.

FLOWERED addresses environmental and health (human and animal) issues related to the fluoride contamination in the **African Rift Valley**. ***It will improve the current scientific knowledge on the presence of fluoride in surface water and groundwater as a consequence of water-rock interaction processes, and on its impact on soils and agro-animals products (food security)***. The project will also investigate the relationships between fluoride contamination of irrigation water and agricultural soils and animal health.

Call “WATER-5-2014/2015: strengthening international R&I cooperation in the field of water”, namely to the topic “WATER 5c) [2015] Development of water supply and sanitation technology, systems and tools, and/or methodologies”.

APPROACH

FLOWERED has a **strong interdisciplinary research approach**
During 36 months, FLOWERED will be developped according to seven Work Packages (WPs)

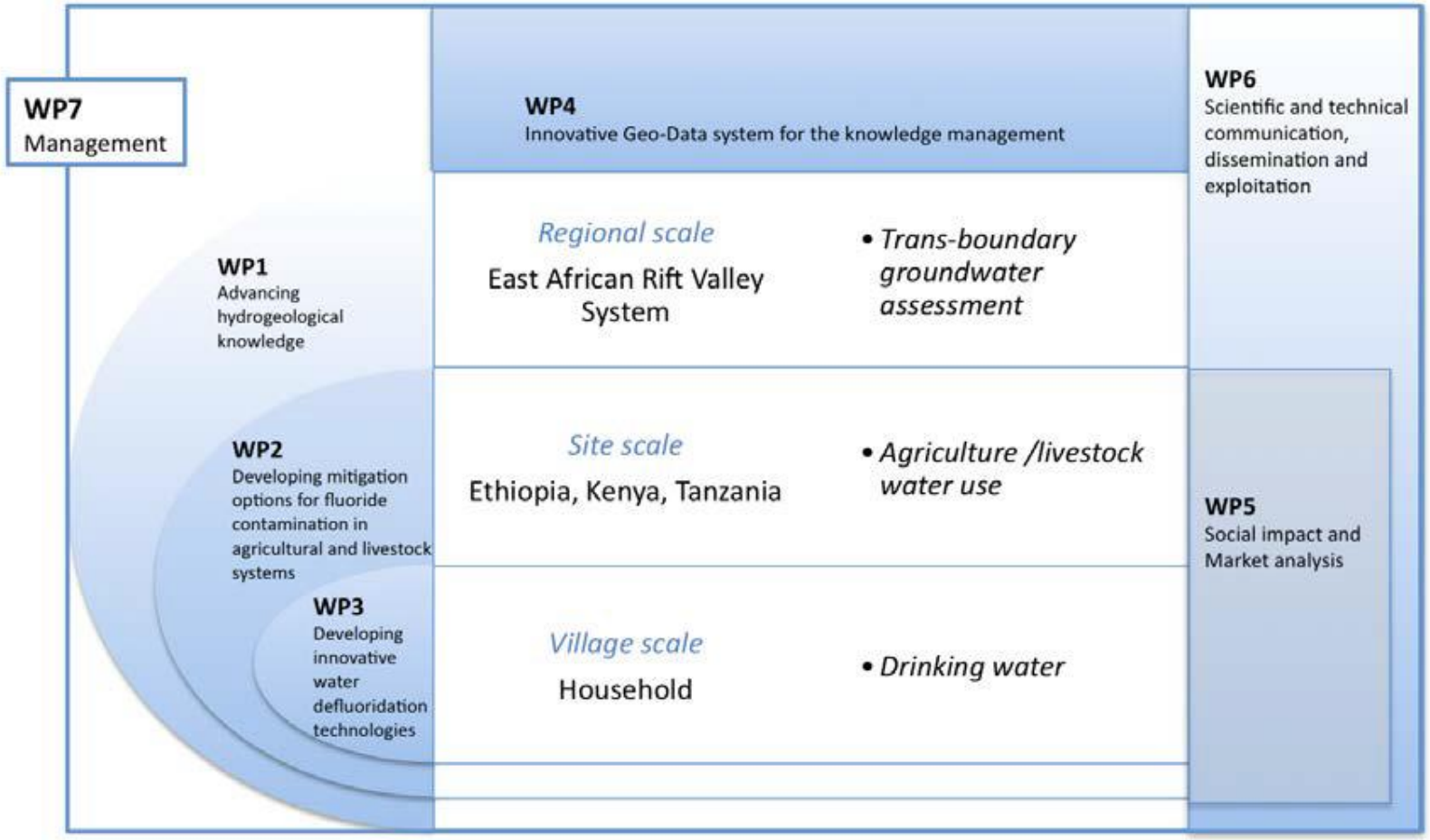

Figure 1.2 FLOWERED is organized in three main activities (WP1, WP2, WP3) supported by a detailed, innovative and shared Geo-data system for the knowledge management (WP4). Specific actions will be dedicated to the market analysis (WP5). The activities of communication, dissemination and exploitation (WP6) will attend the whole project from the beginning as well as those of coordination and management (WP7) that will be organized to guarantee the high scientific and innovative level of the results.

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METHODOLOGY

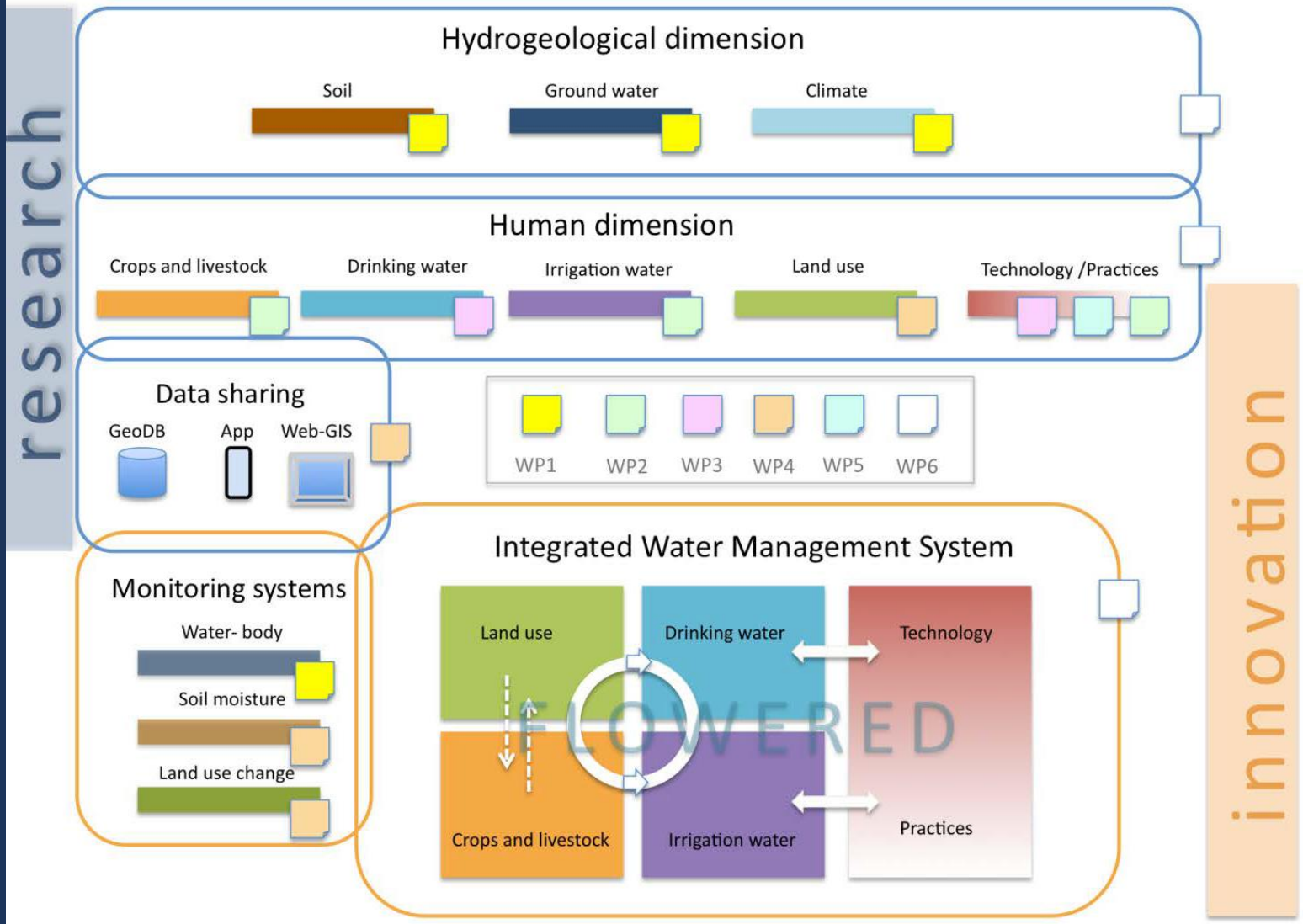

Figure 1.3 FLOWERED **methodology** is planned to answer to the need to achieve an Integrated Water Management System based on the deep knowledge of the natural and human dimension of the study areas: research (blu boxes) and innovation (orange boxes) activities are overlapped to demonstrate the relationship between them.

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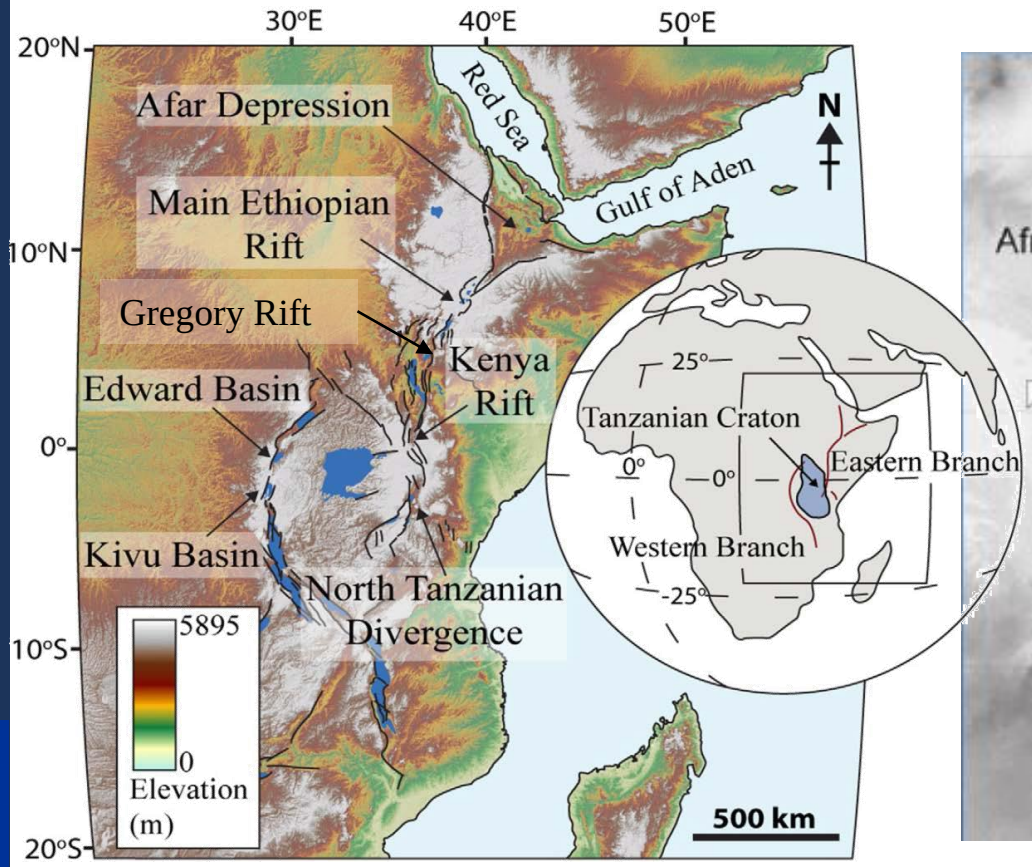
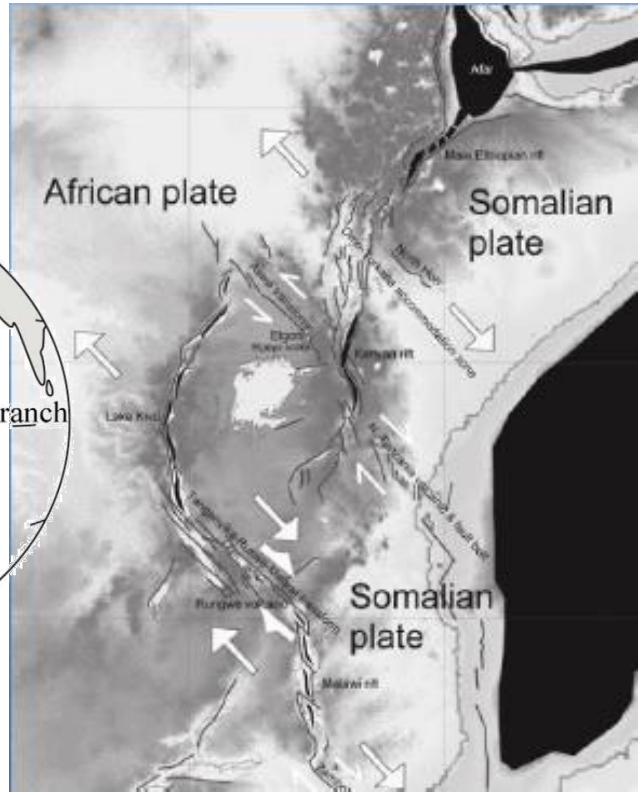
FRAMEWORK

The EARS is a complex network of grabens splitable into two main branches Western and eastern respectively with the Gregory rift in the middle. Some transfer faults shift the two branches

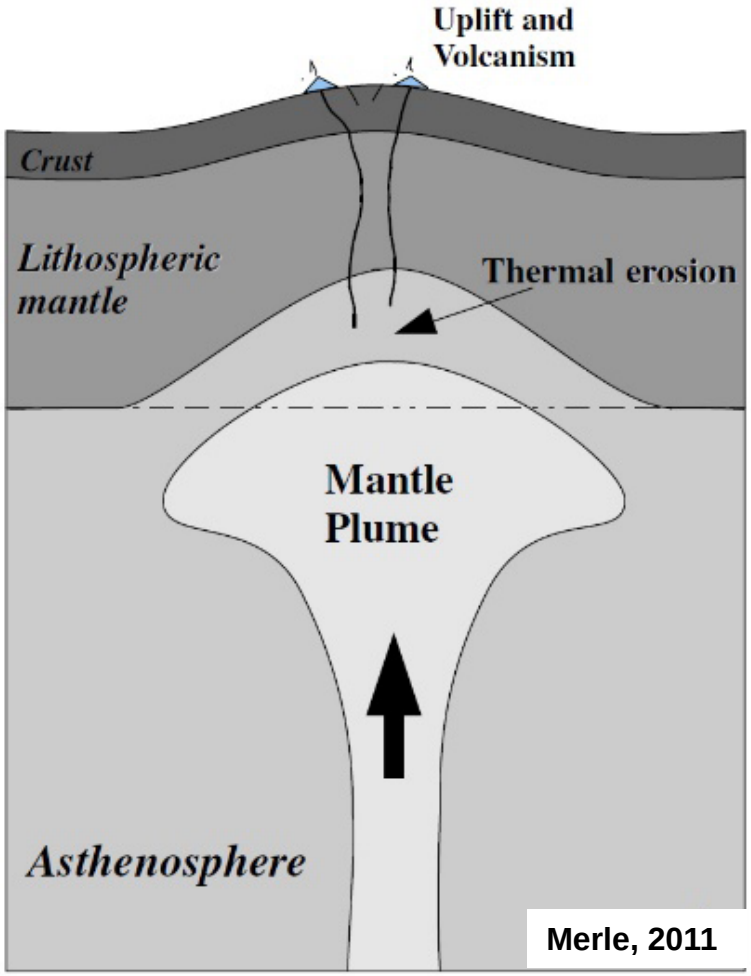




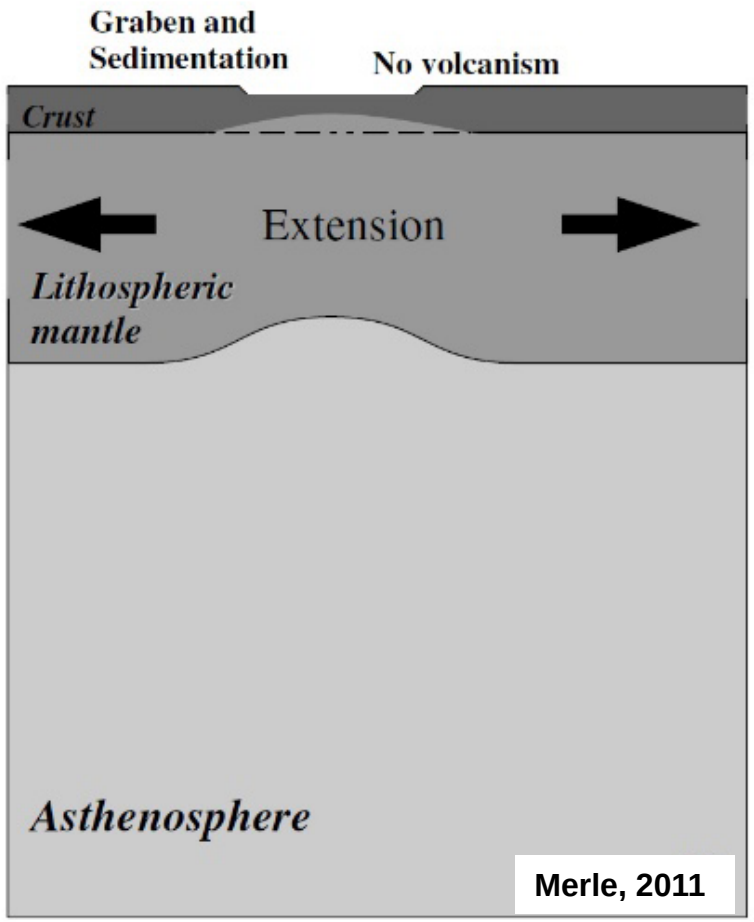
Muirhead et al., 2015

FRAMEWORK

The EARS can be ascribed to the “mantle activated” rifts type. The mantle upwelling from plume causes thermal erosion of the lower lithosphere and its bulging. The collapse of the bulge generates extension.



