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The impact of fluoride contamination on cropping systems: a case study from Kenya and Tanzania

Giovanna Seddaiu, UNISS

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Teaching methods

Case study-based analysis

Rural Rapid Appraisal and Participatory Rural Appraisal

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What is a case study?

- It refers to the collection and presentation of detailed information about a particular situation: **context matters**!
- It usually focuses on one specific "thing" (issue, case) (e.g., fluoride contamination in the Eastern African Rift Valley)
- It can be geographically located but also be referred to a community/individuals

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Main features of case study analysis

- In-depth analysis
- Multiple sources and data generation methods
- Holistic study
- Awareness that case study analysis is not for discovering a universal "truth", a "real" description of a situation, but rather the multiple perspectives, beliefs, understandings (**constructivist approach**)

- **The goal: a rich and detailed description of the issue/case and its relationships and processes**

- As opposed to surveys and experiments where the goal is to eliminate complex relationships and focus on few parameters

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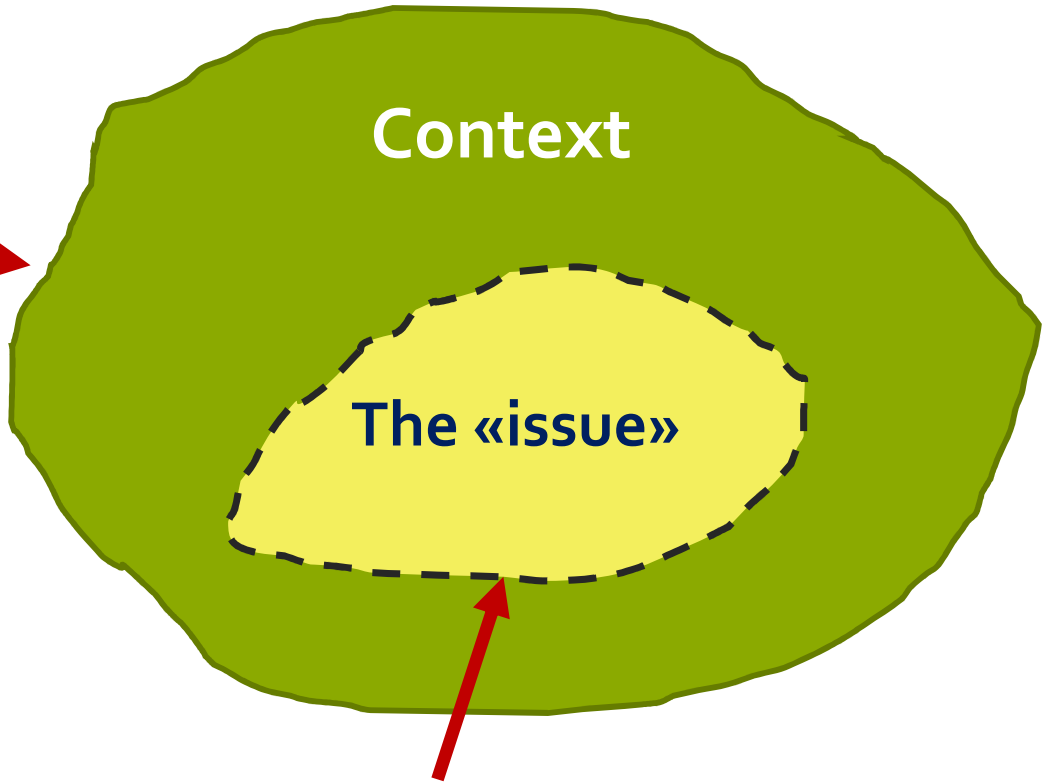
Case study analysis

Case study analysis considers the «issue», the context in which is embedded, and the relationship between them



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Why a case study research approach can be useful for agroecosystem management?

- Many current complex agri-environmental issues involve:
  - Incomplete and conflicting understandings of the situation
  - Issue boundaries that are difficult to define
  - Controversies about actions to implement because of uncertain outcomes and multiple goals (Rockström, et al., 2009)
- Resilient adaptive socio-biophysical landscapes and systems' thinking are needed because research outcomes are not adequately used in this complex "real world" (eg Failing et al. 2007)
- If our purpose is to contribute to improve complex situations, more than just a biophysical agroecosystem must be considered (Folke, et al., 2010)

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Case study research for……?

- enabling a researcher to closely examine the data within a specific context
- explore and investigate contemporary real-life phenomenon through detailed contextual analysis of a limited number of events or conditions, and their relationships
- providing a systematic way of observing the events, collecting data, analysing information, and reporting the results over a long period of time

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How to design a case study analysis for guiding sustainable agroecosystem management?

- You learn how to do things by-----
  - doing things (**learning by doing**)
  - **listening**, appreciating and exploring others' views
  - **thinking**
  - looking at the past (**lessons learned**)
  - posing **good questions** (why did it happen? Which are the major reasons of success/failure? Which are the priorities of the different stakeholders? Who is/should be involved?)
  - ……..

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Advantages of case study based approaches

- Decision-making can be easier within a context of messy-real-life situations
- Quality of decisions can improve
- Time required to take "desirable " decisions can be reduced
- The probability of taking "desirable" decisions (and thus likely more accepted and effective) can increase
- Promote a reflexive attitude ("why am I doing what I'm doing") as opposite to just following the tradition (Roling et al., 2000. Cow Up a Tree….)

