Groundwater-based natural infrastructure solutions: The missing link to resilience?”

28 Aug 2018 | 11:00-12:30 | NL Pillar Hall

Id:7832

GRIPP
GROUNDWATER SOLUTIONS INITIATIVE FOR POLICY AND PRACTICE

IWMI
International Water Management Institute

WaterforF
ROBERT B. DAUGHERTY at the University

igrac
International Groundwater Resources Assessment Centre

IGES
Institute for Global Environmental Strategies

CAWR
Center for Advanced Water Research

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Managed Aquifer Recharge in Nebraska

Nick Brozovic, Director of Policy
Daugherty Water for Food Global Institute

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Water for Fo
ROBERT B. DAUGHERTY I
at the University c

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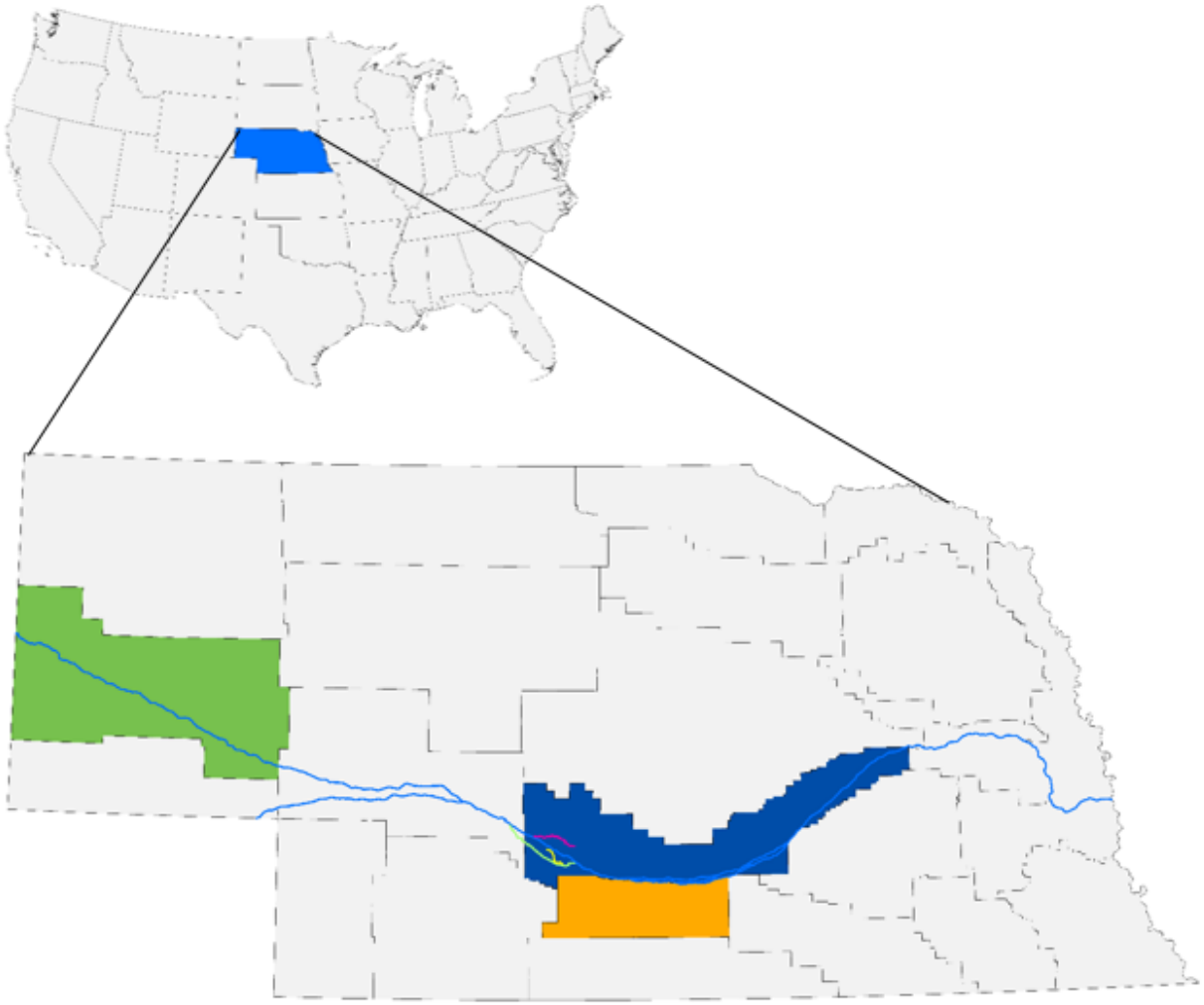
Nebraska overview