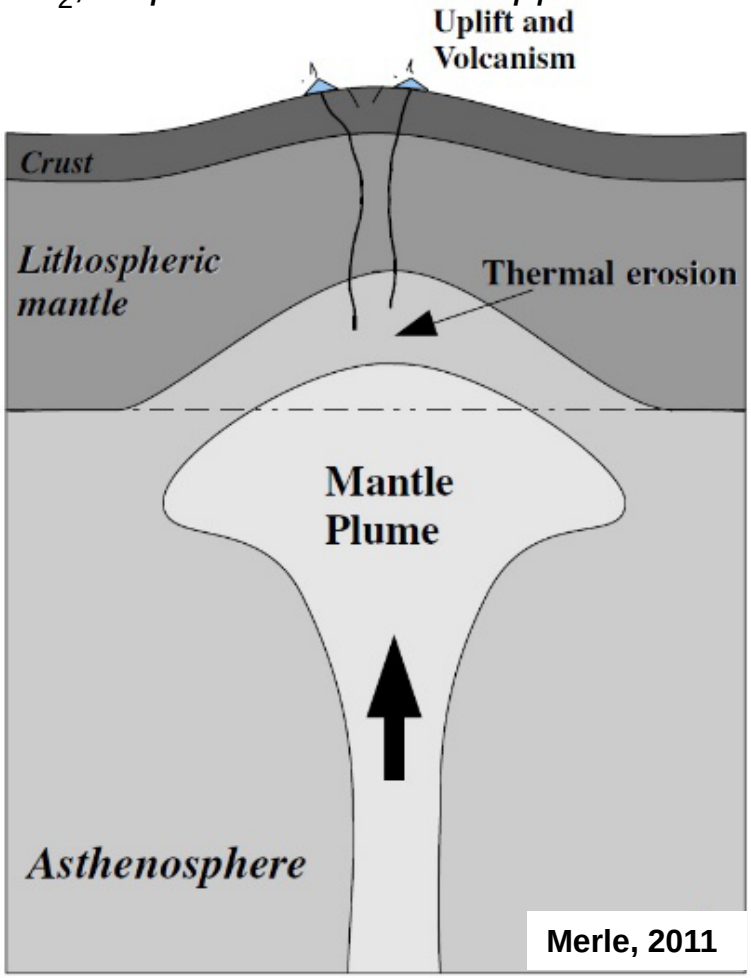
“Mantle activated” or Active Rift



Passive Rift

FRAMEWORK

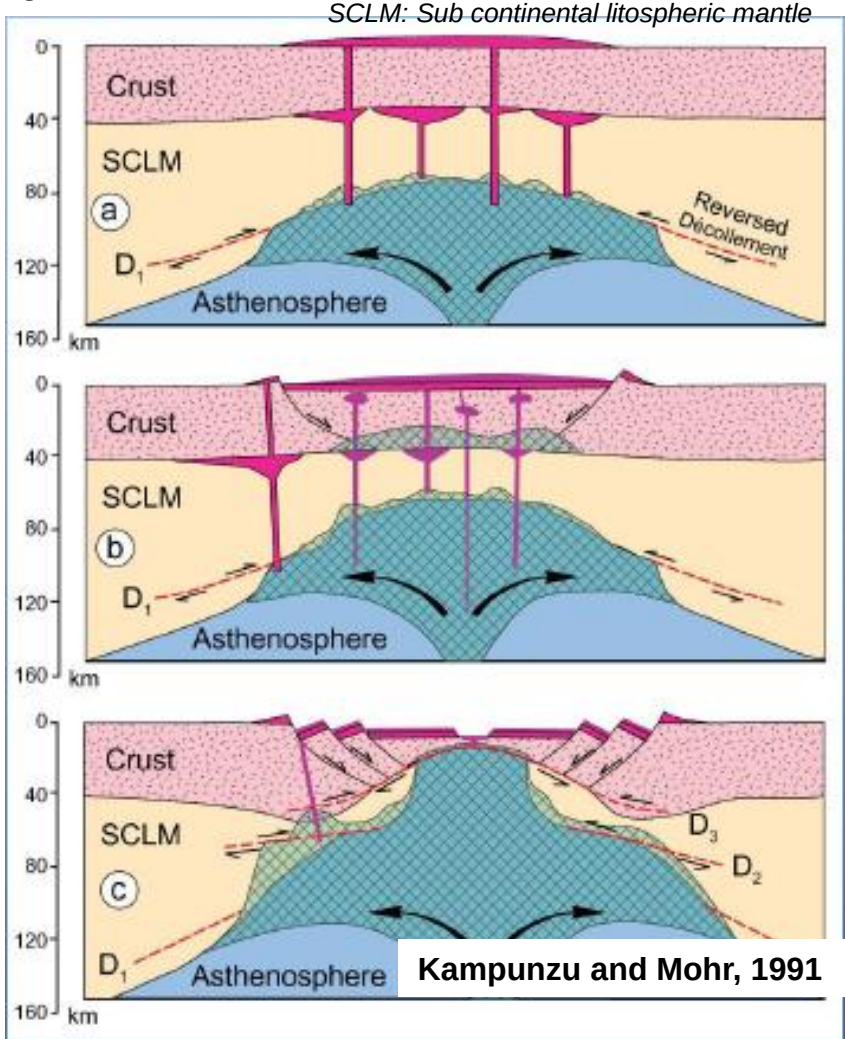
A huge amount of alkalic to transitional basalt pre-date the onset of the rift system across the Ethiopian dome. In the Gregory rift composite volcanoes erupted phonolite to natrocarbonatite magmas after the rift opening. Alkaline rocks are deficient in SiO_2 with respect to Na_2O, K_2O, and when they become "critically undersaturated" in SiO_2, *Nepheline or Acmite appears in the norm*



Merle, 2011

"Mantle activated" or Active Rift

SCLM: Sub continental litospheric mantle



Kampunzu and Mohr, 1991

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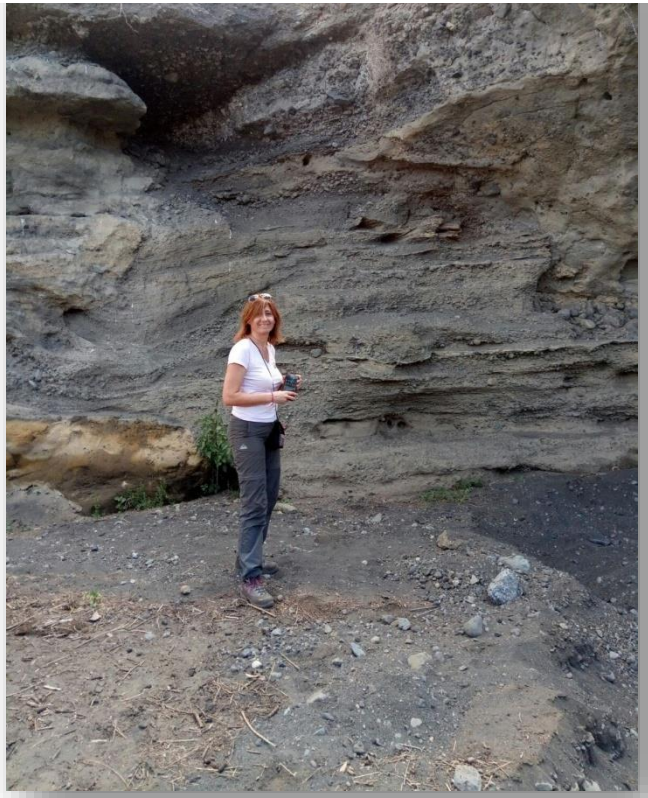
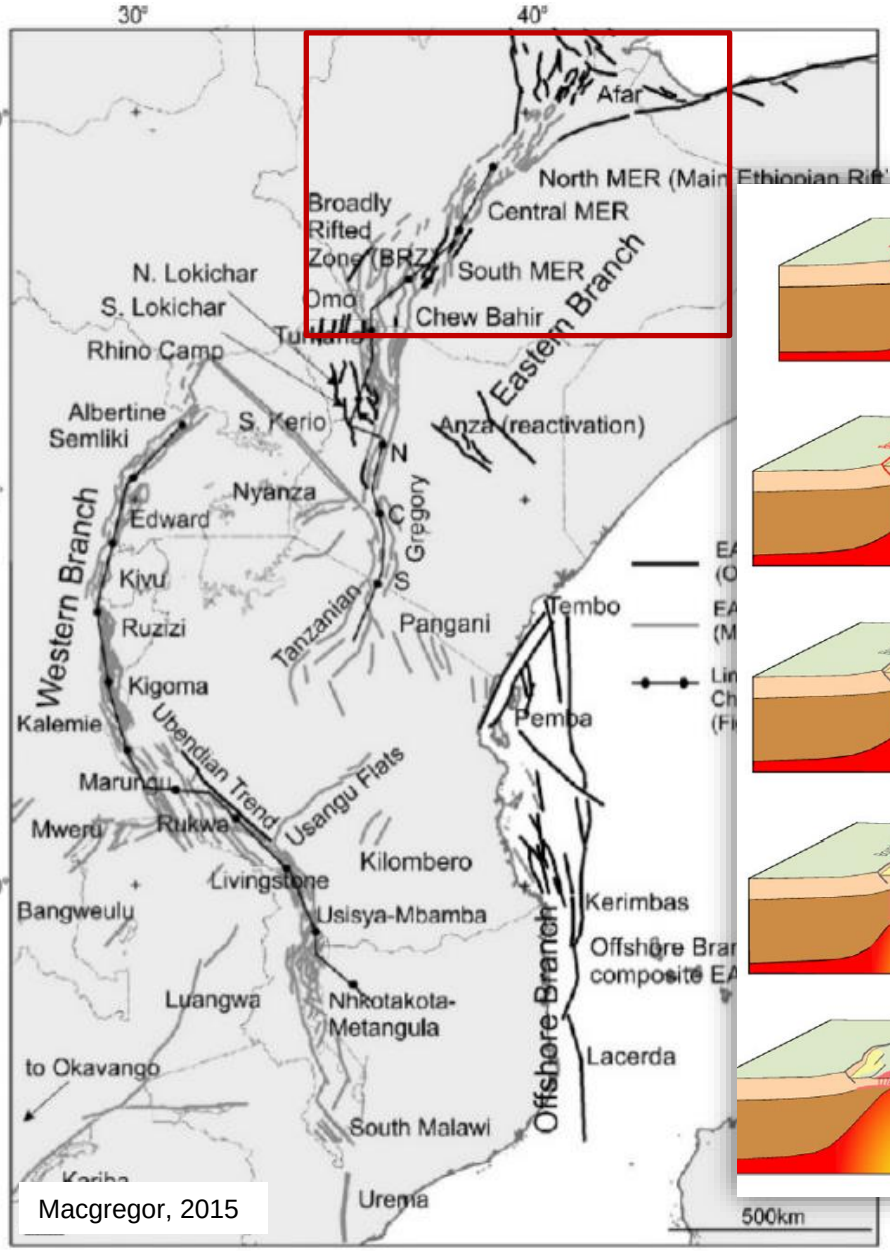
FRAMEWORK

Ash fall deposits are susceptible of easy weathering and consequent leaching of anions including fluorides. The high pH and the wormer condition enhance the precipitation of calcite at the base of the soil profile, where calcrete and ooidal cooncretion are common. In this way the saturation in fluorspar and sequestration of fluorine is prevented for the lack of Ca^{2+} in the water.

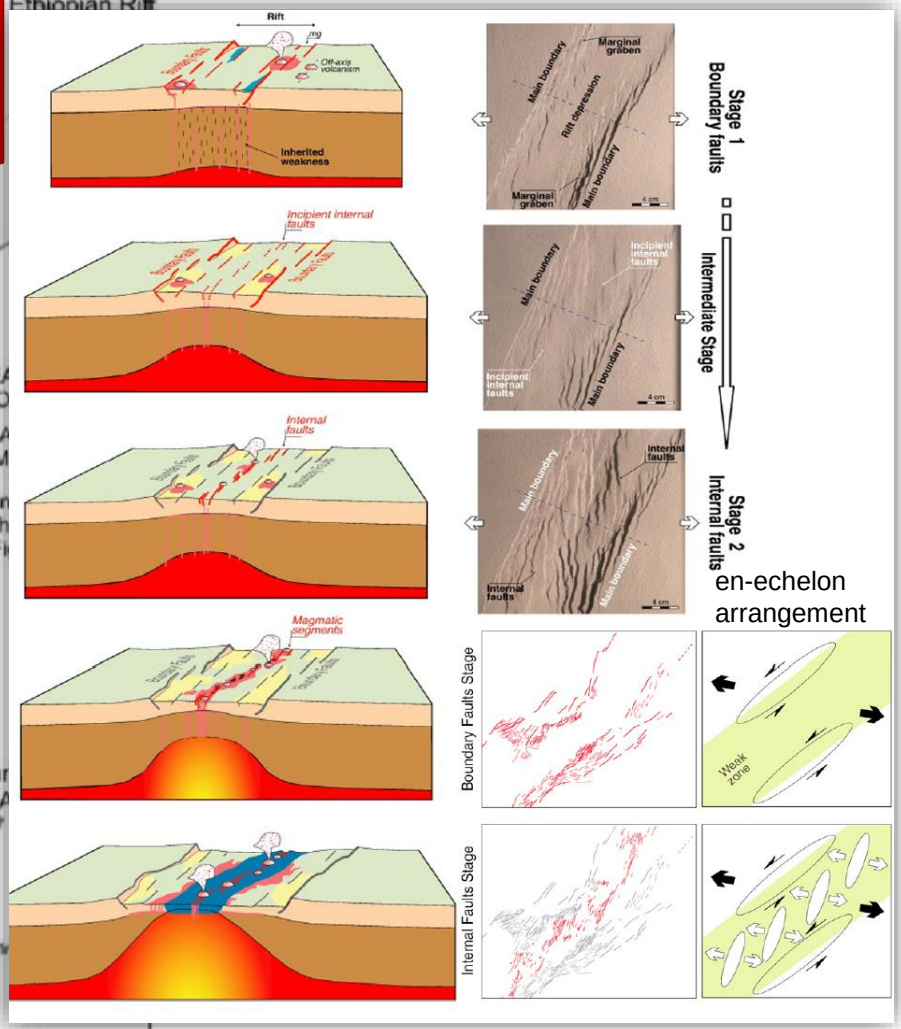


FRAMEWORK

To the north, the Gregory rift joins the Ethiopian rift, which extends into the Afar Triangle



Macgregor, 2015



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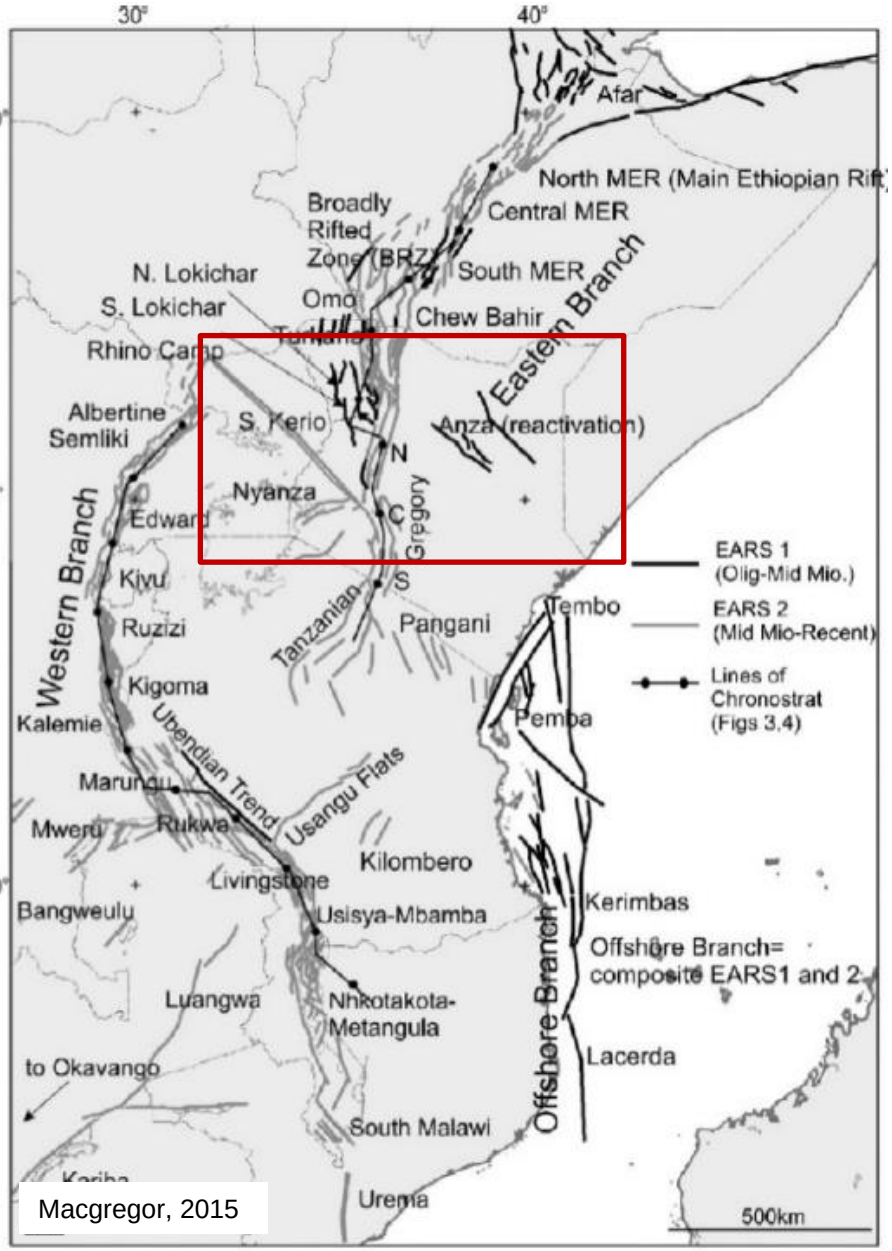
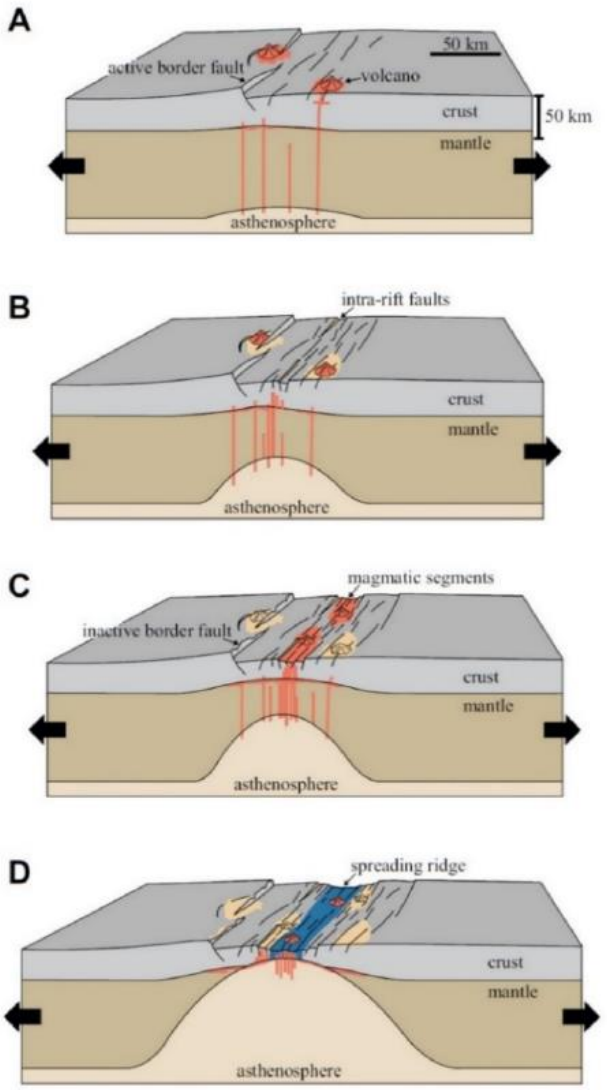
FRAMEWORK



Macgregor, 2015

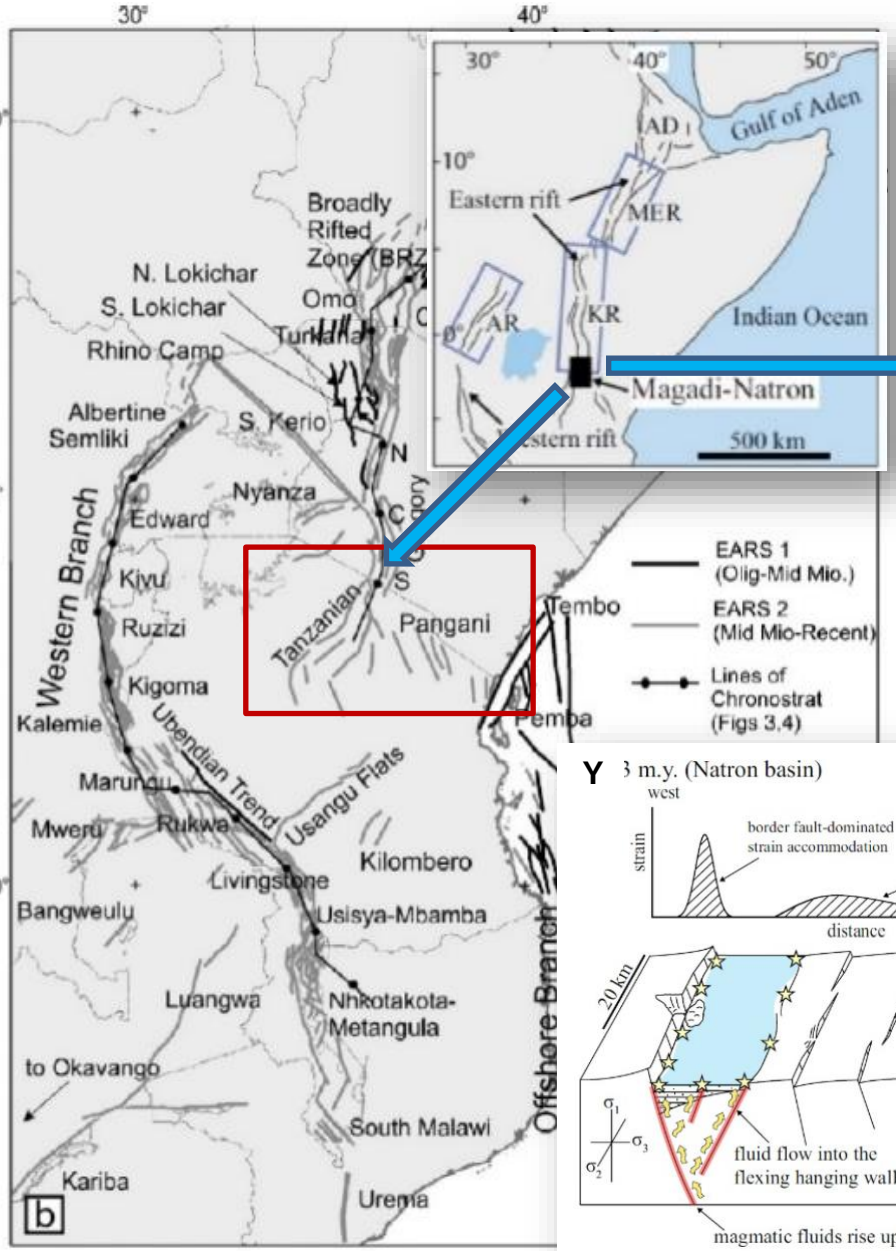
The Gregory rift in the Kenyan zone is a typical hortogonal rift