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Constraints of case study based approaches

- Generalization can be difficult
- It can be time-consuming and resource-demanding
- It can be confusing (e.g. not easy to start with good questions)
- It cannot be easy to have access to data and information
- Outcomes can be biased by who is doing the analysis (but this can happen also in the positivist approach (e.g., experimental research)
- Usually criticized by "hard" scientists

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Tips

- Remember that there may be many other management strategies to be followed
- Never forget to keep an open mindset while analyzing management strategies
- Be aware that the identified strategies can be affected by pre-conceived notions about success or failure
- Identified strategies should be "desirable" (not "best") and should be practically implemented (at least in the long term)

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References on case study based analysis

- Cow up a tree: knowing and learning for change in agriculture case studies from industrialised countries 2000 pp.492 pp. (Eds. Cerf, M.; Gibbon, D.; Hubert, B.; Ison, R.; Jiggins, J. (et al)).
- Failing, L., Gregory, R., & Harstone, M. (2007). Integrating science and local knowledge in environmental risk management: A decision-focused approach. Ecological Economics, 64(1), 47-60.
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- Yin, R.K., 1984. Case Study Research: Design and Methods. Beverly Hills, Calif: Sage Publications.

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What is the Rural Rapid Appraisal (RRA)?

- It can be described as "a semi-structured activity carried out **in the field** by a multidisciplinary team and designed to acquire **quickly** new information on, and new hypotheses about, **rural life**" (McCracken et al. 1988 in RUAF, 2004.).

- It emerged in the 1970$_S$ as a more efficient and cost-effective way of learning by outsiders on case studies, particularly used for agricultural systems, than was possible by large-scale social surveys or brief rural visits by urban professionals.

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What is the Participatory Rural Appraisal (PRA)?

- It is a methodology for **interacting with a rural community** members, understanding them and learning from them. It involves a process of communicating with them using a set of menu of methods that seek **community participation**.

- Besides enabling outsiders to obtain information about the communities, PRA is intended to enable the community members to conduct and share their own investigations and analysis

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Why using RRA and PRA for researching on sustainable agroecosystem management?

- Valuable approaches for gathering information that will provide insights about people, the communities in which they live, the agroecosystems involved (RRA, PRA)
- Identification of conflicting interests between groups (RRA, PRA)
- Customize interventions according to the different priorities and perspectives of the different stakeholders involved (RRA, PRA)
- Better focus questions for "quantitative" surveys and research (RRA, PRA)
- Refine approaches and activities mid-stream as information is gathered also for monitoring purposes (PRA)
- Improve follow-up activities and inform future projects as a result of what is learned in evaluations (PRA)

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Main techniques used in RRA and in PRA (1/3)

- **Secondary data**: books, files, reports, news articles, maps, etc.
- **Observation**: direct and participant observation, wandering, DIY (do-it-yourself) activities, transect walks, etc.
- **Interviews and Discussions**. These include informal discussions, focus group discussions, semi structured interviews, etc.
- **Analytical game**: a quick game to find out a group's list of priorities, performances, ranking, scoring, or stratification.
- **Stories and portraits**: colorful description of the situation, local history, trend analysis, etc.
- **Diagrams**: System diagrams
- **Interactive Workshops**: Locals and outsiders are brought together to discuss the information and ideas intensively.

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Main techniques used in RRA and in PRA (2/3)

Transect walks in Tanzania (right) and in Sicily, IT (left)

DIY (do-it-yourself) activities

Analytical games for listing and ranking SHs priorities

SHs	SH1	SH2	SH3	SHn	Median
Priorities					
Priority 1	9	2	5	9	7.0
Priority 2	2	5	5	1	3.5
Priority 3	9	9	9	8	9.0
…	…	…	…	…	…

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Main techniques used in RRA and in PRA (3/3)

Semi-structured interview in Tanzania (Dec 2016)

Focus group discussion in Sardinia, IT (Jun 2013)

Interactive workshop in Sardinia, IT (Jun 2013)

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Possible dangers and limitations of PRA

- Difficulty in getting exact information
- Difficulty in finding the right questions to ask
- Not enough time to spend with the rural community
- Difficulty in finding the right interdisciplinary team
- Lack of experience of team members, particularly lack of skills in the field of communication and facilitation
- No right attitude of team members (no neutral, no respectful, no good listeners, etc.)
- Overlooking opinions and demands of low power stakeholders
- Lack of institutional support
- PRA becoming a fashionable label to satisfy institutional and/or donor expectations for "participatory approaches"
- Lack of interest by community members to participate

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Hints for a successful PRA

- Team members attitude: more listening than talking
- The team from outside should be multidisciplinary in nature and each one has to play a clear role
- Create trust with people
- Organize do-it-yourself activities at the start
- Identify carefully key informants
- Choose places where to meet with stakeholders with key informants
- Create an open and enabling atmosphere to encourage participation
- Ask open-ended questions in an informal way
- Be respectful, flexible, sensitive, neutral