- Large irrigated area
- Management issues around transboundary surface water allocation and endangered species
- Strong local groundwater governance system (Natural Resources Districts)
- MAR efforts to use flood flows to increase recharge for both irrigation and ecosystem purposes



Irrigation Canals - Central Platte NRD

Central Platte NRD is a public groundwater management agency that has been rehabilitating and reoperating private canal infrastructure. Goals:

1. Ensure continued delivery of surface water for irrigation
2. Re-time surface water flows into the adjacent Platte River
3. Use excess flow diversions from the river to recharge groundwater via canals

Total expenditures $15 million over 5 years

Irrigation Canals – Central Platte NRD

Other approaches

Canals

North Platte NRD diverts excess springtime flows to irrigation canals, paying drainage companies to do so

Wetlands

The Tri-Basin NRD delivers excess flows from the Platte River to five wetlands:

- Ensures additional flooded wetland habitats for migratory birds
- Contributes to groundwater recharge under the wetlands

Other approaches

- **Tri-Basin NRD** has installed check structures along a creek to slow streamflow and facilitate groundwater recharge.

- The inter-state **Platte River Recovery Implementation Program** (PRRIP) works to improve endangered species habitats along the Platte River. PRRIP has created 6.5 miles of small earthen berms (constructed wetlands) over a 1.7 km^2 area along the Platte River for habitat and recharge.

MAR lessons learned

- Collaboration between multiple entities is essential for MAR development and implementation
- Many projects reoperate existing canal infrastructure
- Project infrastructure and land acquisition costs are high
- Excess streamflow eligible for diversion and eventual recharge cannot be guaranteed each year

Payment for ecosystem services (PES) for groundwater recharge through paddy fields in Kumamoto Japan

Binaya Raj Shivakoti, Institute for Global Environmental Strategies (IGES)

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IGES Institute for Global Environmental Strategies

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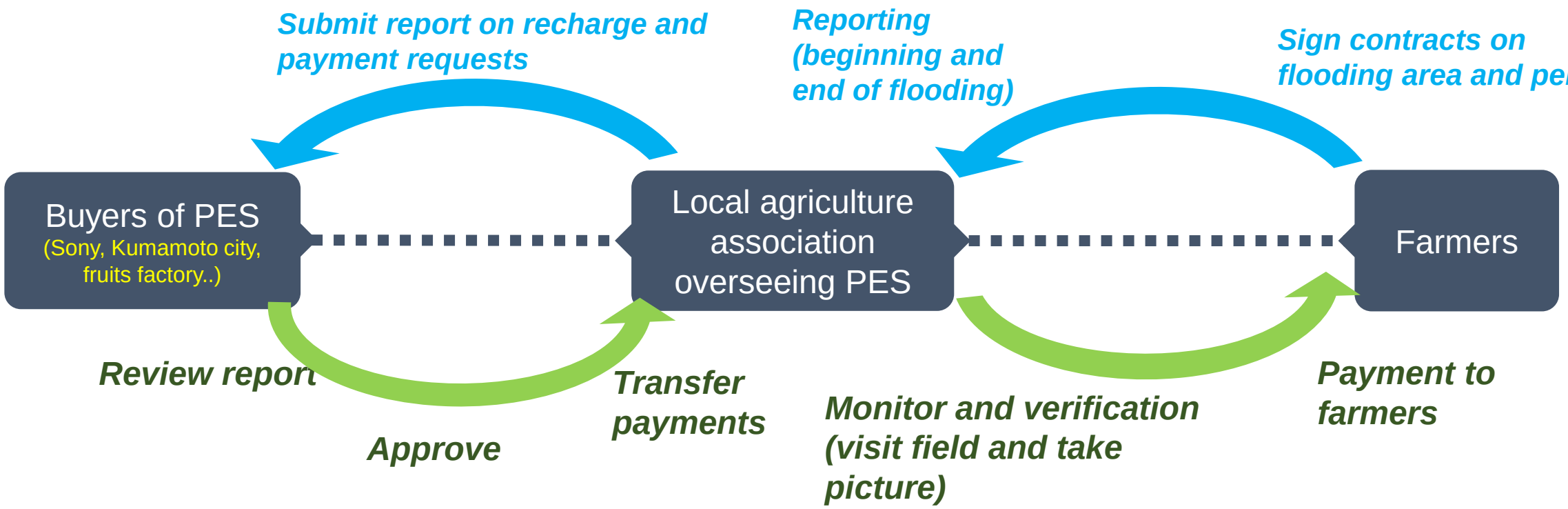
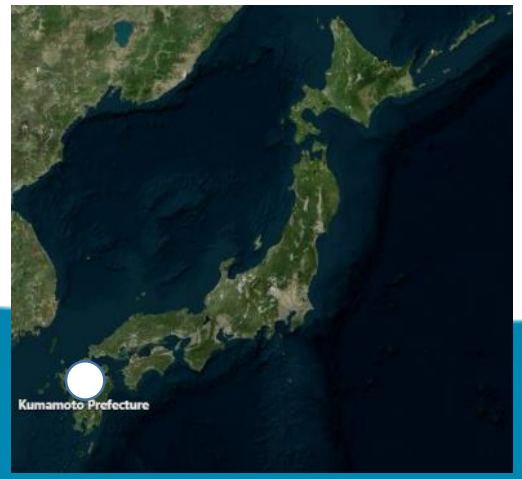
CONDITION