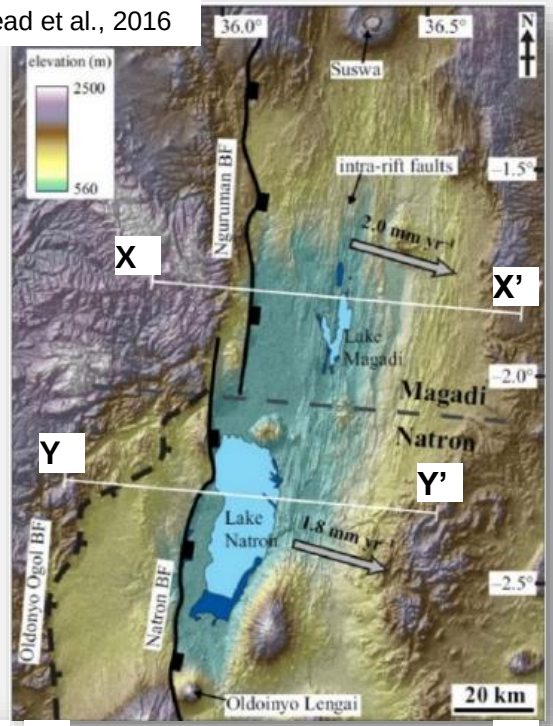
Muirhead et al., 2016

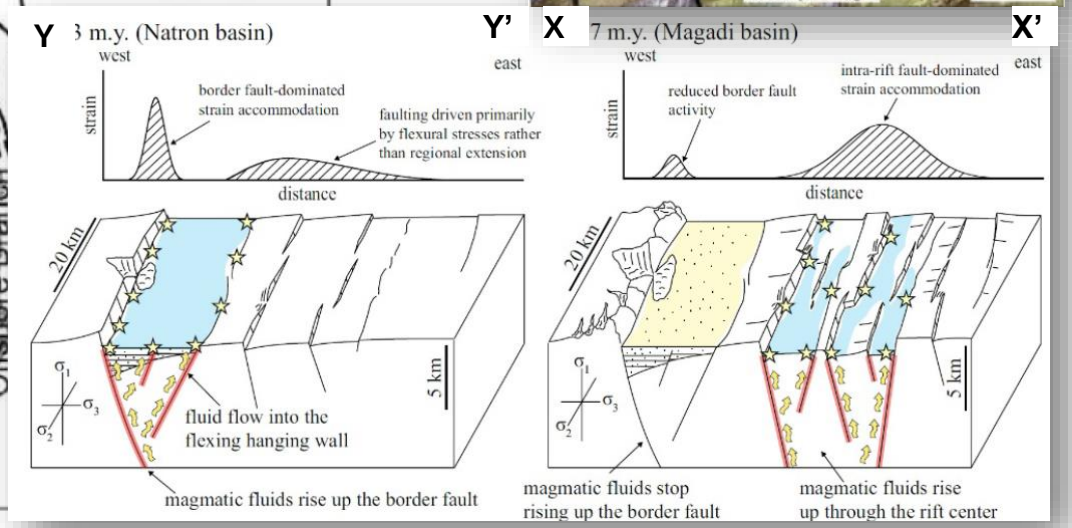
FRAMEWORK

To the south, the Gregory rift fans out in the Tanzanian divergence



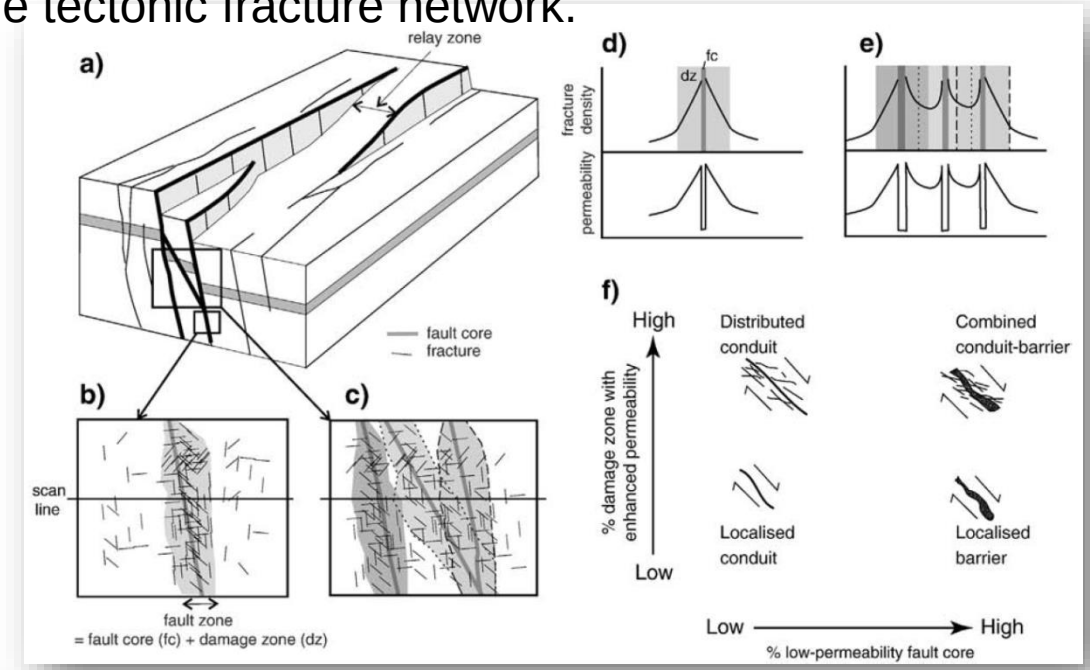
Muirhead et al., 2016



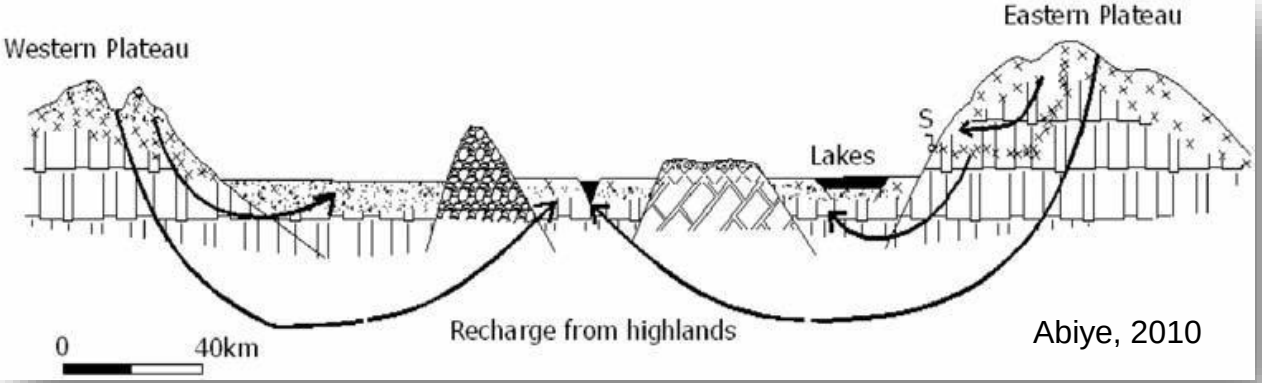


FRAMEWORK

The orientation of faults strongly influences the recharge area, the geometry and relationship between aquifers and groundwater flow direction. Deep groundwater can locally give rise to hydrothermal fluids along the tectonic fracture network.



Childs et al., 2009



Abiye, 2010

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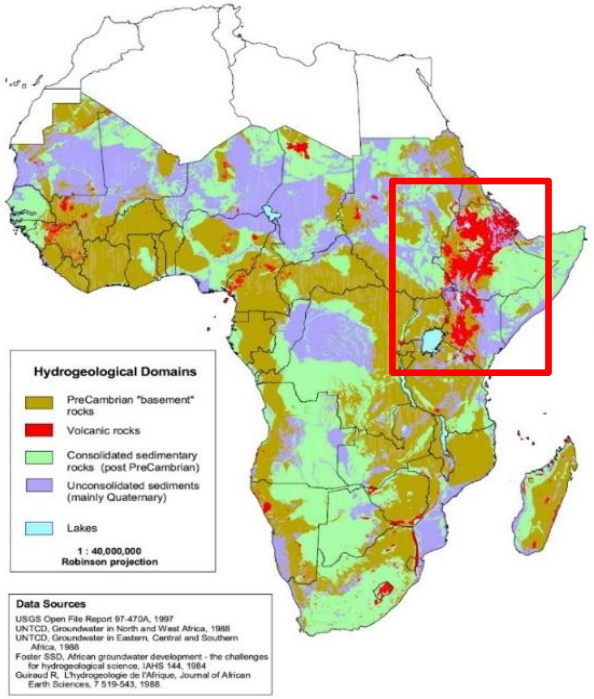
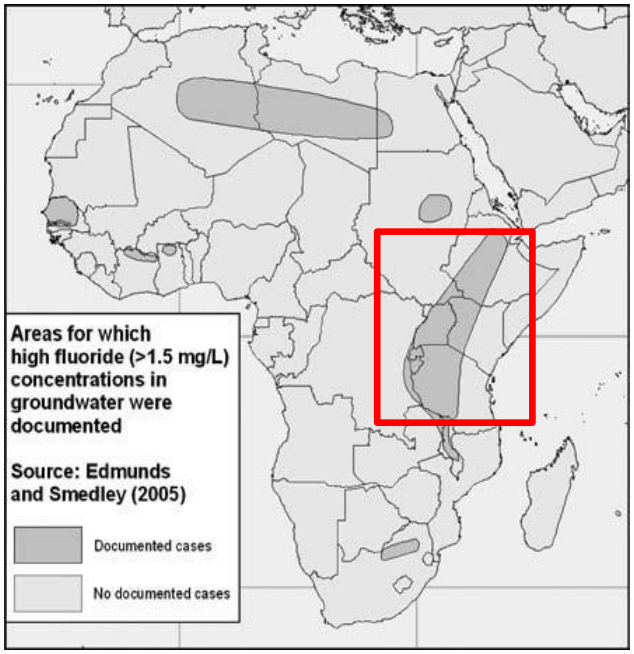
Fluoride in groundwater of the East African Rift System (EARS)





WHO limits for fluoride in drinking water 1,5 mg/L

High fluoride concentrations have been detected in surface and groundwater within East Africa:

- **Ethiopia 1.3–300 mg/L (Gizaw, 1996; Alemayehu et al., 2006, Tekle-Haimanot et al., 2006, Ayenew, 2008)**
- **Kenya up to 180 mg/L (Nair et al., 1984; Gaciri and Davies, 1993),**
- **N Tanzania up to 70 mg/L (Ghiglieri et al. 2010, 2012); 437 mg/L (Kilham and Hecky, 1973) and 12–690 mg/L (Nanyaro et al., 1984)**

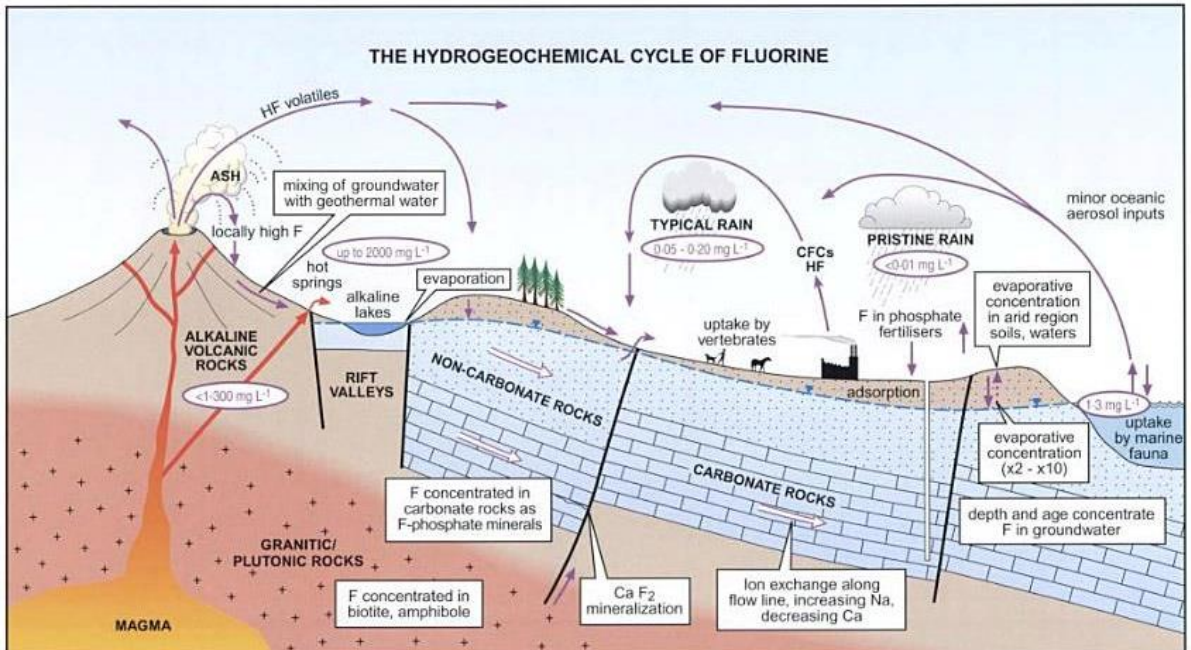
Sources of fluoride in the EARS

Past and present volcanic activity

- **Lithology: alkaline volcanic rocks of East Africa are richer in F than analogous rocks in other parts of the world (Gerasimovskiy and Savinova, 1969).**
- **Hydrotermalism**
- **Recent volcanic eruptions**

Evaporation from alkaline lakes → **Precipitation of fluorine-rich minerals both in salt crust and hardpan (trona) deriving from supersatured alkaline waters**

Antropogenic and other sources → **Negligible**



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EXPECTED OUTPUTS

The main project's outputs will consist on:

(**i**) **identification and mapping of the specific geological-hydrogeological and geochemical conditions of water contamination in relation to different land uses,**

(**ii**) development of mitigation options for fluoride contamination in agricultural and livestock systems,

(**iii**) *identification and testing of innovative water defluoridation technologies,*

(**iv**) **development of an innovative Geo-Data system for the knowledge management with a web platform for data sharing and a mobile app for the collection of data.**

to ensure **sustainable and safe food production systems in the areas affected by** fluoridation,

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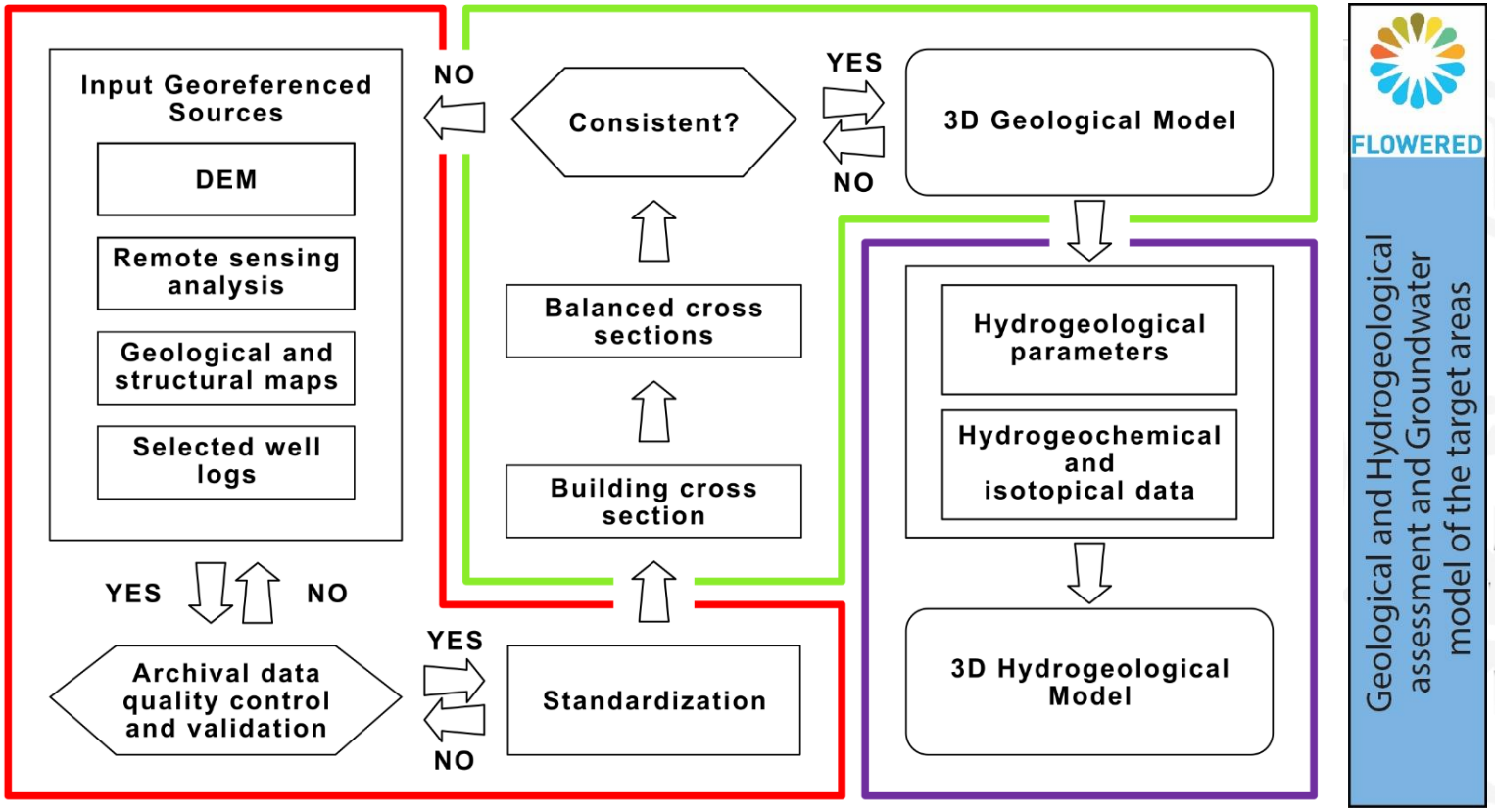
WP1

Integrated approach



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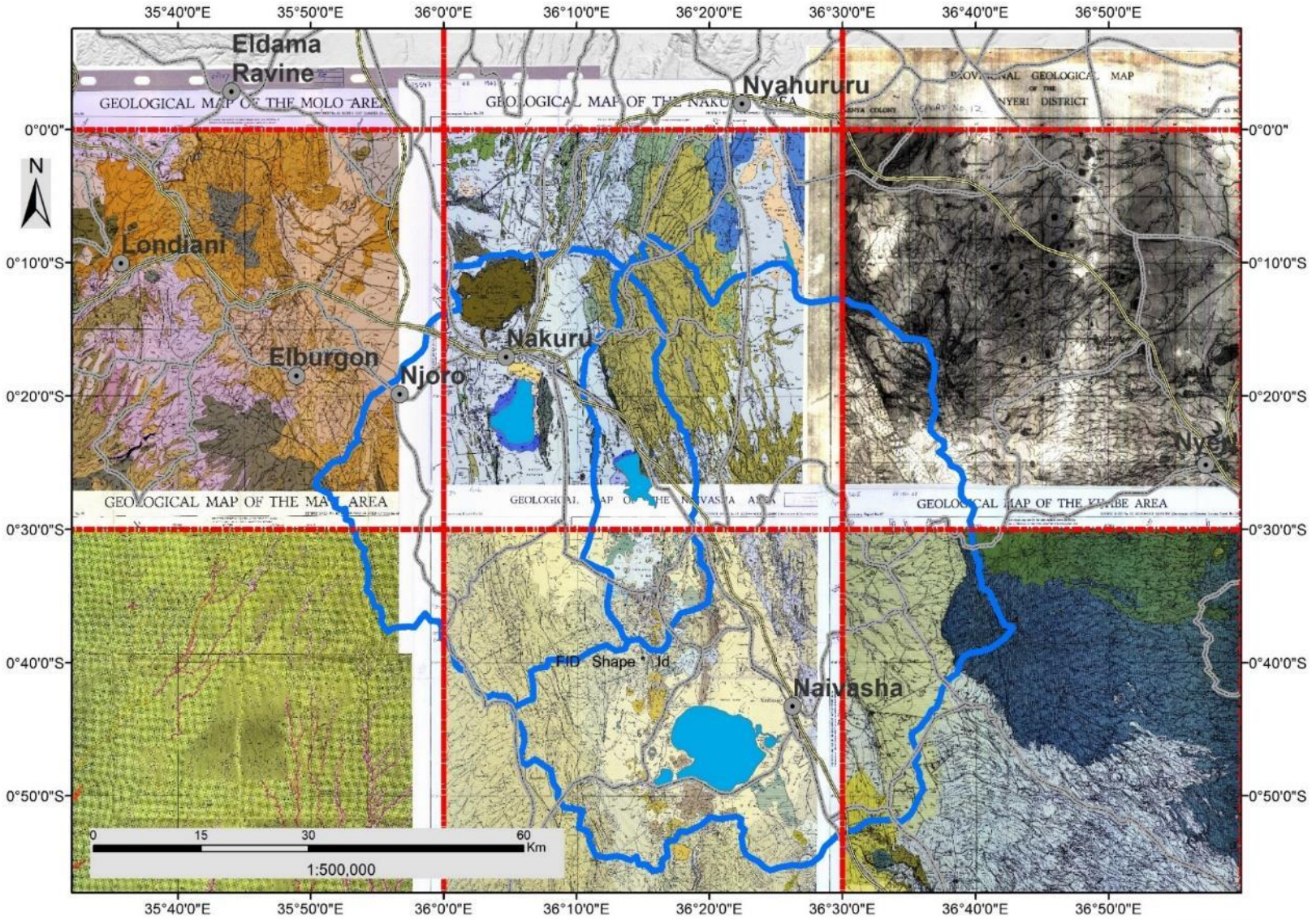
The geology of the study area: geological maps 1:125.000 scale, Geological Survey of Kenya (GSK)