Some readings and RRA and PRA

- Menconi et al., 2017. European farmers and participatory rural appraisal: A systematic literature review on experiences to optimize rural development. Land Use Policy, 60, 1-11.
- McCracken, J.A., Pretty, J.N. and Conway, G.R., 1988. *An Introduction to Rapid Rural Appraisal for Agricultural Development*. IIED, London.
- Narayanasamy, N., 2009. Participatory Rural Appraisal: Principles, Methods and Application (New Delhi, India: SAGE Publications India Pvt Ltd.
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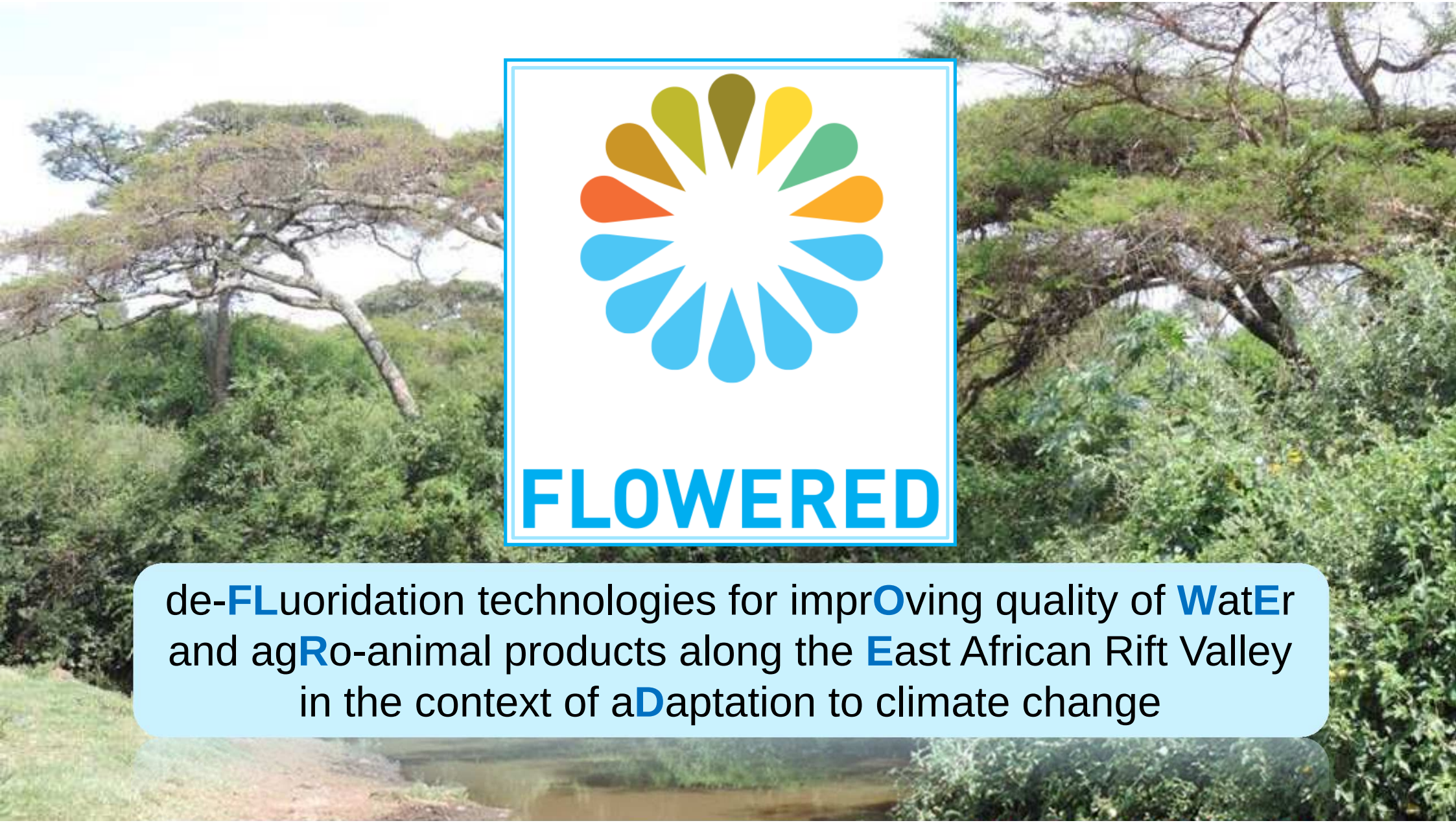


FLOWERED

de-**FL**uoridation technologies for impr**O**ving quality of **W**at**E**r and ag**R**o-animal products along the **E**ast African Rift Valley in the context of a**D**aptation to climate change