Submit report on recharge and payment requests
Reporting (beginning and end of flooding)
Sign contracts on flooding area and period
Buyers of PES
(Sony, Kumamoto city, fruits factory..)
Local agriculture association overseeing PES
Farmers
Review report
Approve
Transfer payments
Monitor and verification (visit field and take picture)
Payment to farmers

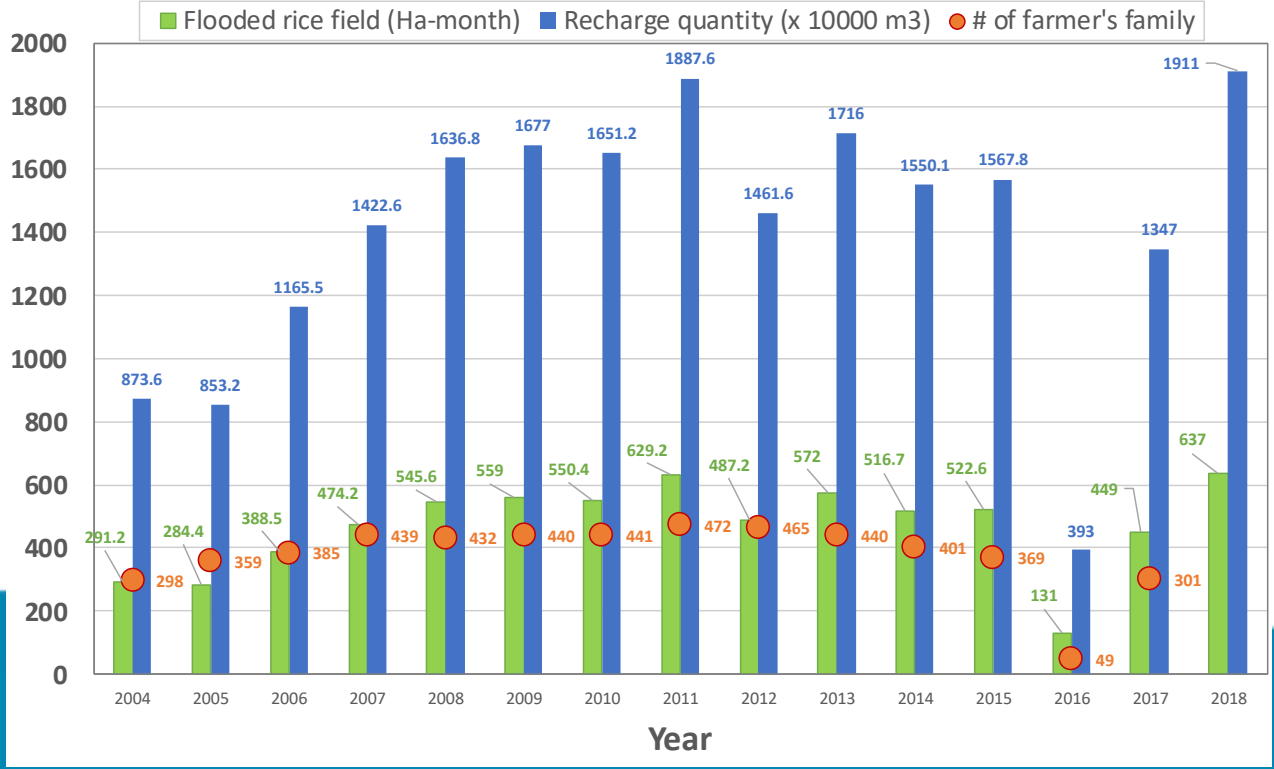

森が育む豊かな農業用水、白川中流域の田んぼがつくる、くまもとの水
水土里ネット大菊
(大菊土地改良区)


Kumamoto Prefecture

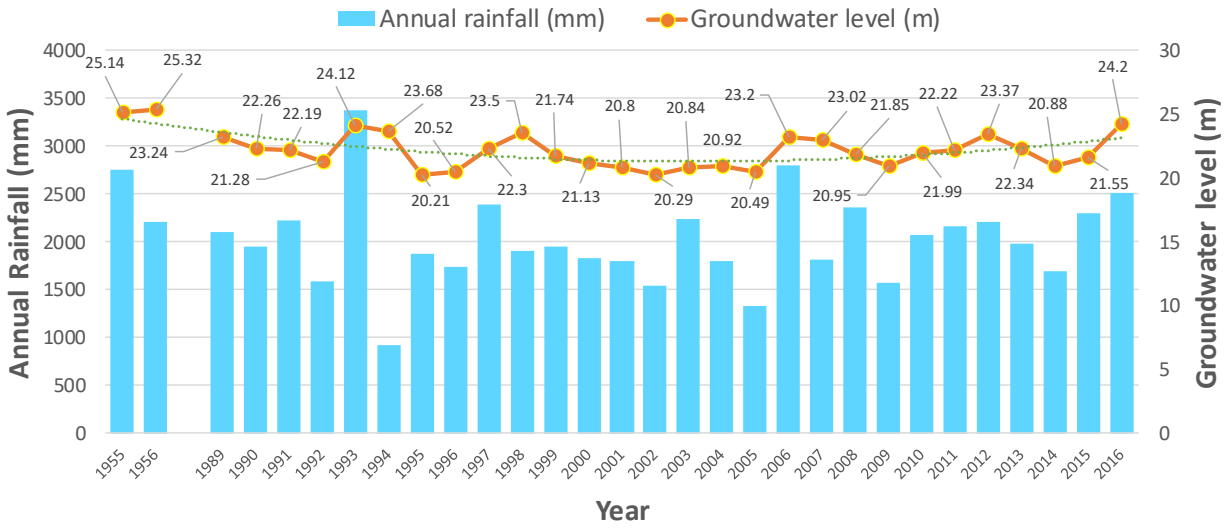
Fully operational since 2004,

The recharge area has expanded by the participation of 5 companies in addition to Kumamoto City Water Supply Utility

Expected recharge in 2018 is 19110000 m3, more than doubled since 2004;



PROGRESS/IMPACTS



Gradual recovery of groundwater table;

Beverage company SUNTORY signing a new contract with another group of farmers (11 ha area);

Groundwater recharge is one of the important water resource management priorities of the city.

LESSONS LEARNED

-PES for MAR: a unique approach developed out of a need

-Operation of PES system: transparency, flexibility, and trust

-Visible impacts

-Public support and evolution of parallel voluntary schemes

- Is this model only applicable in the developed country (i.e., Japan) situation?

- Could PES be an answer to deal with operational constraints of MAR schemes?

- Then, what are the “low hanging” options that could be readily transferred to other situations?