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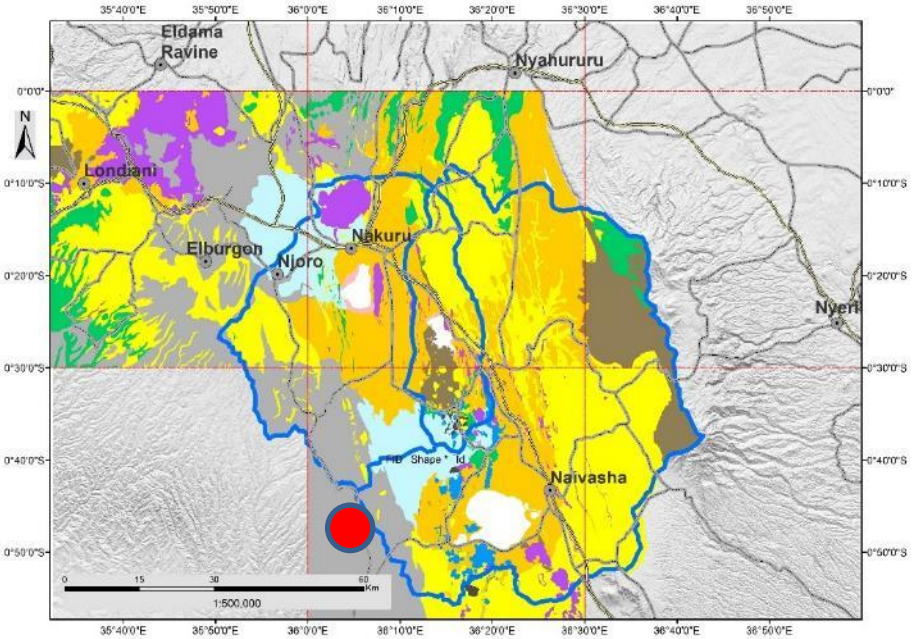
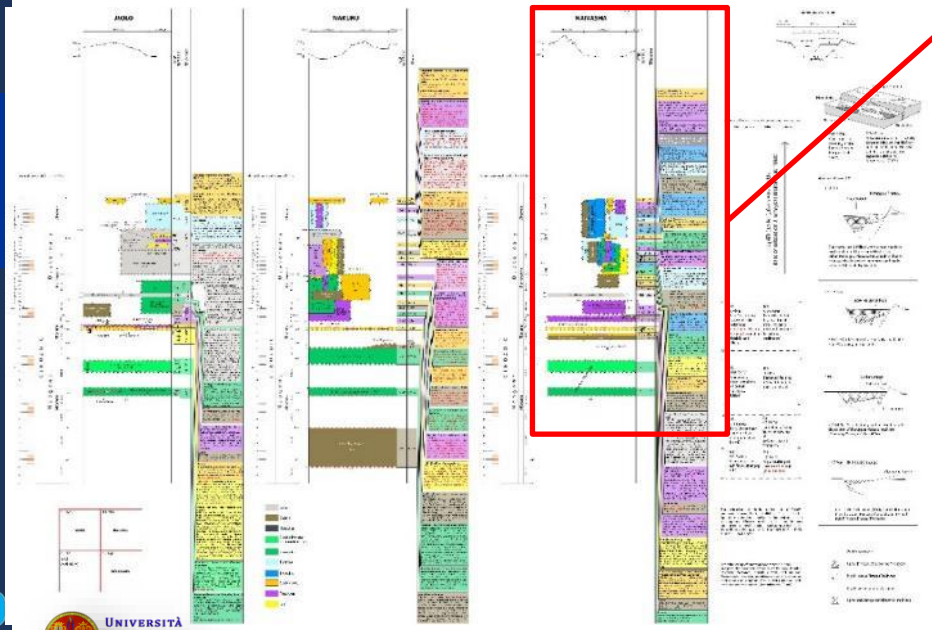
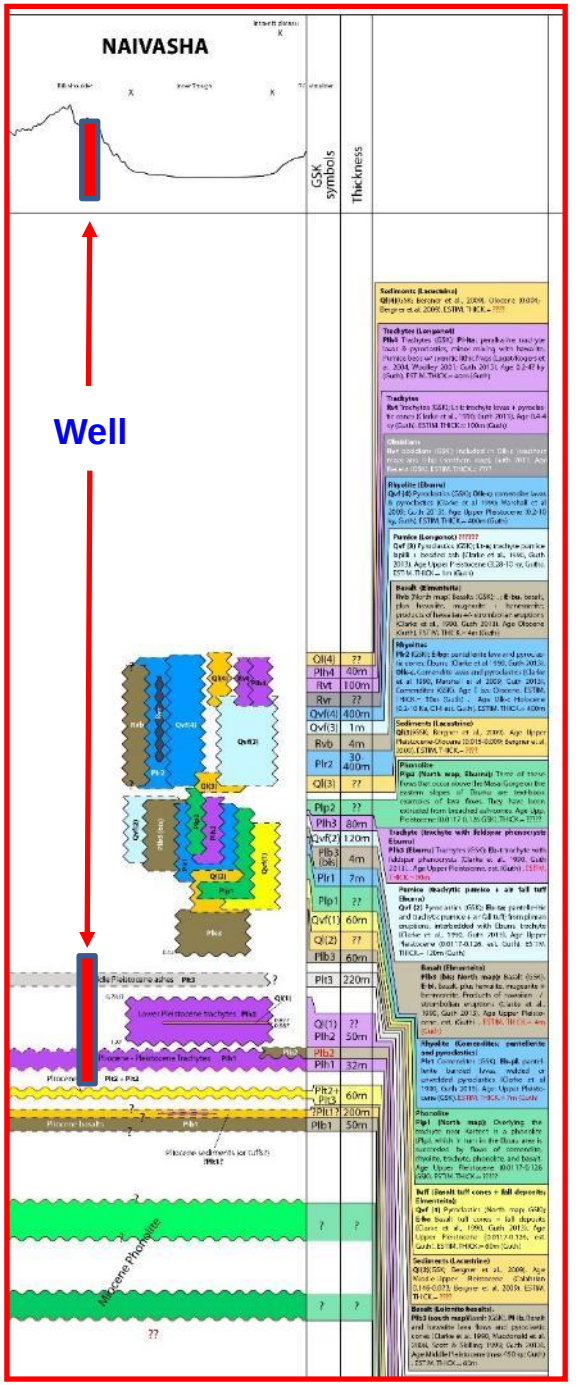
Geochronology and stratigraphy







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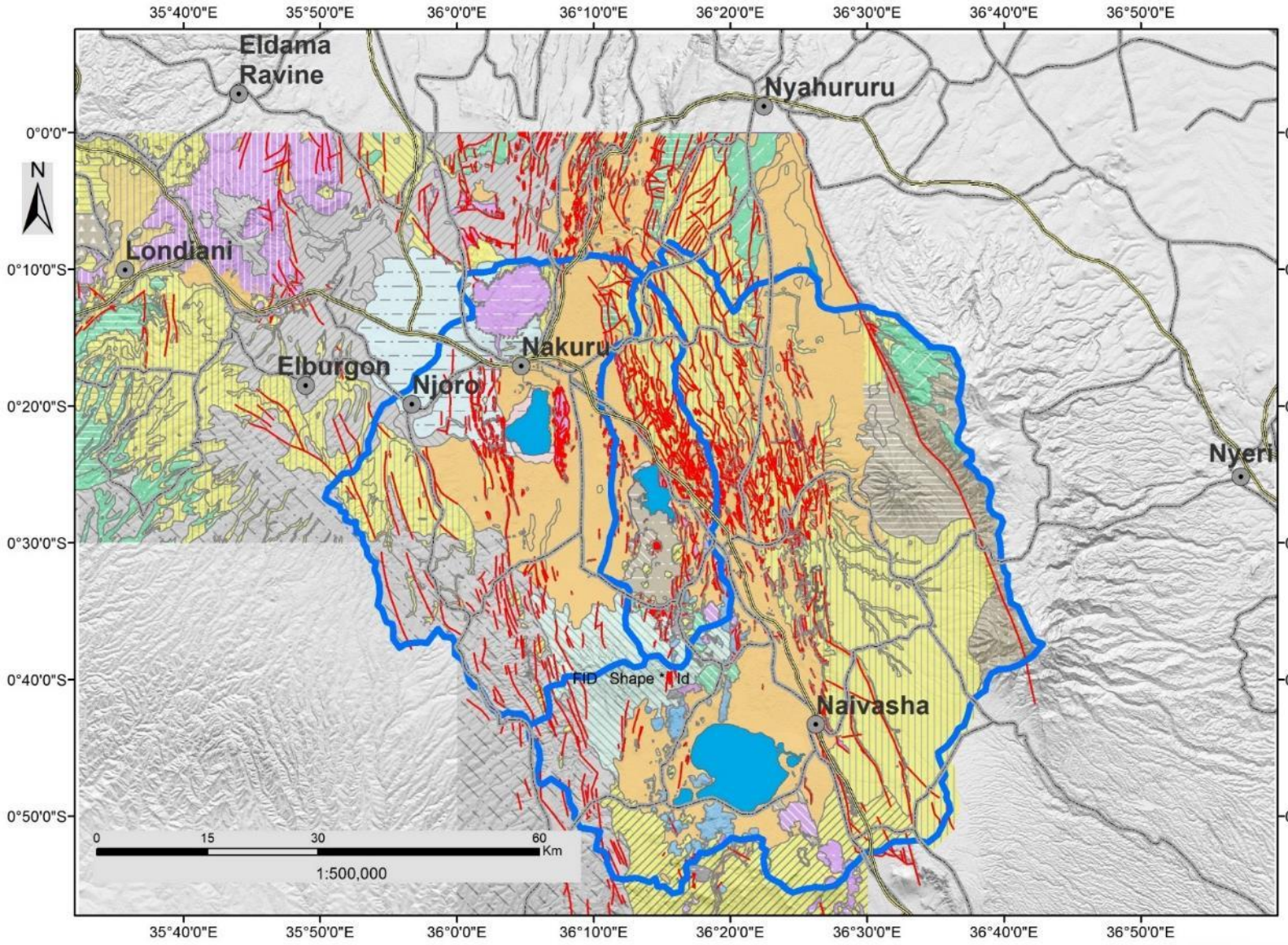
The geological map



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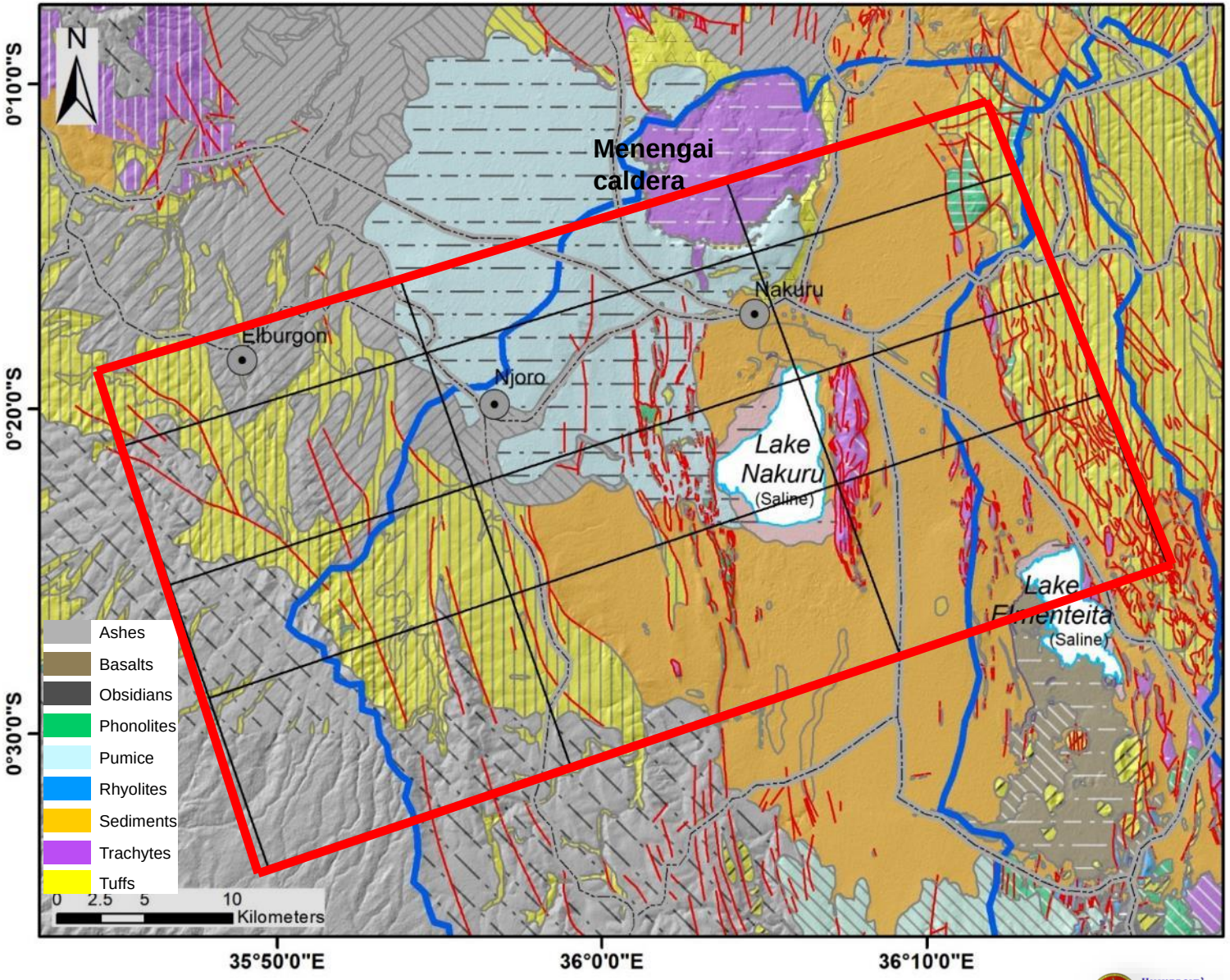
The regional 3D hydrogeological conceptual model: the geological cross-sections



- 9 Geological cross-sections at 1:125.000 scale
- 5 transversal and 4 parallel to the rift axis

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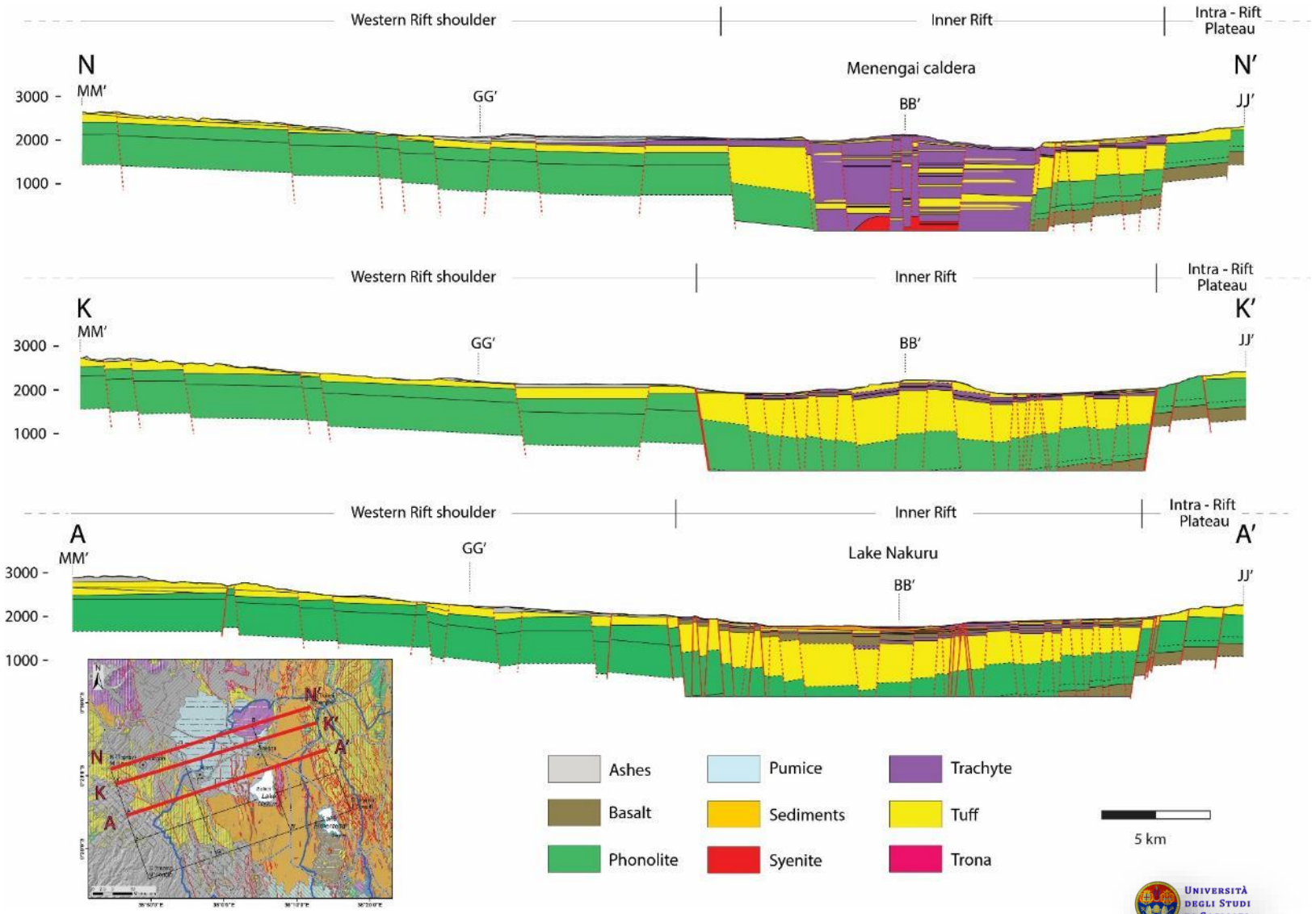
The regional 3D hydrogeological conceptual model: the geological cross-sections



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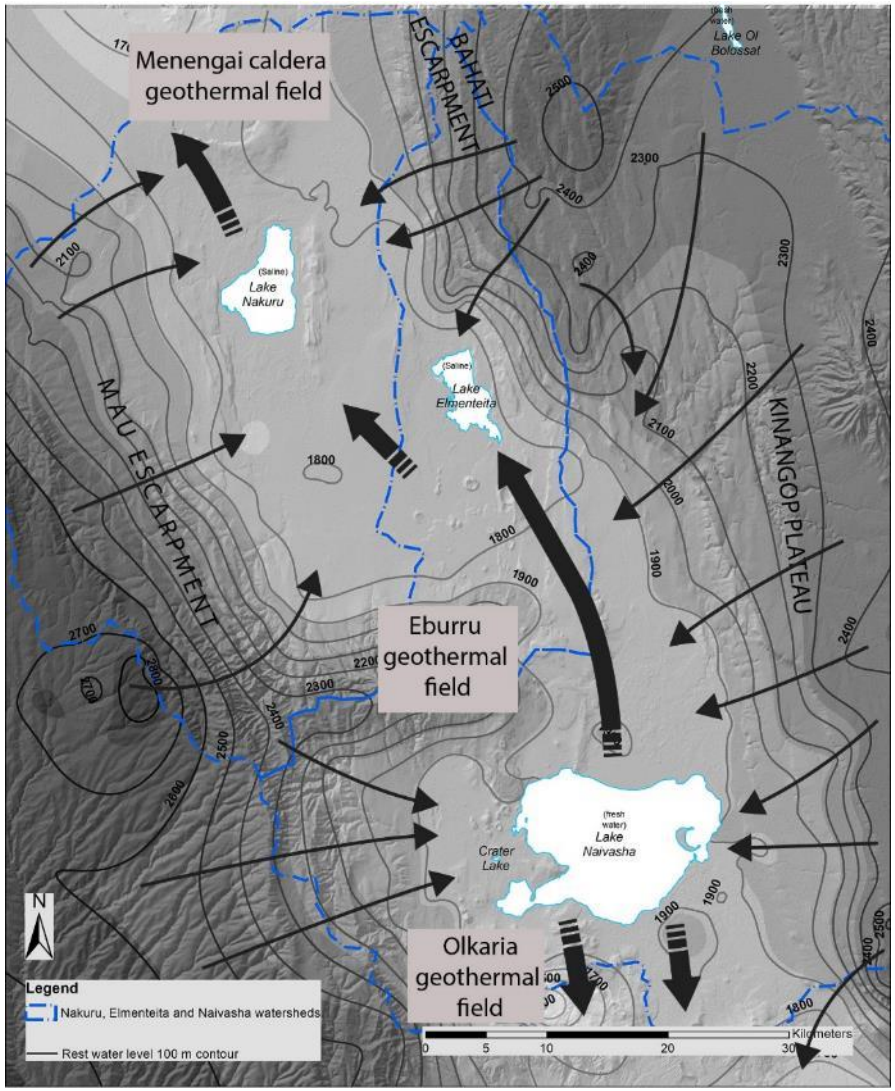
Regional groundwater flow



FLOWERED project. Modified from Allen et al. (1989), Nabide (2002), Kanda (2010)

The groundwater flows from elevated recharge areas to low-lying discharge areas, the flow occurring both laterally and longitudinally accordingly to the Rift geometry.