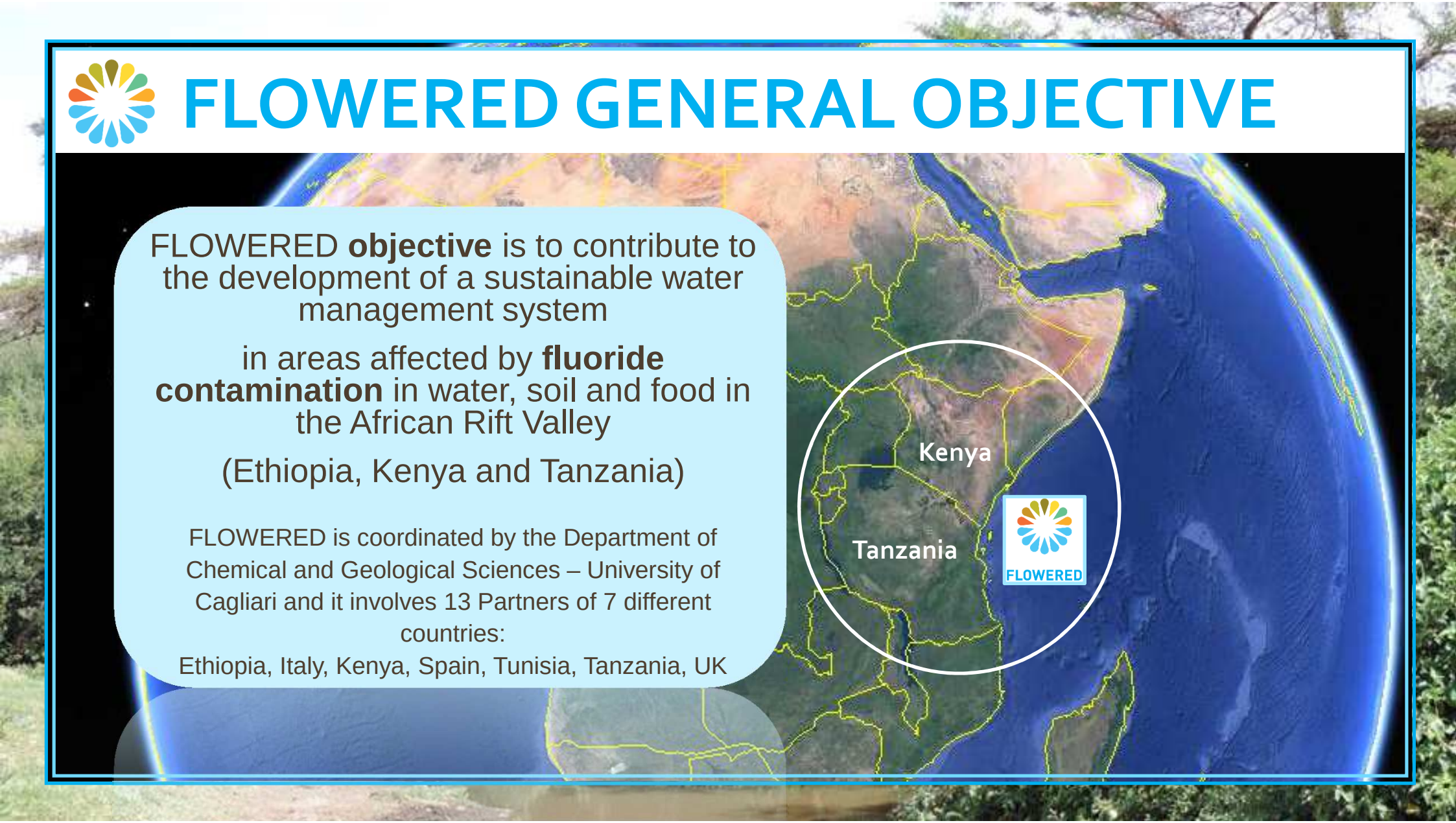
FLOWERED GENERAL OBJECTIVE

FLOWERED **objective** is to contribute to the development of a sustainable water management system

in areas affected by **fluoride contamination** in water, soil and food in the African Rift Valley

(Ethiopia, Kenya and Tanzania)

FLOWERED is coordinated by the Department of Chemical and Geological Sciences – University of Cagliari and it involves 13 Partners of 7 different countries:
Ethiopia, Italy, Kenya, Spain, Tunisia, Tanzania, UK



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Specific objective for UNISS

To provide scientific evidences on benefits and constraints of a selection of existing and *innovative mitigation strategies* for fluoride contamination of water (for irrigation and drinking for animals) and cultivated soils in *cropping and livestock systems* of case study areas of Tanzania and Kenya

FLOWERED

CASE STUDY AREAS

bimodal rainfall patterns alternating a long (Feb/Mar - May) and a short rainy season (Oct - Dec) with the remaining months dry

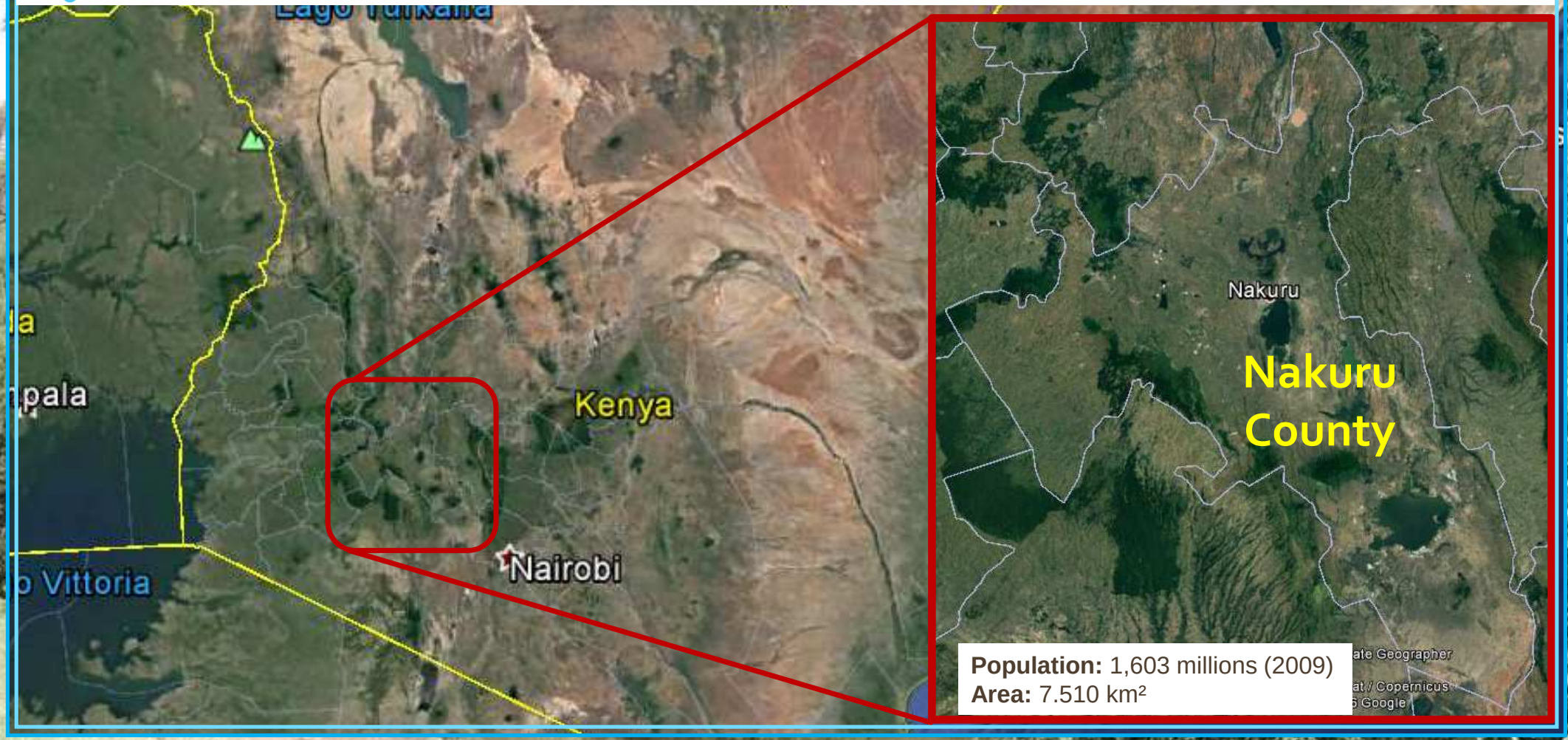
Annual rainfall range:
500 mm - > 1000 mm depending on the altitude and physical features