Underground ‘Taming’ of Floods for Irrigation, India

Paul Pavelic
International Water Management Institute (IWMI)
Vientiane, Lao PDR

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Research Program on Water, Land and Ecosystems

IWMI International Water Management Institute

RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security

Intervention/ approach

Objectives

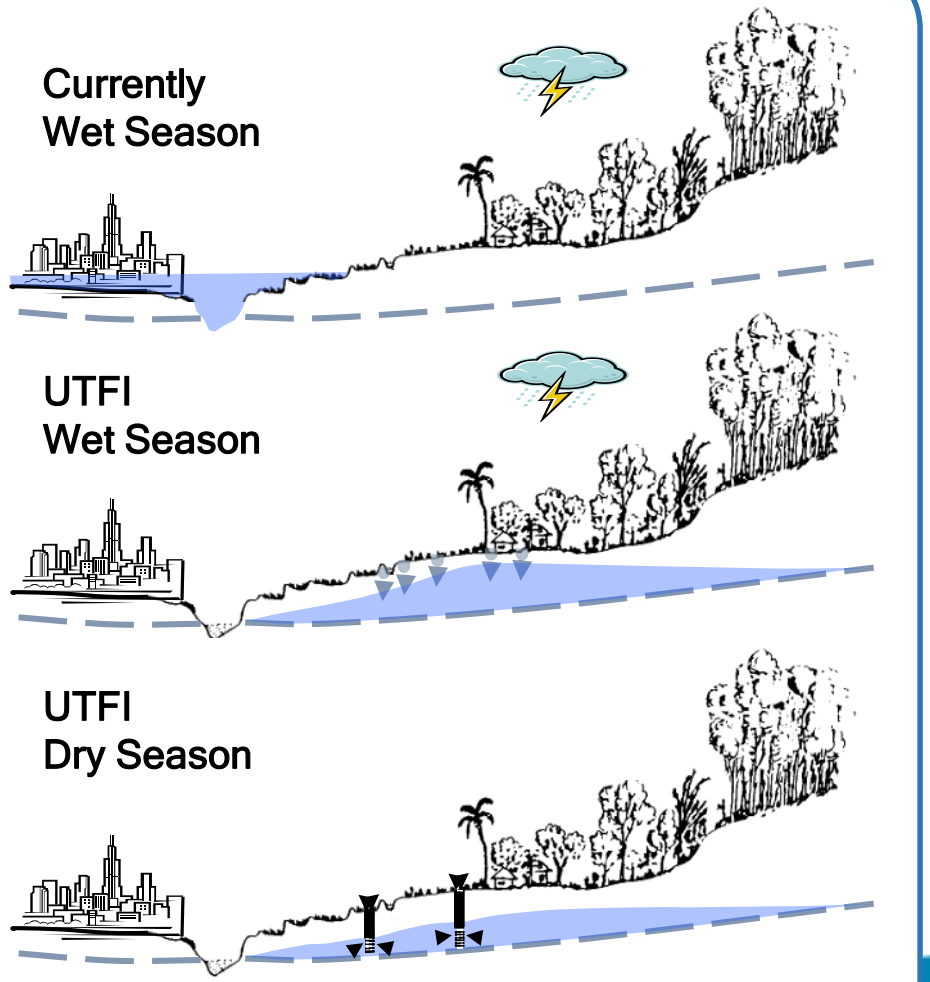
1. Develop a sound evidence-based case for Underground Taming of Floods for Irrigation (UTFI)
2. Facilitate opportunities for scaling up in prospective parts of the Ganges

Interdisciplinary Approach

Research - mapping, hydrologic/ hydraulic modelling, pilot testing (technical, social/gender, economic, institutional, environmental analysis)

Engagement - workshops, open days, dialogue, trainings

UTFI Concept



Source: IWMI

Impact / engagement

Pilot Trial

- UTFI pilot demonstration trial since 2015
- Detailed monitoring and evaluation underway
- 40-70 x10^3 m^3 excess water recharged seasonally
- '000s of village ponds underutilized in the region

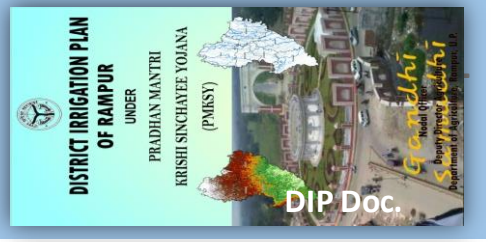
Engagement/Impact

Village Level:

Consultation with villagers

State Level:

Dist. Irrig. Plan.