NAKURU – ELMENTEITA

Groundwater flows

- **north-east from the Mau Escarpment;**
- **south-west from the Bahati Escarpment;**
- **northwards from Eburru;**

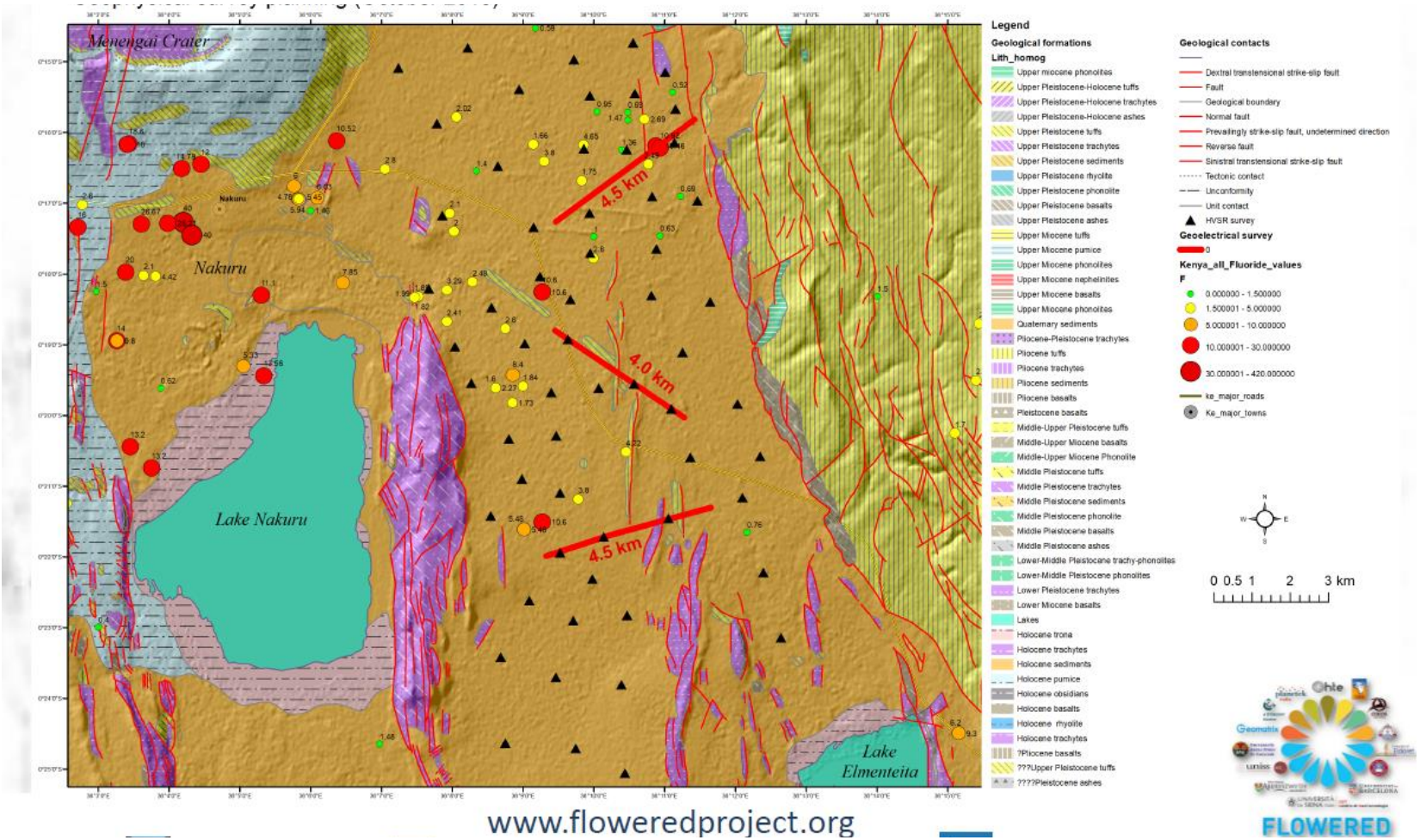
NAIVASHA

Groundwater flows

- **towards Lake Naivasha from the Mau Escarpment and the Kinangop Plateau;**
- **away from Lake Naivasha, both to the north and to the south;**
- **The piezometric surface has an uninterrupted fall from Lake Naivasha, around the east side of Eburru, towards Lake Elmenteita, indicating flow in this direction.**

Clarke et al. (1990)

Geophisical survey



www.floweredproject.org

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Geophysical survey

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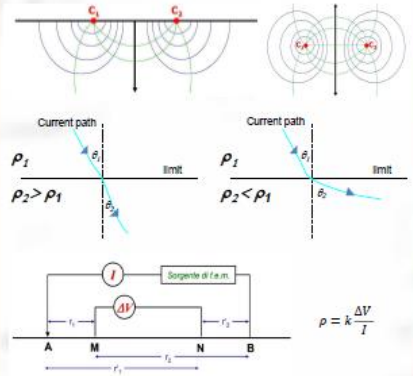
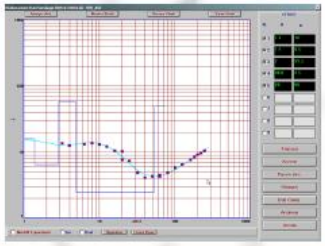
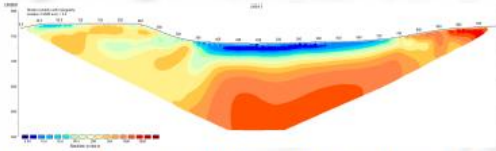
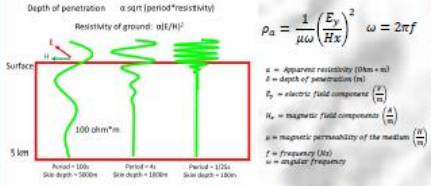
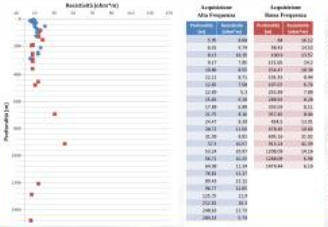
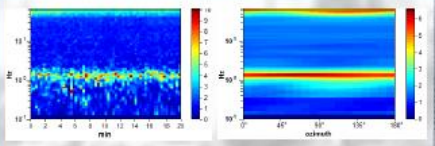
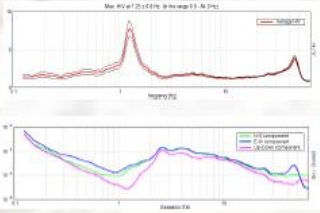
	Features of the method	Data acquisition	Results & Applicability
1D and 2D Geoelectrical method	 Fig. 1. A - Distribution of electric field lines and equipotential lines. Fig. 1. B - Behavior of the electric current in a situation of discontinuity of the investigated body. Fig. 1. C - Simplified diagram of the quadrupole (A-B current electrodes, M-N potential electrodes).	 Fig. 2. Syscal PRO Equipment (IRIS Instruments - France) for Vertical Electrical Soundings (VES)	 Fig. 4. The result is a 1D model of electrical resistivity. In the Flowered project the vertical electric survey will allow to integrate and control the results of the electric tomography and at the same time will allow to obtain a greater data coverage in the deep attack portions of the roll-along system.
		 Fig. 3. Equipment Syscal PRO (IRIS Instruments - France) for electrical resisitivity tomography (ERT)	 Fig. 5. 2D model of electrical resistivity. In the Flowered project, it will be possible to determine the electrical resistivity in the superficial thickness (<180m) ensuring the lateral continuity of the data. It will be suitable to locate the main discontinuities and the presence of conductive levels.
Magnetotelluric method	 Fig. 6. Physics of Magnetotelluric exploration	 Fig. 7. Stratagem equipment (GEOMETRICS - U.S.A.) for magnetotelluric measurements	 Fig. 8. The result is a 1D model of electrical resistivity for locating discontinuities at greater depth. The standard configuration provides for acquiring data in the range of 10 Hz to 92 kHz. The low-frequency configuration will allows the use of frequencies to as low as 0.1 Hz
HVSR method	 Fig. 9. Passive measurement of seismic noise and comparison of the spectral components of the recorded motion for the determination of the resonance frequency of the site (H/V time series and H/V directionality).	 Fig. 10. Tromino Engineering (Micromed – Italy) 9-channel digital tromograph with GPS	 Fig. 11. The trend of the ratio between the horizontal spectral components and the vertical component is extrapolated, depending on the frequency. Using these data and integrating them with other direct and indirect techniques, it is possible to locate discontinuities at variable depths

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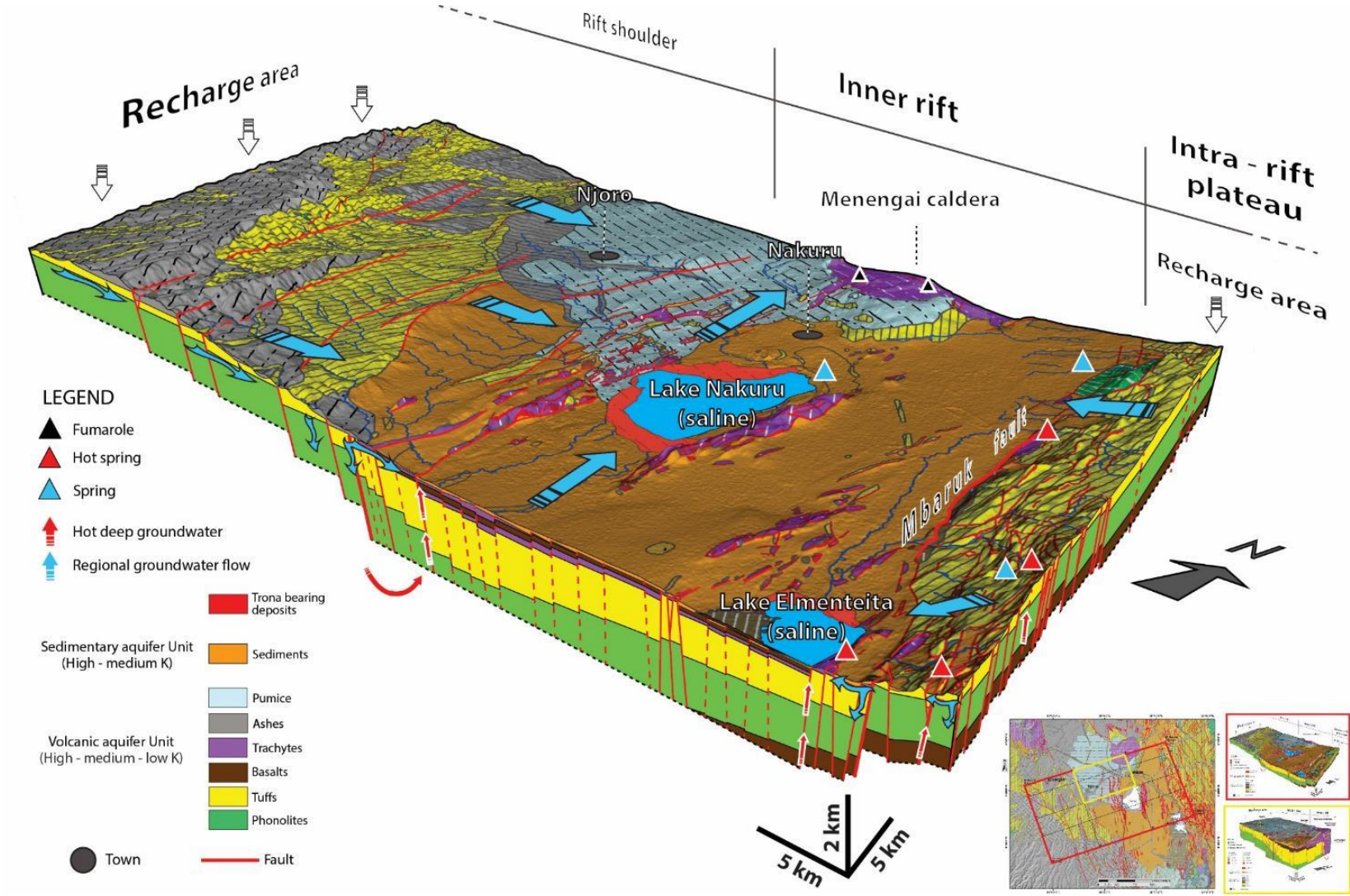
The regional 3D hydrogeological conceptual model



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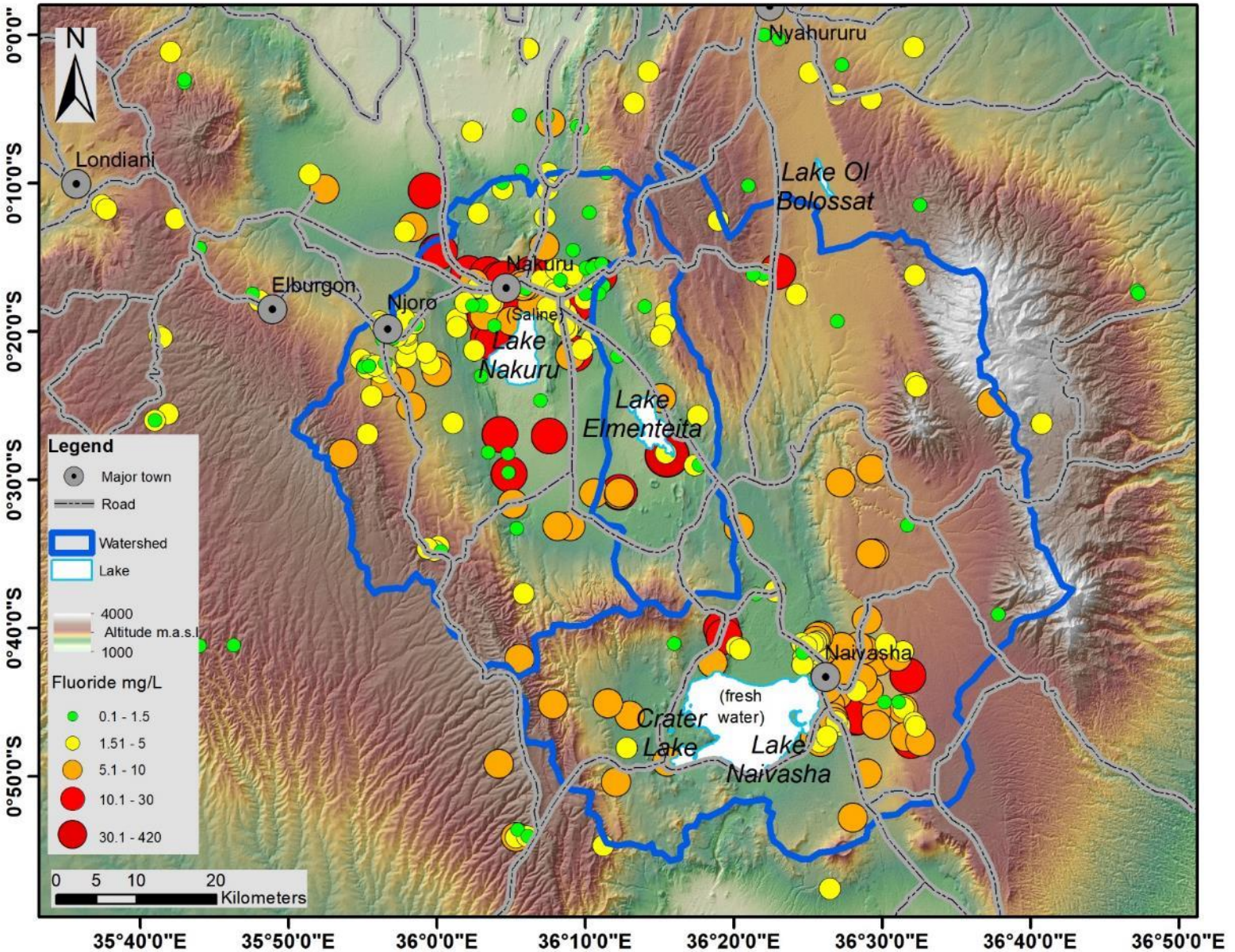
Distribution of F^- (literature data)
For the Njoro – Nakuru area



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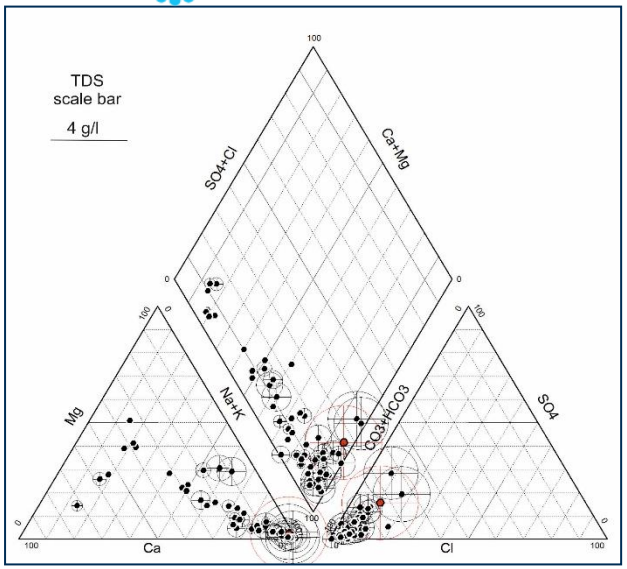
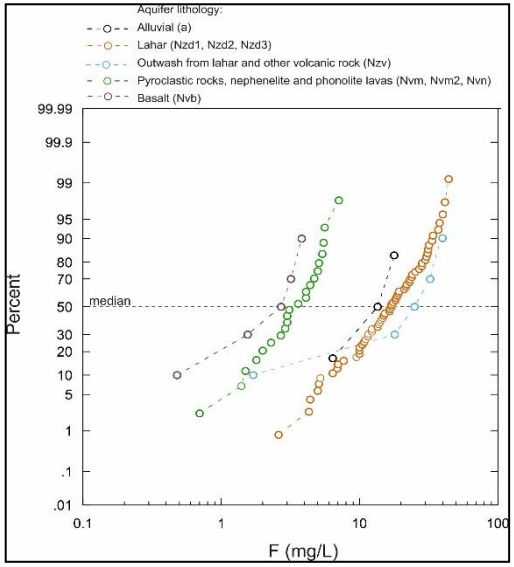
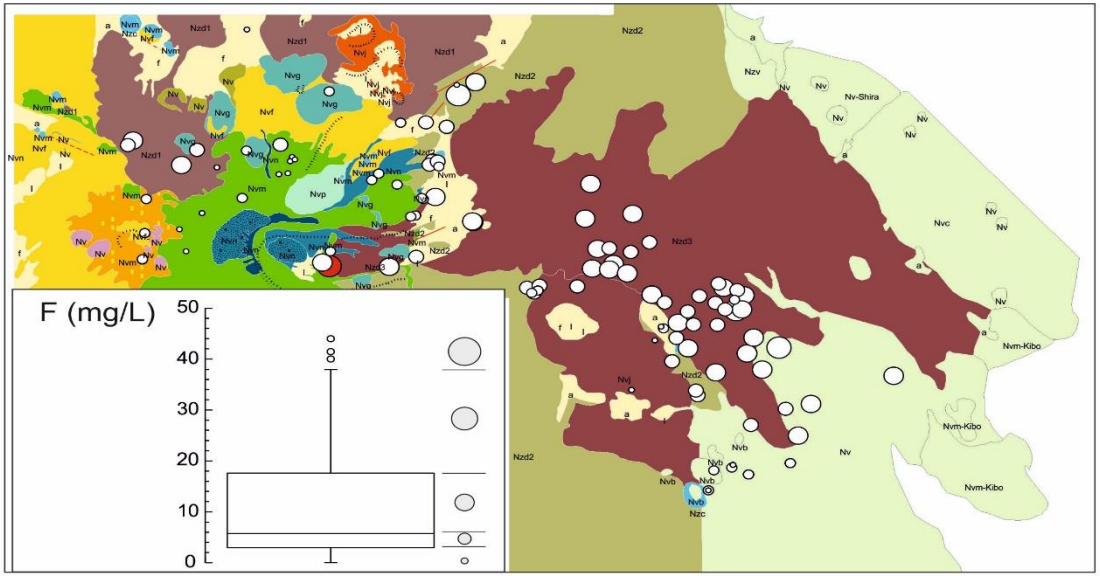
Definition of Natural Background