some areas can be quite arid and this influence the movement and accumulation of salts in the soils

storms in the rainy season often associated to intense surface water flow, also influencing fluoride contamination of soils downward the water streams

higher levels of F in areas of lower rainfall, elevated average temperatures, low altitude, low slopes

KENYA


Kenya
Nairobi
Nakuru
Nakuru
County
Population: 1,603 millions (2009)
Area: 7.510 km²

TANZANIA


Burundi
Tanzania
US Dept of State Geographer
Ngare Nanyuki Ward
Ngare Nanyuki
Mount Meru Forest Reserve
Arusha National Park
Arusha
Singisi
kikatiti
ONE DI ARUSHA

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Case study analysis

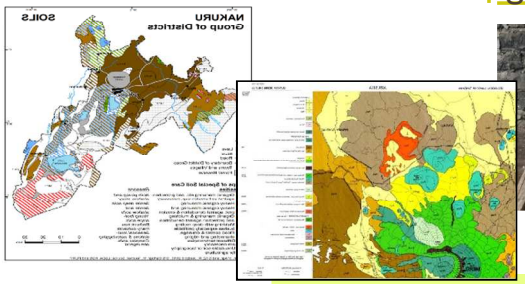
Fluoride contamination and cropping and livestock systems

Three main approaches

(i) **secondary data** collection

(ii) **interviews and focus group and transect walks** discussions with key informants and local stakeholders

(iii) administration of a **questionnaire at household scale**



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Why a case study-based approach?

- To get deep insights of the fluoride contamination issue with a **systemic and holistic approach** (not sectorial, not only scientific…)

- To design mitigation strategies for cropping and livestock systems that are grounded on the integration of scientific and lay knowledge and, thus, that are feasible and meaningful at local scale ("**desirable**" (not "best") practices)

- To **build trust** with local stakeholders and enhance the **effectiveness** of the research outcomes in the

Engaging local people.....

FLOWERED

Appendix 2. Household consumption of food over past one week

Within the past 7 days, did the members of this household eat/drink any the items below within the household?

ITEM CODE	ASK THIS QUESTION FOR ALL ITEMS, BEFORE MOVING ON TO THE NEXT QUESTIONS FOR ITEMS WITH YES	Yes 1 No 2	How much in total did your household consume in the past 7 days? KILOGRAMS.....1 GRAMS.....2 LITRE.....3 MILLILITRE....4 PIECES.....5		How much came from own-production? IF NONE WRITE 0 FOR QUANTITY AND LEAVE UNIT BLANK	
			UNIT	QUANTITY	QUANTITY	UNIT
Cereals and Cereal products						
0101	Rice (paddy)					
0102	Rice (husked)					
0103	Maize (green, cob)					
0104	Maize (grain)					
0105	Maize (flour)					
0106	Millet and sorghum (grain)					
0107	Millet and sorghum (flour)					
0108	Wheat, barley grain and other cereals					
0109	Bread					
0110	Buns, cakes and biscuits					
0111	Macaroni, spaghetti					
0112	Other cereal products					

Appendix 4. Household livestock: feeding and watering

	ITEM CODE		What have been for this household the major feeding practices for [ANIMAL] in the last 12 months? ONLY GRAZING/SCAVENGING...1 MAINLY GRAZING/SCAVENGING WITH SOME FEEDING.....2 MAINLY FEEDING WITH SOME GRAZING/SCAVENGING.....3 ONLY FEEDING (NO GRAZING AND NO SCAVENGING).....4 TETHERING.....5 OTHER, SPECIFY.....6	In case of feeding, what kind of feeds are used? Specify also if they are mainly produced by the household or if they are bought.	How frequently, on average, has this household watered [ANIMAL] in the last 12 months? ANIMALS GET ON THEIR OWN FROM AVAILABLE SOURCES.....1 ONCE A DAY.....2 TWICE A DAY.....3 THREE TIMES A DAY.....4 THROUGHOUT THE DAY.5 OTHER, SPECIFY.....6	What have been the main sources of water for [ANIMAL] in the past 12 months? TAP WATER=1; BOREHOLE=2; DAM=3; WELL= 4; RIVER=5; SPRING= 6; STREAM=7; CONSTRUCTED WATER POINTS=8; RAINWATER HARVESTING=9; OTHER, SPECIFY=10	Did anyone in this household move with the herds away from the household for more than one week to look for water or pasture?
LARGE RUMINANTS	1	BULLS					
	2	COWS					
	3	STEERS					
	4	HEIFERS					
	5	MALE CALVES					
	6	FEMALE CALVES					
SMALL RUMINANTS	7	GOATS					
	8	SHEEP					
POULTRY	9	CHICKENS					
	10	DUCKS					
	11	OTHER POULTRY					
OTHER ANIMALS	12	RABBITS					
	13	DONKEY					
	14	DOGS					
	15	PIGS					

Appendix 8. SOIL AND IRRIGATION WATER BY PLOT

PLOT ID	PLOT NAME	HOW STEEP IS THE SLOPE OF THIS PLOT? Flat 1 Slightly sloped 2 Very steep 3 Irregular 4	WHAT IS THE SOIL TYPE OF THIS PLOT? SANDY 1 LOAM 2 CLAY 3 OTHER, SPECIFY 4	WHAT IS THE SOIL QUALITY OF THIS PLOT? GOOD 1 AVERAGE 2 BAD 3	IS THIS PLOT USUALLY IRRIGATED? Yes 1 No 2	WHAT IS THE TYPE OF IRRIGATION? Flooding 1 Sprinkler 2 Drip irrigation 3 Bucket/watering can 4 Water hose 5 Other, specify 6	WHAT IS THE SOURCE OF THE WATER? Well 1 Borehole 2 Pond/Tank 3 River/Stream 4 Other, specify 5	WHAT IS THE QUALITY OF THE IRRIGATION WATER USED IN THIS PLOT? GOOD 1 AVERAGE 2 BAD 3
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
.....								
n								

FLUORIDE ISSUE IN EASTERN AFRICAN COUNTRIES

EFFECTS

detrimental effects on agricultural and livestock products

skeletal abnormalities and dental fluorosis

affection of the nervous system of the developing foetus at doses that are not toxic to the mother instead

reduced IQ and behavioural disorders

need to import "clean water" from other areas

socio-economic and environmental costs (in terms of emissions and pollution) associated with road transport

reduction of available fresh water in the target-areas

High levels of F in community drinking water and in the food chain

CAUSES

active volcanic region where bedrock contain high concentrations of F

soil and groundwater contamination

water-rock interaction processes

lack of mitigation options

limited knowledge on the uptake behaviour and effects of F in crops

limited investigations of the effects of F on domestic and wild animals drinking and eating from contaminated sources

lack of reliable and affordable F removal technologies for the poor communities

lack of investigation on implications (public health, technology acceptance, environmental and economic impacts) of current F removal technologies applied in local communities

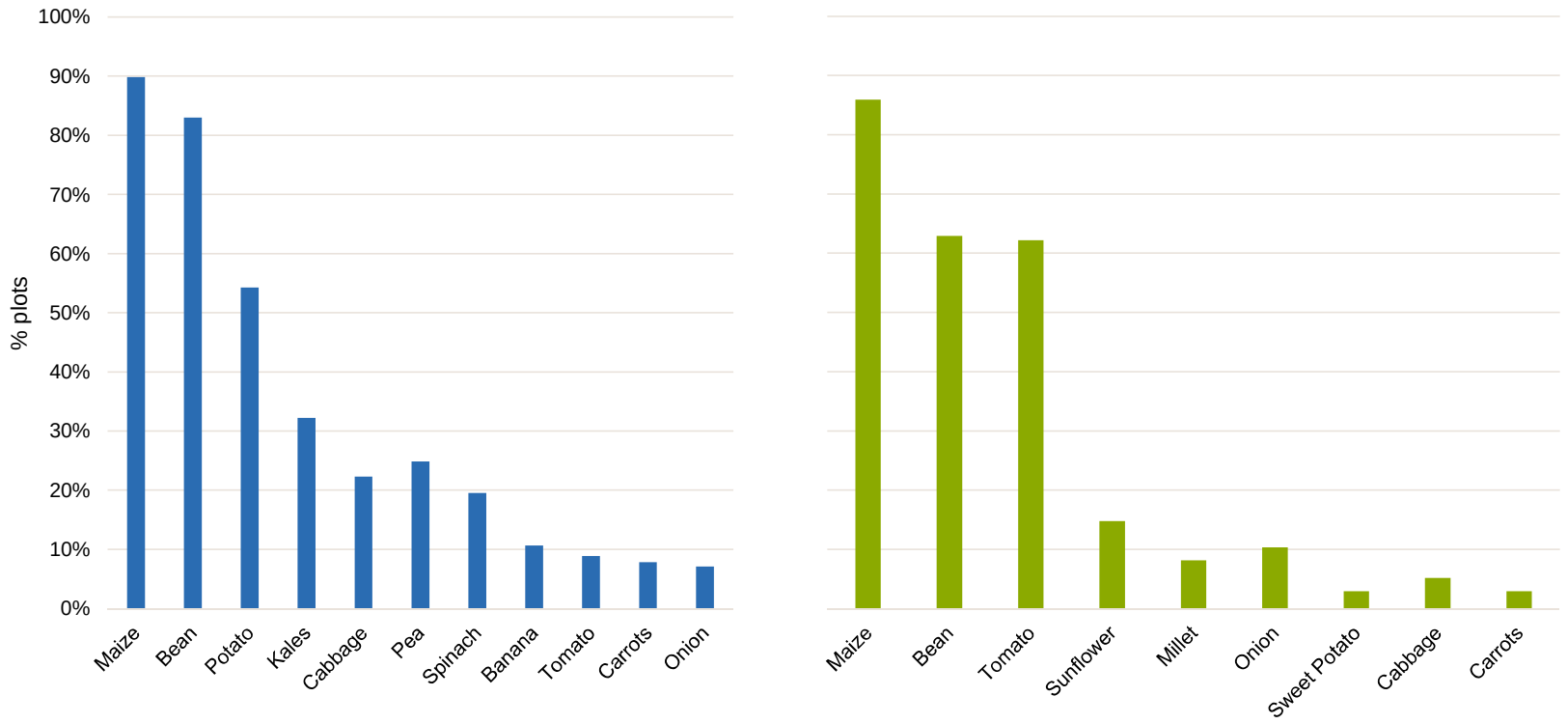
overexploitation of groundwater to cover increasing needs of rapidly expanding urbanization and tourism