SEDIMENTARY HYDROGEOLOGICAL UNIT

- f - Alluvial fan deposits
- l - Lake deposits

VOLCANIC HYDROGEOLOGICAL UNIT

- Nvn - Piroclastics (stippled) and associate lavas - [Ash cone group complex]
- Nzd3 - Momella lahars - [Lahars of various age complex]
- Nzd2 - Ngare Nanyuki lahars - [Lahars of various age complex]
- Nvf - Mantling ash - [Mantling Ash complex]
- Nvn - Nephelinitic and phonolitic lavas (Summit group) - [Main Cone group complex]
- Nvm - Pyroclastics with subordinate nephelenitic and phonolitic lavas - [Main Cone group complex]
- Nvg - Tholoids - [Main Cone group complex]
- Nzd1 - Lahars - [Lahars of various age complex]
- Nvp - Pyroclastics (Little Meru group) - [Main Cone group complex]
- Nv - Phonolite and phonolitic nephenelite lavas (Oldonyo Sambu) - [Main Cone group complex]
- Nvm - Nephelinite lavas and breccias - [Meru West group complex]
- Nvj - Parassitic cones, Northern maar field
- Nvm - Parassitic cones, alkaline
- Nv - Parassitic cones undifferentiated

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Monitoring network implementation WP1

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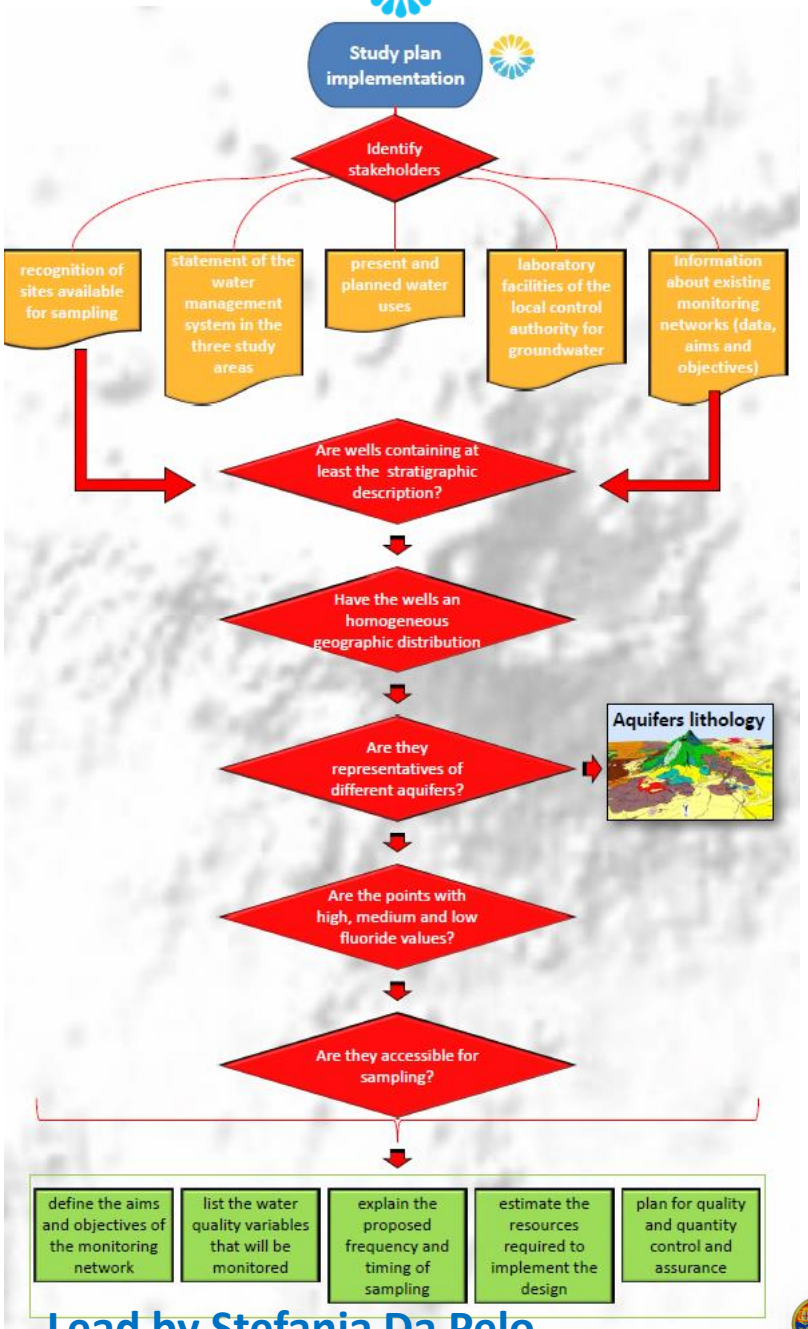


Figure 1: Preliminary FLOWERED monitoring Network water points in Kenya (left) and Fluoride distribution (right)

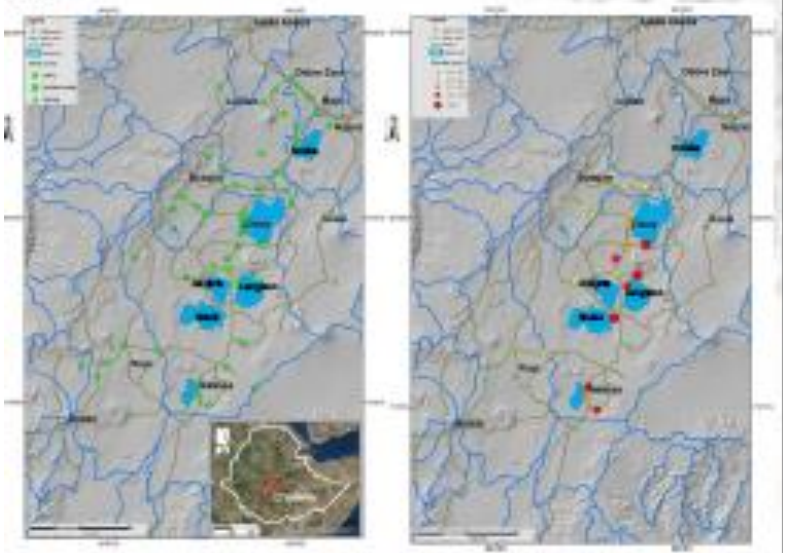
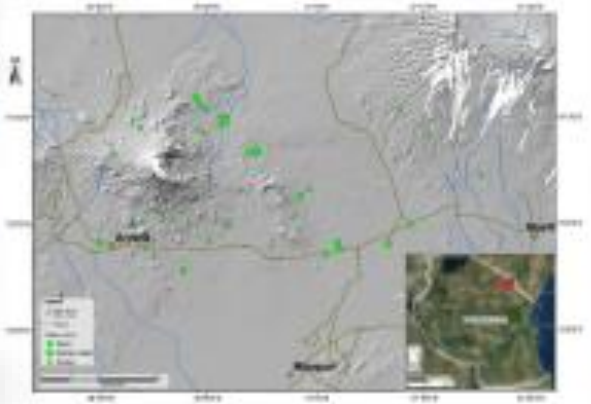


Figure 2: Preliminary FLOWERED monitoring Network water points in Ethiopia (left) and Fluoride distribution (right). Data on fluoride are not complete as analyses are still on going



Lead by Stefania Da Pelo

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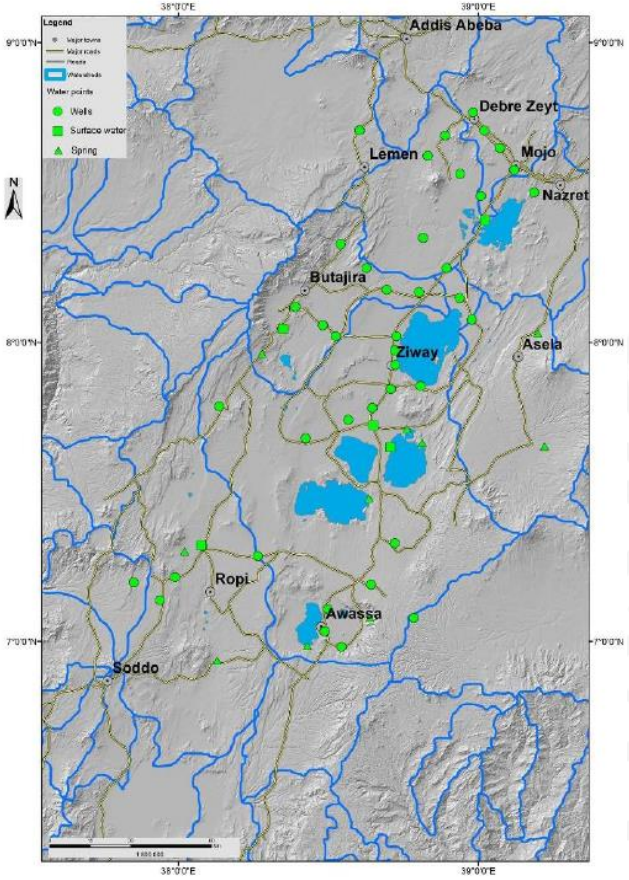
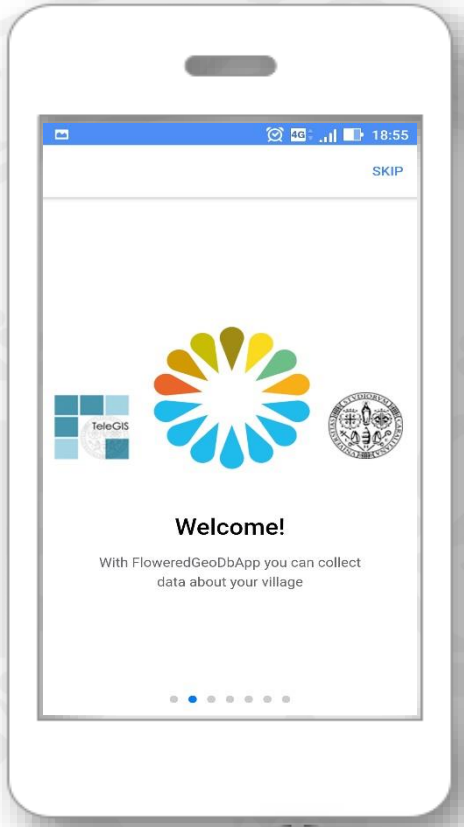
WP1-WP4 SYNERGIES

IMPLEMENTING THE MONITORING NETWORK IN THE *FLOWERED APP*





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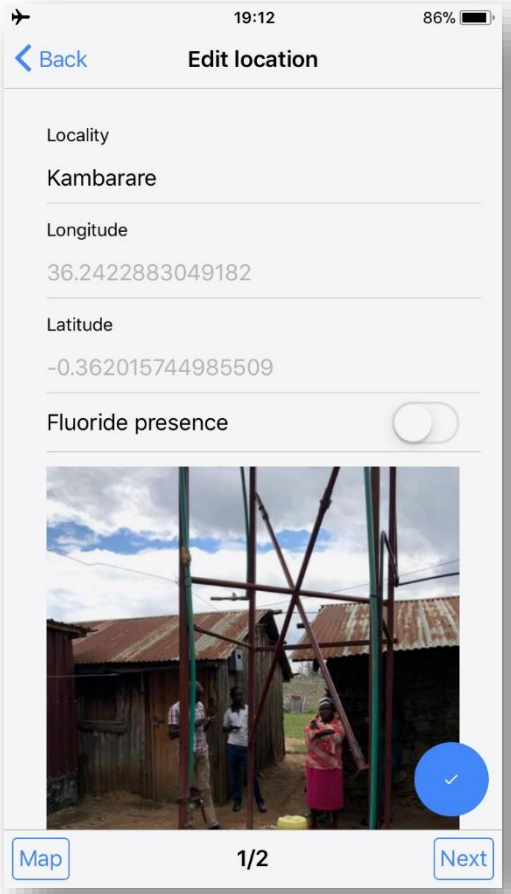
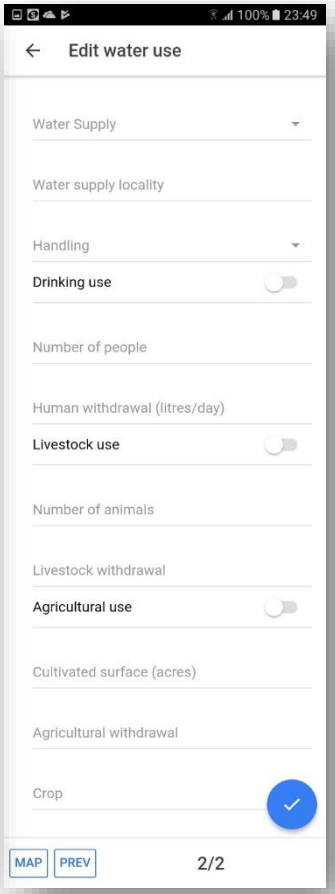
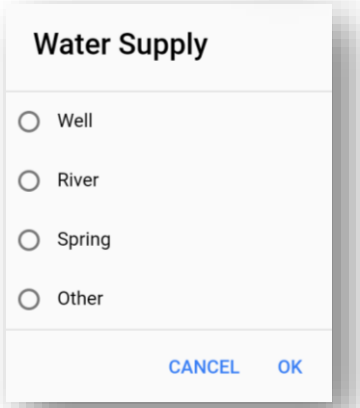
planetek italia

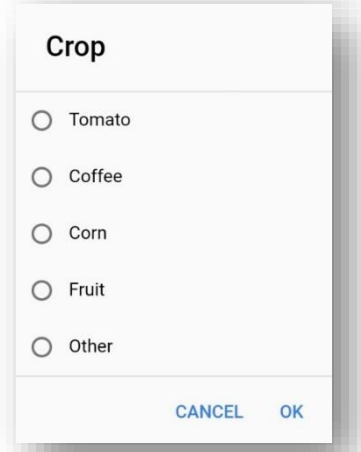
WP1-WP4 SYNERGIES

IMPLEMENTING THE MONITORING NETWORK IN THE *FLOWERED APP*









Water data, water use, analysis of pressures and impacts

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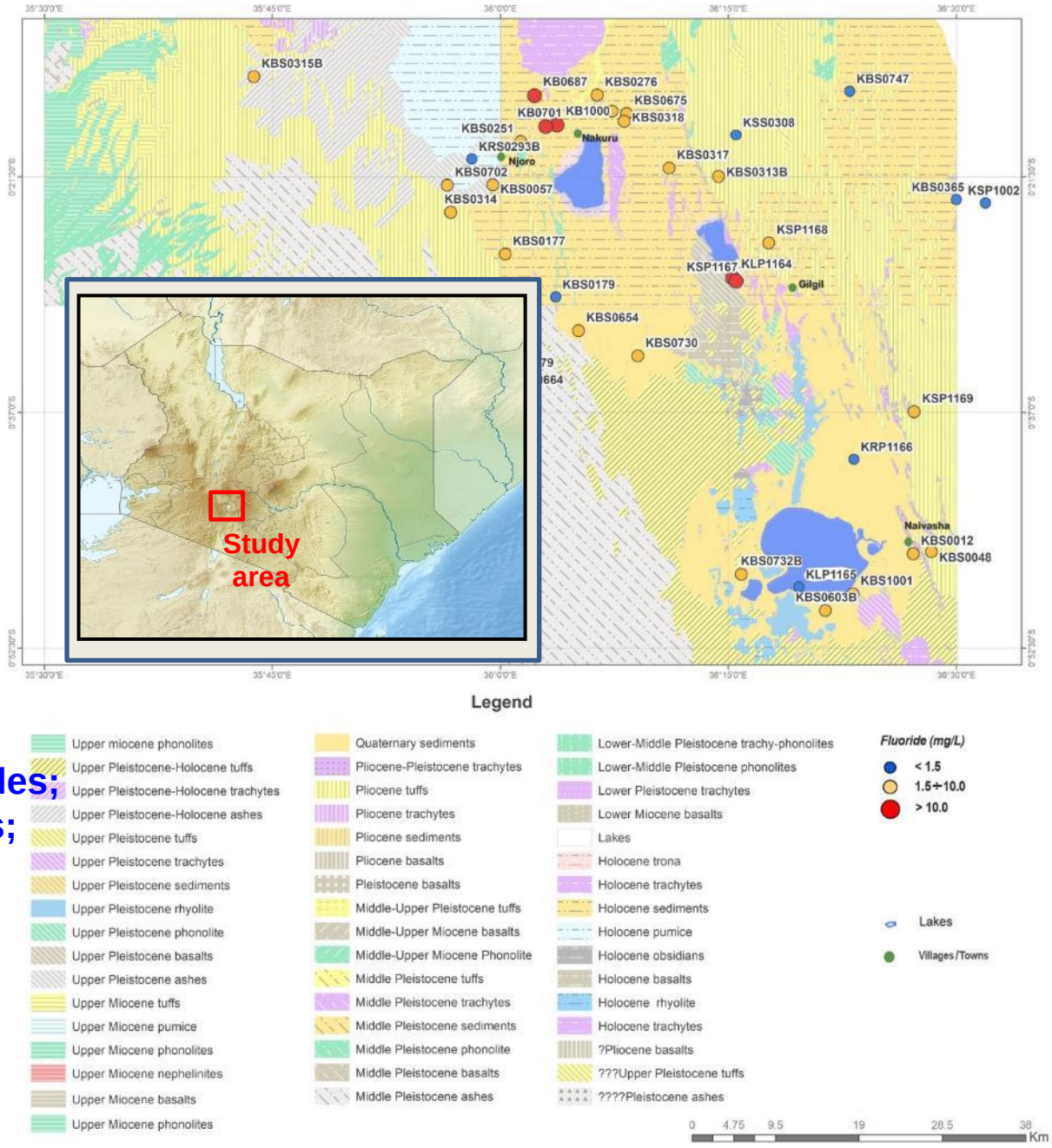
Collecting water samples

1st – JANUARY 201

- **36 water point collected**
  - **27 boreholes;**
  - **5 springs**
  - **2 rivers;**
  - **2 lakes.**

2nd – JULY 2018

- **35 water point collected**
  - **26 boreholes;**
  - **5 springs;**
  - **2 rivers;**
  - **2 lakes.**



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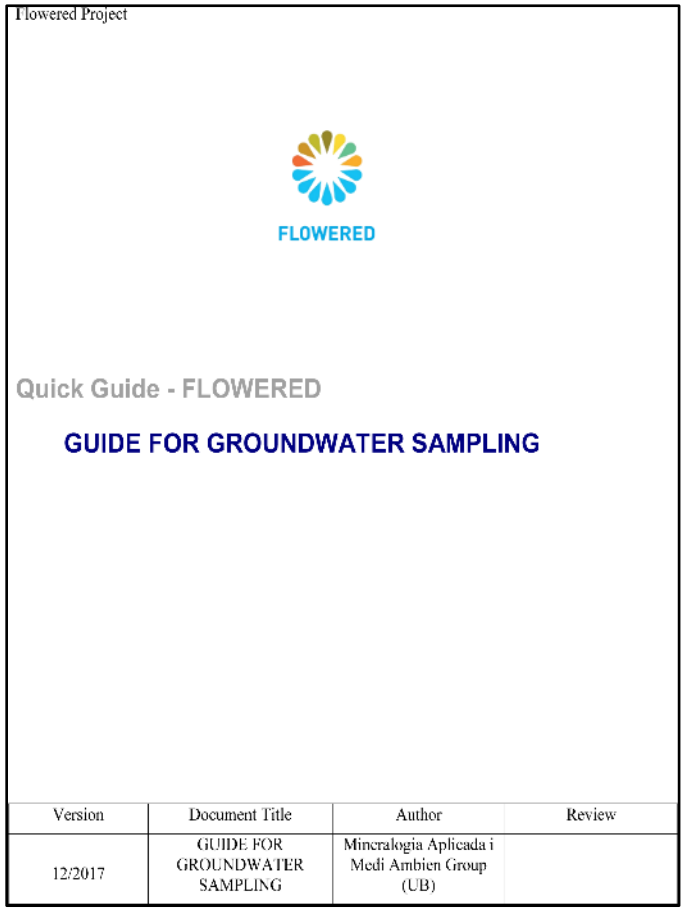
Elements and isotopes detected

- Anions
- Cations and metals
- Dissolved organic carbon (DOC)
- Ammonium (NH_4^+)
- Alkalinity



- $\delta^{18}O$ and $\delta^{2}H$-H_2O
- $\delta^{15}N$ and $\delta^{18}O$-NO_3^-
- $\delta^{34}S$ and $\delta^{18}O$-SO_4^{2-}
- $\delta^{13}C$-DIC
- $\delta^{11}B$