migration of many farmers and herdsmen from mountains to urban centres to seek employment and more income

demand for fresh vegetables and fruits

boom in the touristy sector

Percentage of occurrence of plots cultivated by different crops in the surveyed plots in Kenya (a) and Tanzania (b)



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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

		Kenya			Tanzania	
Agricultural practices	Maize (%)	Beans (%)	Potato (%)	Maize (%)	Tomato (%)	Pulses* (%)
Most common source of irrigation water						
River/Stream	3	3	3	55	89	49
Borehole	3	2	3	4	2	5
Well	-	-	-	1	1	2
Borehole	-	-	-	1	1	2
Pond/Tank	1	1	1	-	-	-
Piped water	1	1	-	-	-	-
Farrow irrigation	-	-	-	-	-	-
None	93	93	91	40	12	43
Common fate of what is harvested						
Consumed within household	54	60	53	93	89	94
Sold fresh to local market	49	44	49	4	4	6
Sold fresh to not local market	11	7	10	2	7	0
Feed for own animals	11	3	8	1	0	0
Transformed into by-product	10	3	1	-	-	-

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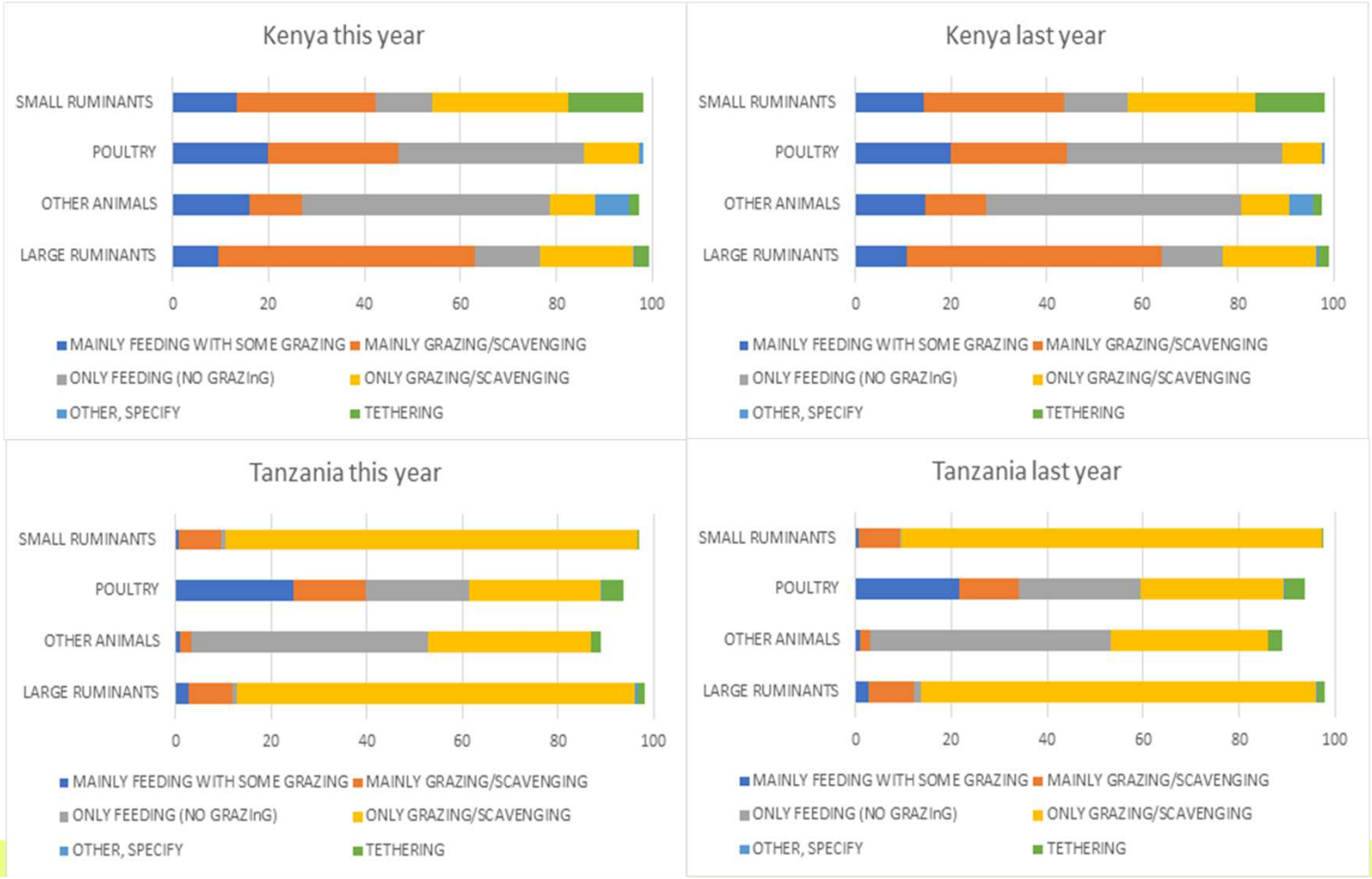
de-FLuoridation technologies for imprOving quality of WatEr and agRo-animal products along the East African Rift Valley in the context of aDaptation to climate change