- ^{3}H
- $^{87}Sr/^{86}Sr$
- ^{36}Cl
- ^{14}C

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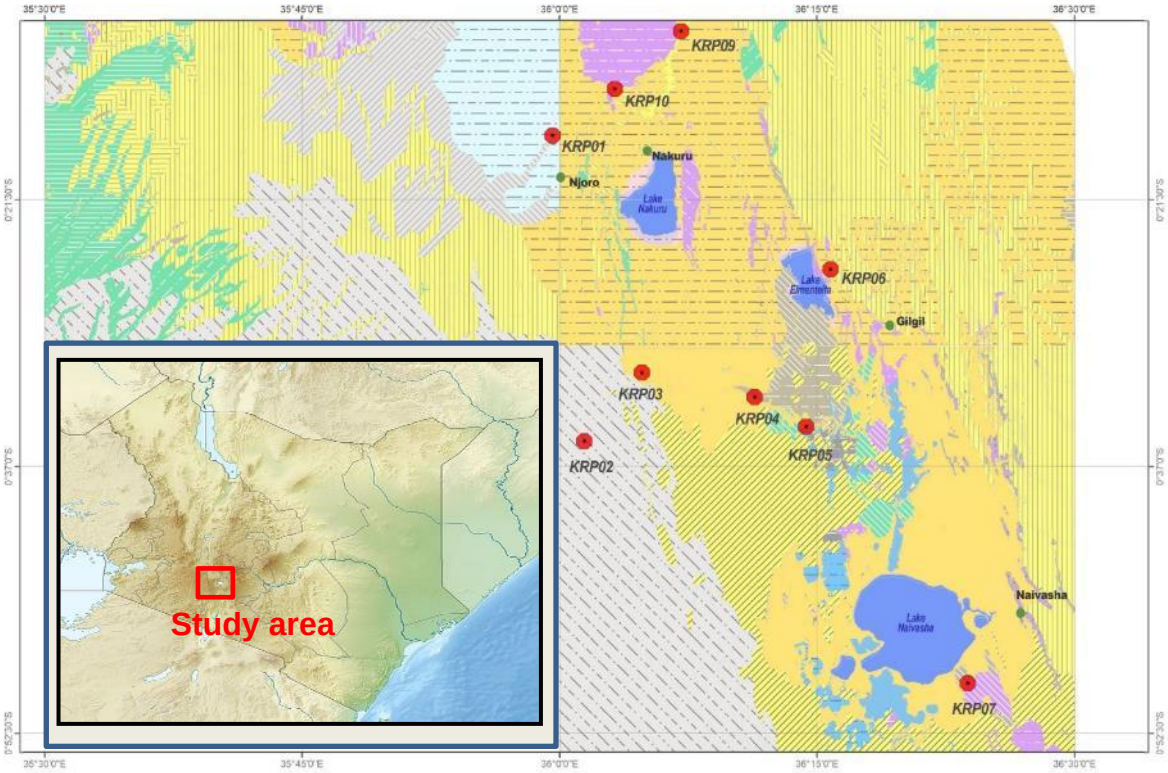
Rock and soil sampling



Legend

- Upper miocene phonolites
- Upper Pleistocene-Holocene tuffs
- Upper Pleistocene-Holocene trachytes
- Upper Pleistocene-Holocene ashes
- Upper Pleistocene tuffs
- Upper Pleistocene trachytes
- Upper Pleistocene sediments
- Upper Pleistocene rhyolite
- Upper Pleistocene phonolite
- Upper Pleistocene basalts
- Upper Pleistocene ashes
- Upper Miocene tuffs
- Upper Miocene pumice
- Upper Miocene phonolites
- Upper Miocene nephelinites
- Upper Miocene basalts
- Upper Miocene phonolites
- Quaternary sediments
- Pliocene-Pleistocene trachytes
- Pliocene tuffs
- Pliocene trachytes
- Pliocene sediments
- Pliocene basalts
- Pleistocene basalts
- Middle-Upper Pleistocene tuffs
- Middle-Upper Miocene basalts
- Middle-Upper Miocene Phonolite
- Middle Pleistocene tuffs
- Middle Pleistocene trachytes
- Middle Pleistocene sediments
- Middle Pleistocene phonolite
- Middle Pleistocene basalts
- Middle Pleistocene ashes
- Lower-Middle Pleistocene trachy-phonolites
- Lower-Middle Pleistocene phonolites
- Lower Pleistocene trachytes
- Lower Miocene basalts
- Lakes
- Holocene trona
- Holocene trachytes
- Holocene sediments
- Holocene pumice
- Holocene obsidians
- Holocene basalts
- Holocene rhyolite
- Holocene trachytes
- ?Pliocene basalts
- ???Upper Pleistocene tuffs
- ????Pleistocene ashes
- Rock/soil sampl
- Lakes
- Villages/Towns

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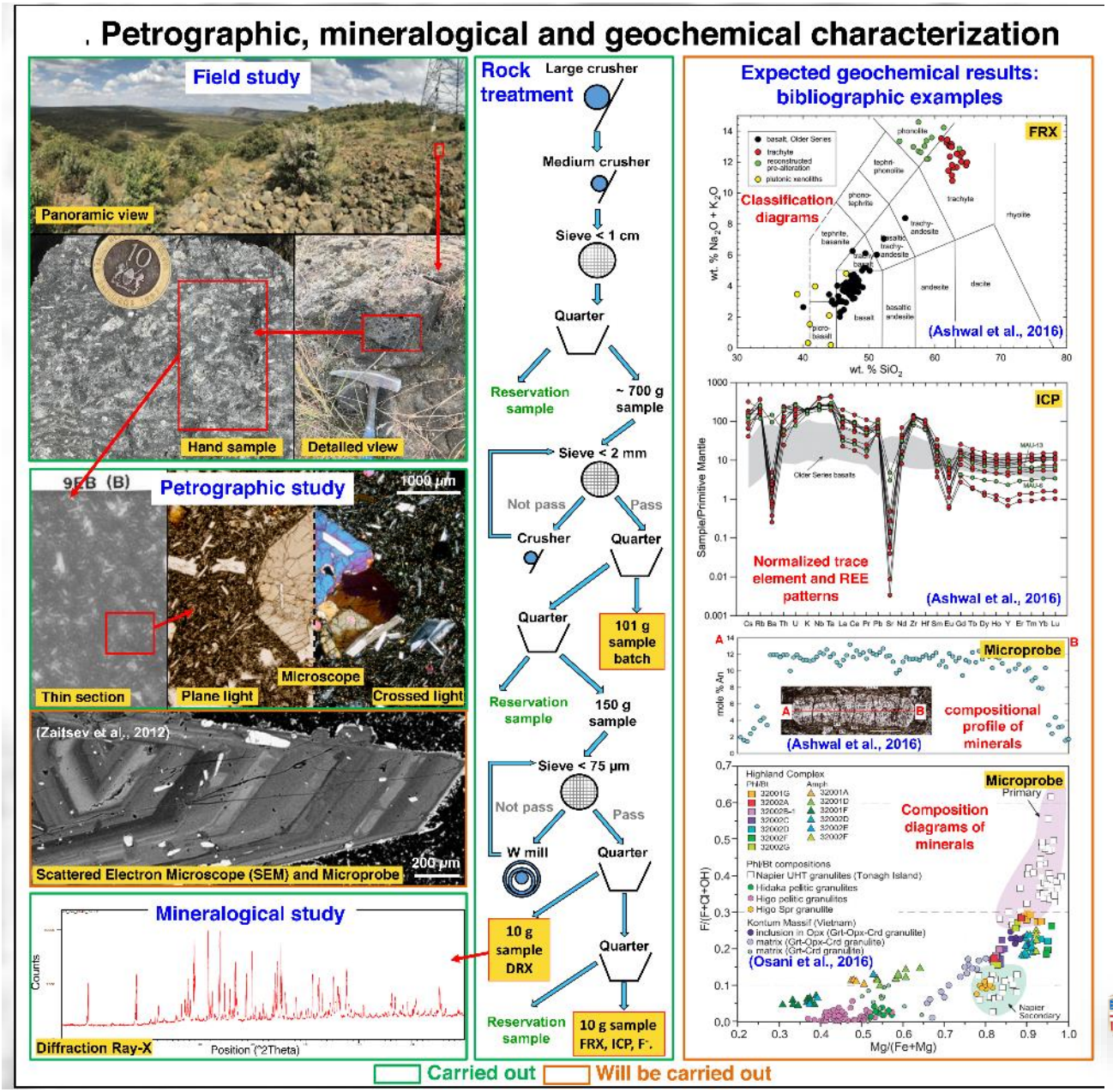
Leaching experiments

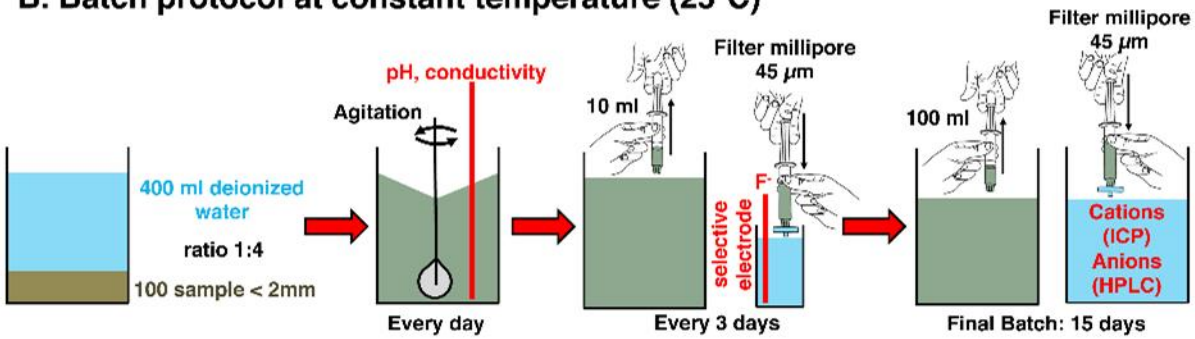


Leaching experiments

Leaching of F^- from sampled rocks by batch method

A. IVHHN batch protocol (Stewart et al., 2013)

B. Batch protocol at constant temperature (25°C)



Name Sample	Time (h)	Analytics (*)	volume
9EBS-0	0	F^-	10 ml
9EBS-1	72	F^-	10 ml
9EBS-2	144	F^-	10 ml
9EBS-3	216	F^-	10 ml
9EBS-4	288	F^-	10 ml
9EBS-5	360	F^-, cations (ICP-OES, ICP-MS), anions (HPLC), alkalinity	100 ml

(*) Every day pH and Conductivity measurements

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de - FLuoridation technologies for imprOving quality of WatEr and agRo - animal products along the East African Rift Valley in the context of aDaptation to climate change

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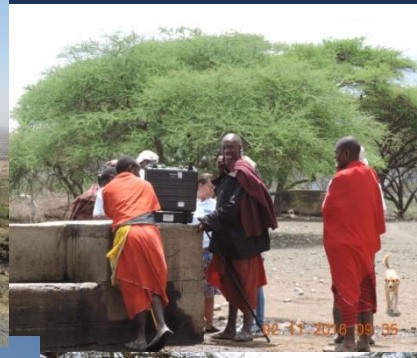




FLOWERED

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Project Coordinator
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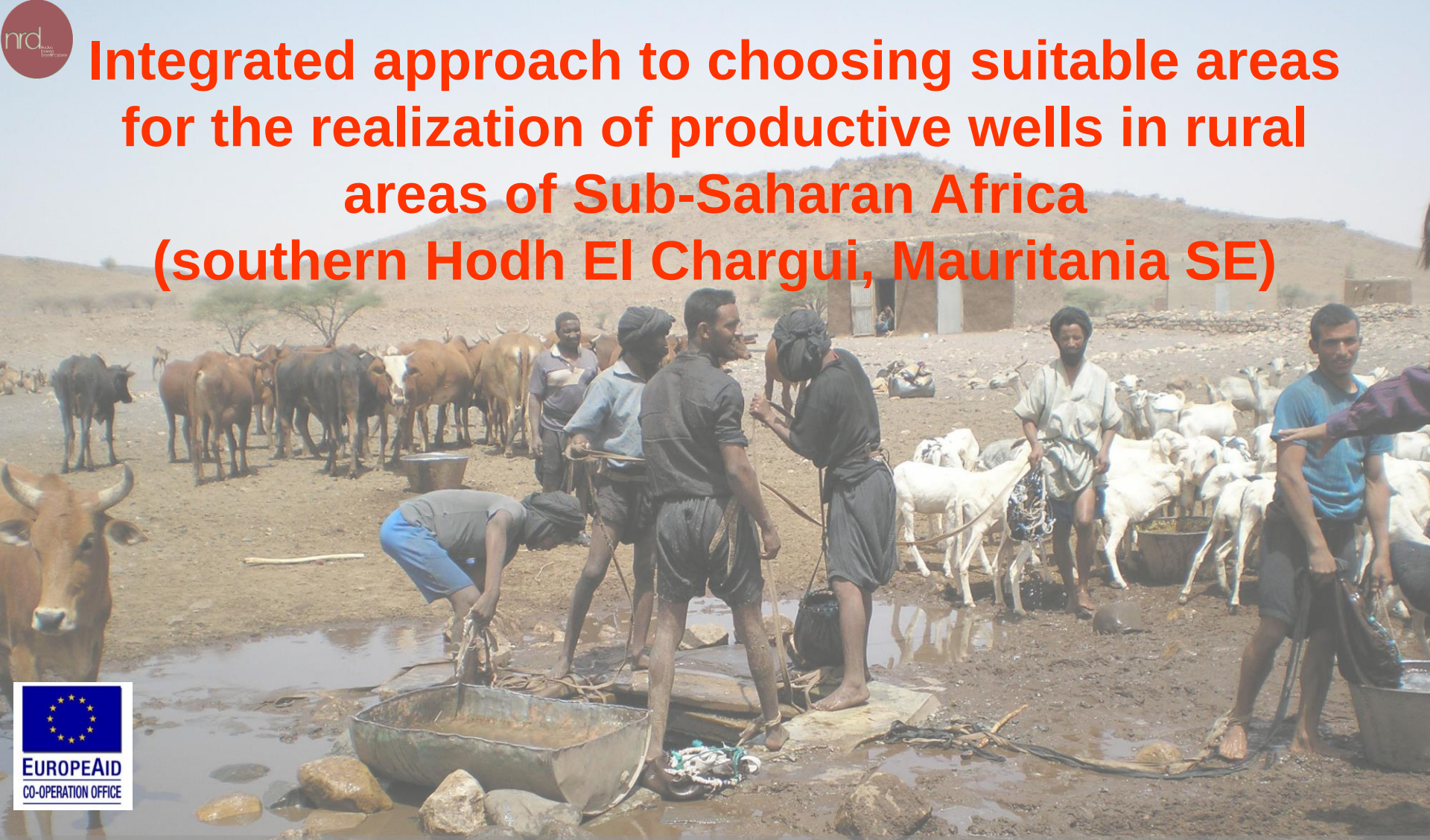
www.floweredproject.org

Integrated approach to choosing suitable areas for the realization of productive wells in rural areas of Sub-Saharan Africa (southern Hodh El Chargui, Mauritania SE)



This work was carried out within the Water Facility Programme HEFEM Project (http://www.projet-hefem.org:8080/servlet/ae5Mau) with ACP-EU financial contributions.

Partnership

TIMESIS s.r.l.

Istituto OIKOS Onlus

Terre Solidaire ONG

Terre Solidali Italia ONG

GRAIA s.r.l.

Nucleo Ricerca Desertificazione UNISS

Comune San Giuliano Terme (PI)

Objectives

The general objective was to guarantee easier access to water to the inhabitants of 13 rural municipalities of the provinces of Nema and Timbedgha, in the South of Hodh El Chargui (Mauritania SE).

A multicriteria approach in studying hydrogeology was used in the project area.

In order to identify some main areas in which to carry out pilot interventions, water accessibility and availability, and hydrogeological and water quality criteria were considered.

Furthermore, during the project, it was possible to transfer know-how and hand over responsibilities.

- **Minimum standards for water quality: establishing concentration level limits for a set of organic and inorganic chemical parameters.**
- **classification based on accessibility**

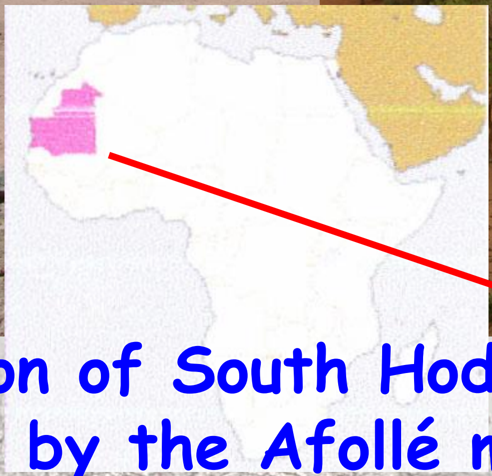
Service level	Access measure (distance or time)	Needs met	Level of health concern
No access – quantity collected often below 5 litres (L) per capita per day	More than 1,000 metres (m) or 30 minutes total collection time	Consumption cannot be assured Hygiene not possible (unless practised at the source)	Very high
Basic access – average quantity unlikely to exceed 20 L per capita per day	Between 100 and 1,000 m or 5 to 30 minutes total collection time	Consumption should be assured Handwashing and basic food hygiene possible; laundry and bathing difficult to assure unless carried out at source	High
Intermediate access – average quantity about 50 L per capita per day	Water delivered through one tap on plot or within 100 m or 5 minutes total collection time	Consumption assured All basic personal and food hygiene assured; laundry and bathing should also be assured	Low
Optimal access – average quantity 100 L per capita per day	Water supplied through multiple taps continuously	Consumption: all needs met Hygiene: all needs should be met	Very low

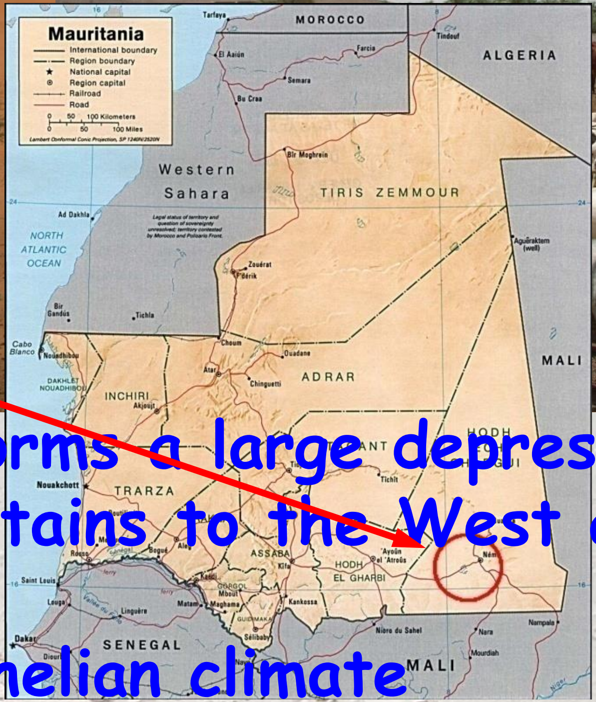
Source: Howard and Bartram, 2003.

(Guidelines for drinking-water quality. First addendum to third edition. Vol.1 – Recommendations. WHO 2006)

- **minimum standard that has to be guaranteed in the developing countries corresponds to the *basic access* category (distance within 1 km and water availability of 20 litres per day per person).**

Study area





The region of South Hodh forms a large depression delimited by the Afollé mountains to the West and by the cliffs of Dhar to the East.

The area shows a typical Sahelian climate

Main activities are grouped around livestock (farming, including sheep, goats, beef, and camels.)

The study area, corresponding to the Moughataa (Province) of Nema and Timbedra, is situated in the South-East of Mauritania and lies entirely within the Wilaya (Region) of Hodh El Chargui.

Area is about 22.000 Kmq with 86.000 inhabitans

Selection criteria of the suitable intervention areas: deciding which well site is best (Nema and Timbedgha - Hodh El Chargui, Mauritania SE).

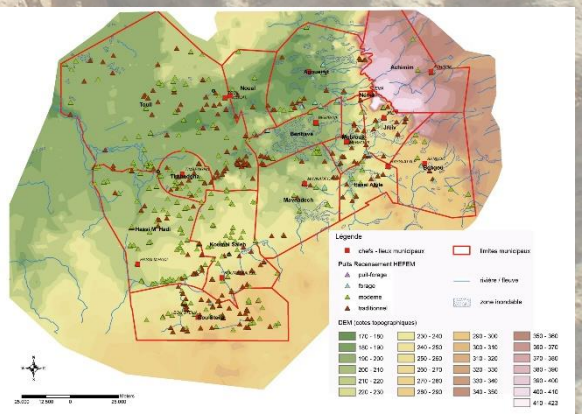
Accessibility - Availability of Water

Hydrogeological Criteria

Hydrogeological Quality Criteria

Determination of pilot intervention areas

Evaluation and sharing of technical choices (sites for the realisation of wells) with Local Authorities



Once the list of suitable areas was defined, it was submitted to the opinion of the Territorial Communities of Nema and Timbedgha and of the different Municipal Authorities, in order to reach a consensus.

In fact, in making the above-mentioned decisions and interventions, the technical results are not sufficient, since a relevant role is played by social and economical factors, of which the development plans had been already approved by local Authorities and by local people.

CONCLUSIONS

The methodology developed during the projects represent the basis for taking several decisions and planning interventions aimed at improving the access to safe water

Furthermore, the methodological approach can be exported with success to other rural areas, particularly in arid or semi-arid areas of developing countries.

It is vital that a scientific approach to groundwater development is more widely adopted, and incorporated at the planning stage of new projects

Legge Regionale 11 aprile 1996, n. 19

Norme in materia di cooperazione con i Paesi in via di sviluppo e di collaborazione internazionale

Regione Autonoma della Sardegna
Direzione Generale
Servizio Affari Comunitari ed Internazionali

WATER MASTER PLAN PROJECT FOR THE WARDS OF NGARENANYUKI AND OLDONYOSAMBU (ARUMERU DISTRICT)-TANZANIA

INTEGRATED WATER PROJECT TO IMPROVE THE SOCIO-ECONOMIC CONDITIONS OF RURAL COMMUNITIES IN THE NGARENANYUKI AND OLDONYOSAMBU WARDS (TANZANIA)"

"MAJI: IMPROVING WATER ACCESS PROJECT IN LEGURUKI AND KING'ORI WARD, TANZANIA"

Nucleo Ricerca Desertificazione Università di Sassari

Oikos East Africa

Dip. Ing.Territorio Università di Cagliari

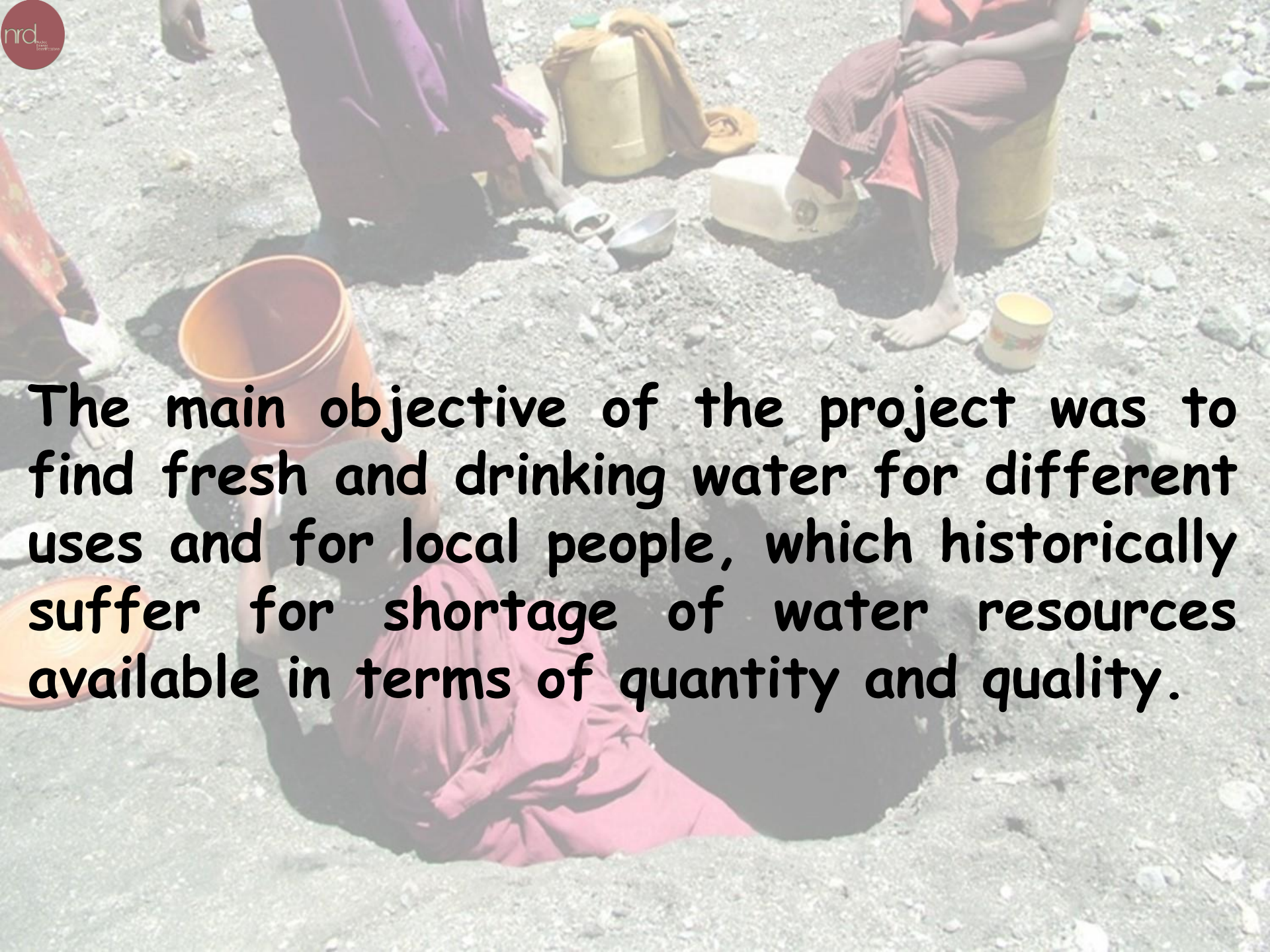
InTreGa Spin-off ENEA

OSVIC

Comune di Sassari

Arumeru District Council Tanzania

Giorgio Ghiglieri



The main objective of the project was to find fresh and drinking water for different uses and for local people, which historically suffer for shortage of water resources available in terms of quantity and quality.

RESULTS

Groundwater circulation and recharge

Recharge occurs by:

- direct infiltration (rainfall),
- infiltration following runoff (volcanic uplands in correspondence of slope changes),
- through lateral systems (aquifer hosted in the weathered and scoriaceous basalts, as in the Mkuru area, at a depth of about 40-60 m below g. l.).

Shallow groundwater circulation system: referred to as local systems because of their limited occurrence (sandy river beds)

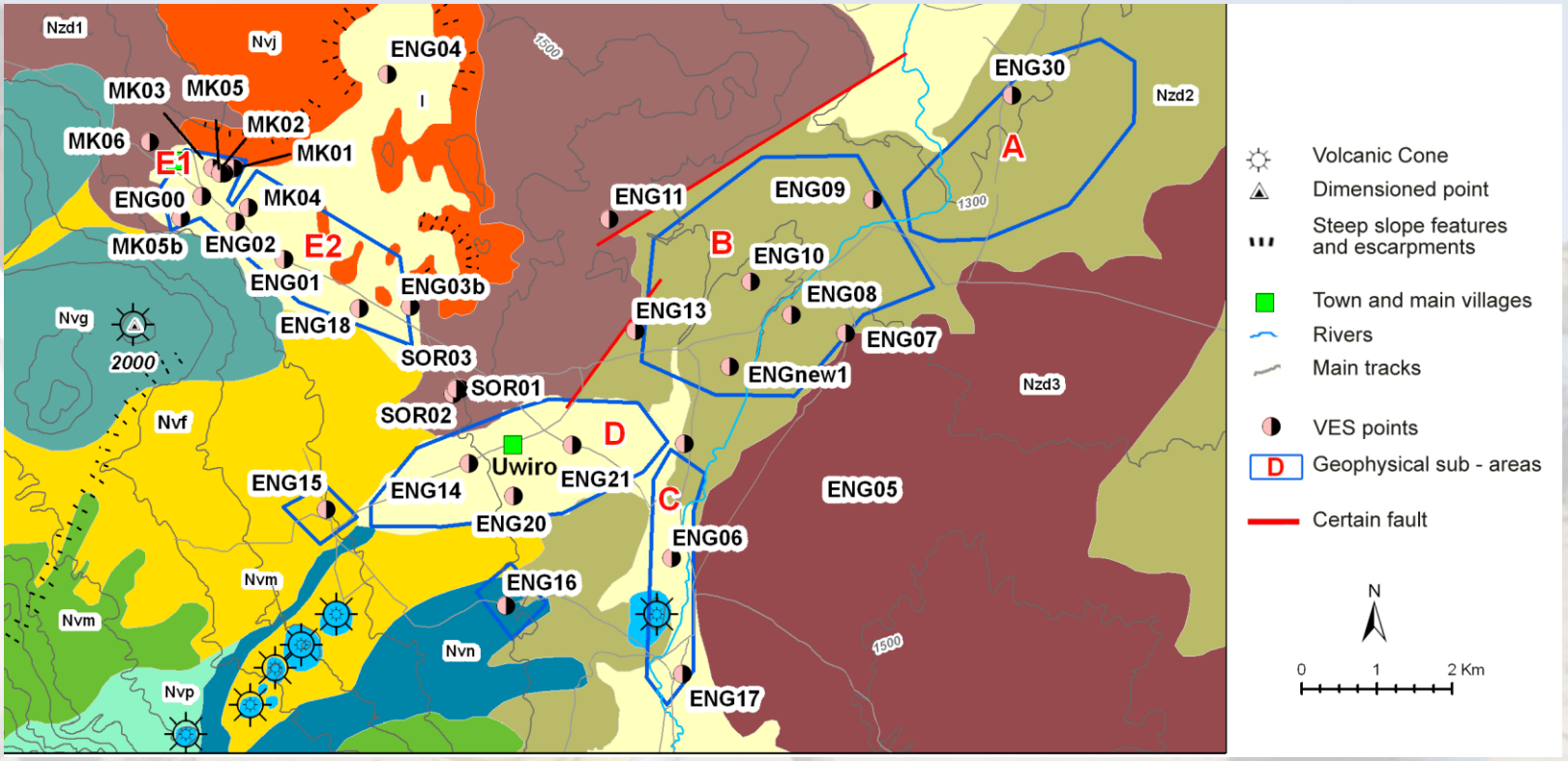
Intermediate and deep groundwater circulation systems:

- by permeability of the aquifers and elevation difference between recharge and discharge areas;
- fracturing and faulting affect brittle rocks over wide areas (e.g. Main cone group complex Nvm)

The groundwater regional flow system generally controlled by morphology and involves a multidirectional flow with the dominant pattern from the higher elevation area in the south, towards the area of lower elevation in the north.

RESULTS

Operative synthesis of the survey results



Columns 3 and 4 show, respectively, drilling suitability and a suggested maximum drilling depth. The former is scaled from 0-5, where "0" = do not drill at all, and "5" = area particularly suitable for drilling. The sub-areas in the second column are shown in Figure

Ward	Sub-area	Drilling suitability (0 - 5)	Maximum drilling depth (m)
Ngarenanyuki	A	1	40
	B	2	100
	C	1	80
	D	3	80
	E1	2	50
	E2	5	100

RESULTS: Construction of the borehole Ichnusa Well at Mkuru

Contractor OIKOS EAST AFRICA	**Borehole No.** Ichnusa Well 1	**Drilling method** Hammer drilling
Drilled by Water Solutions Drilling Company Ltd.	**Elevation (m a.s.l.)** 1545	**Drilling diameter (mm)** 254
Hydrogeological Supervisor Prof. Giorgio Ghiglieri	**UTM Coordinates (WGS 84 Zone 37S)** E: 256407 N: 9653511	**Diameter of casing (mm)** 150
Date January 2008	**Depth (m g.l.)** 64.50	**Notes**

scale (m)	Lithology	Graphic log	Water strikes (m g.l.)	Well equipment: Depth (m g.l.)	Length (m)	Type	Depth (m g.l.)	Length (m)	Type	Static level (m g.l.)
							0.50		casing pipes	
										29.88
							1.00		screen filters	
							3.00		casing pipes	

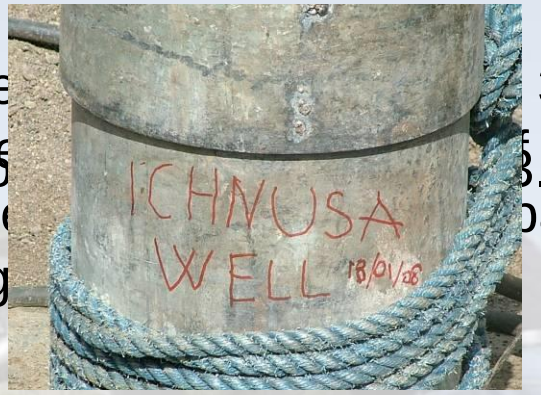
Confined aquifer with good water quality (fluo 3.1 mg/l);

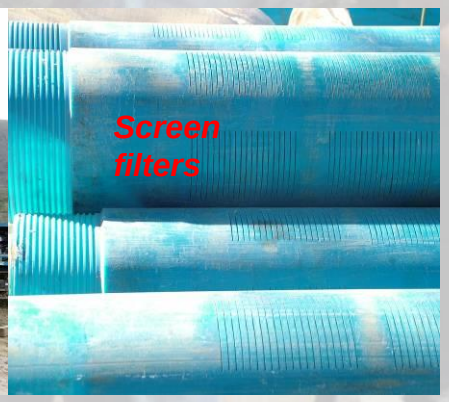
Thickne 38 and

59 m be

scoriace basalt

with hig



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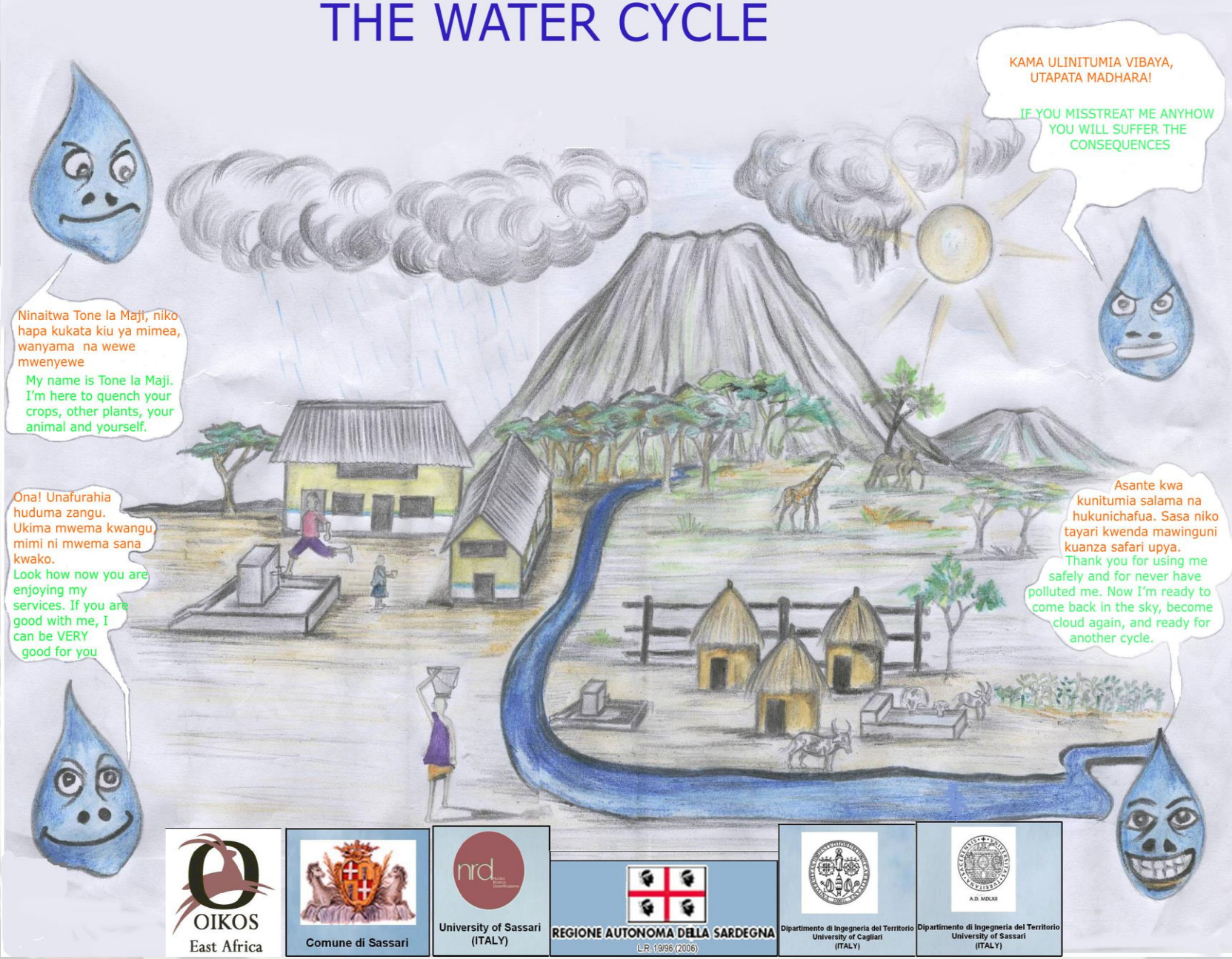
UNATEKELEZWA KWA HISANI YA SHIRIKA
LA OIKOS EAST AFRICA KWA KUSHIRIKIANA
NA JAMII YA MKURU MWAKA 2008/09
UMEZINDULIWA LEO TAREHE 10/10/2008
NA MHE..JEREMIA SUMARI (MB) NAIBU WAZIRI
WA FEDHA NA UCHUMI
Ichnusa Well 1

Azioni di sensibilizzazione sul corretto uso dell'acqua scuola di Uwiro (Tanzania)

MZUNGUKO WA TONE LA MAJI
THE WATER CYCLE



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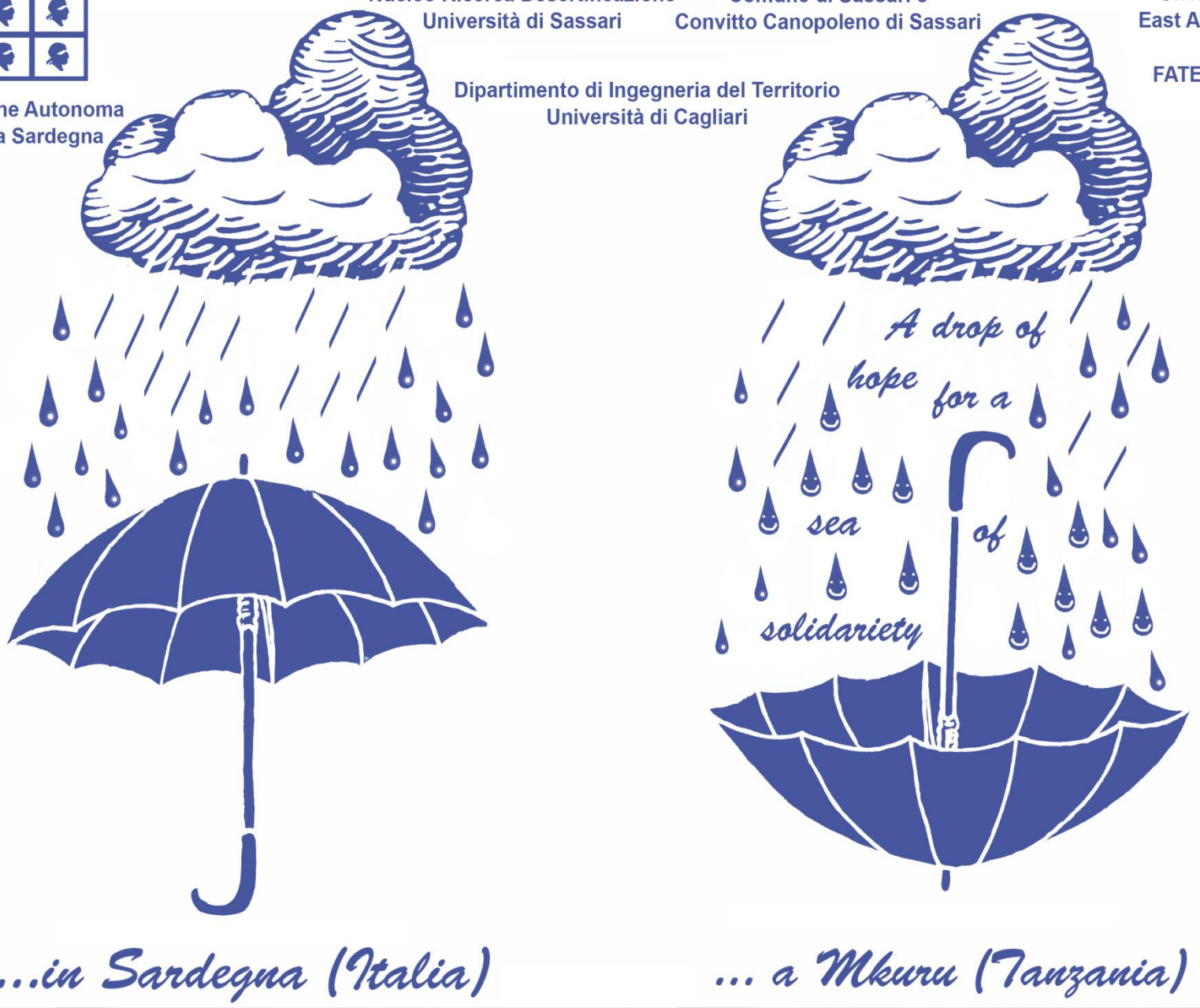

...in Sardegna (Italia)

... a Mkuru (Tanzania)


Thank you