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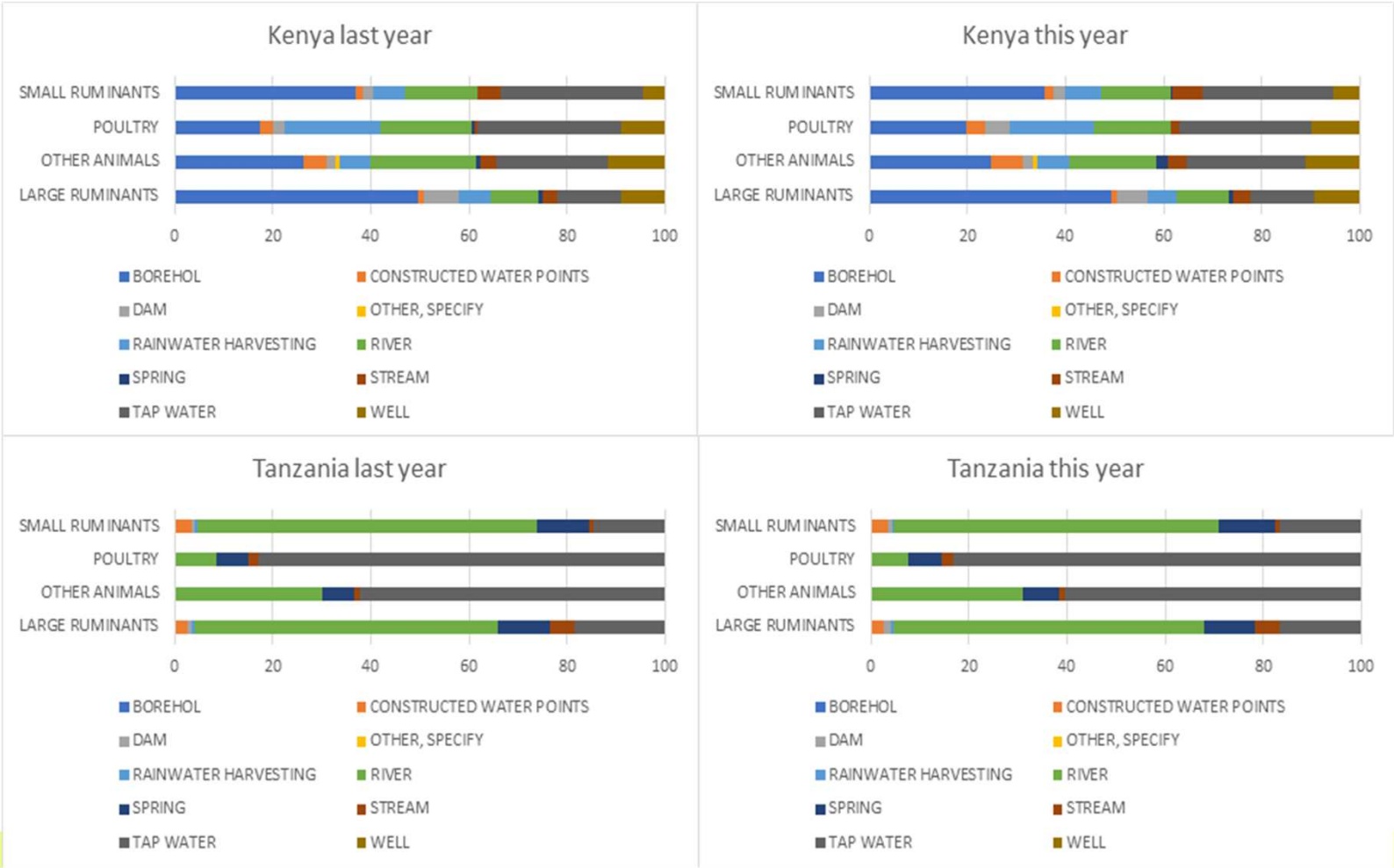


Some findings….

- the very limited use of irrigation water in the Kenyan study area for the most important crops suggest that the food products may be less affected by fluoride
- The surveyed Tanzanian farms are highly relying on irrigation and, therefore, they can be much more vulnerable to fluoride contamination
- The planned studies on fluoride transfer from water to livestock will need to, at the very least, consider poultry and ruminants as separate units given the difference in water supply

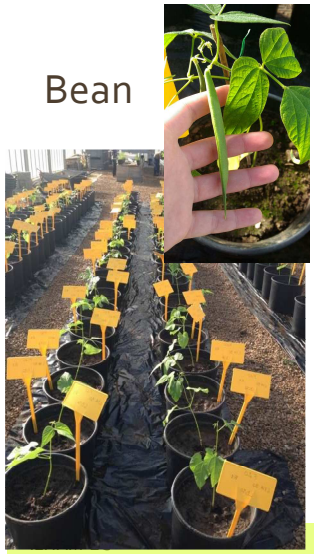
On going and next steps

Crop evaluations at two different scales: **mesocosm** and **field**:

Plant level (mesocosm): effects of soil amendments, water quality and their interaction

Sukuma wiki

Bean



Tomato

Maize

Field pilot scale: comparison of the most suitable soil amendments according to the mesocosm findings with no amendment treatment