District Level:

Meeting CDO, Rampur

National Level:

MWR visit

Image credits: IWMI

Community pond converted for UTFI on the Gangetic Plain. The village is periodically flooded and groundwater levels have been falling, which impact on domestic water supplies and agricultural livelihoods.

Ways Forward

Advance Knowledge:

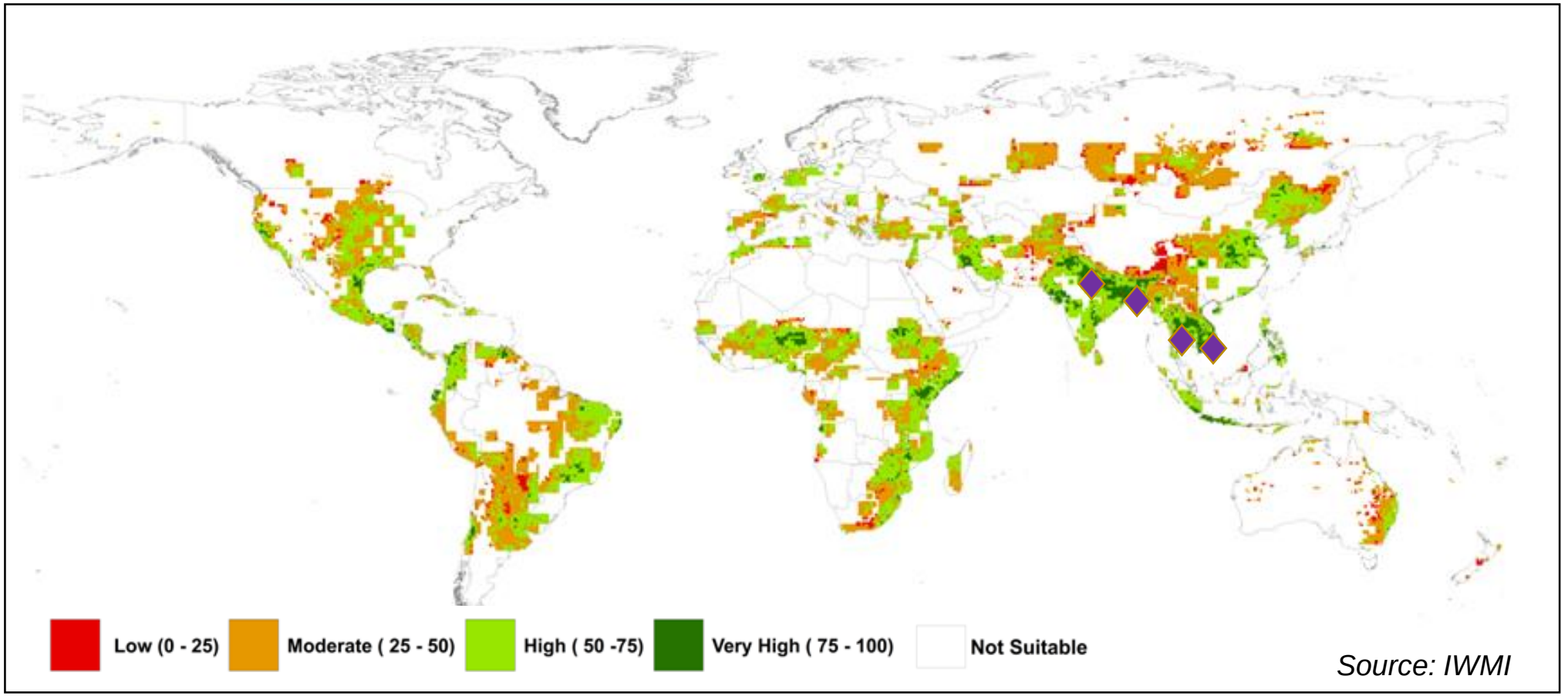
- Strengthen local institutions & governance
- Evaluate benefits to local farm households
- Establish how CC affects scaling up parameters
- Examining relationship between upstream land use practices & UTFI

Policy & Outreach:

- Support scaling up efforts
- Awareness raising

Further Information:
http://utfi.iwmi.org/

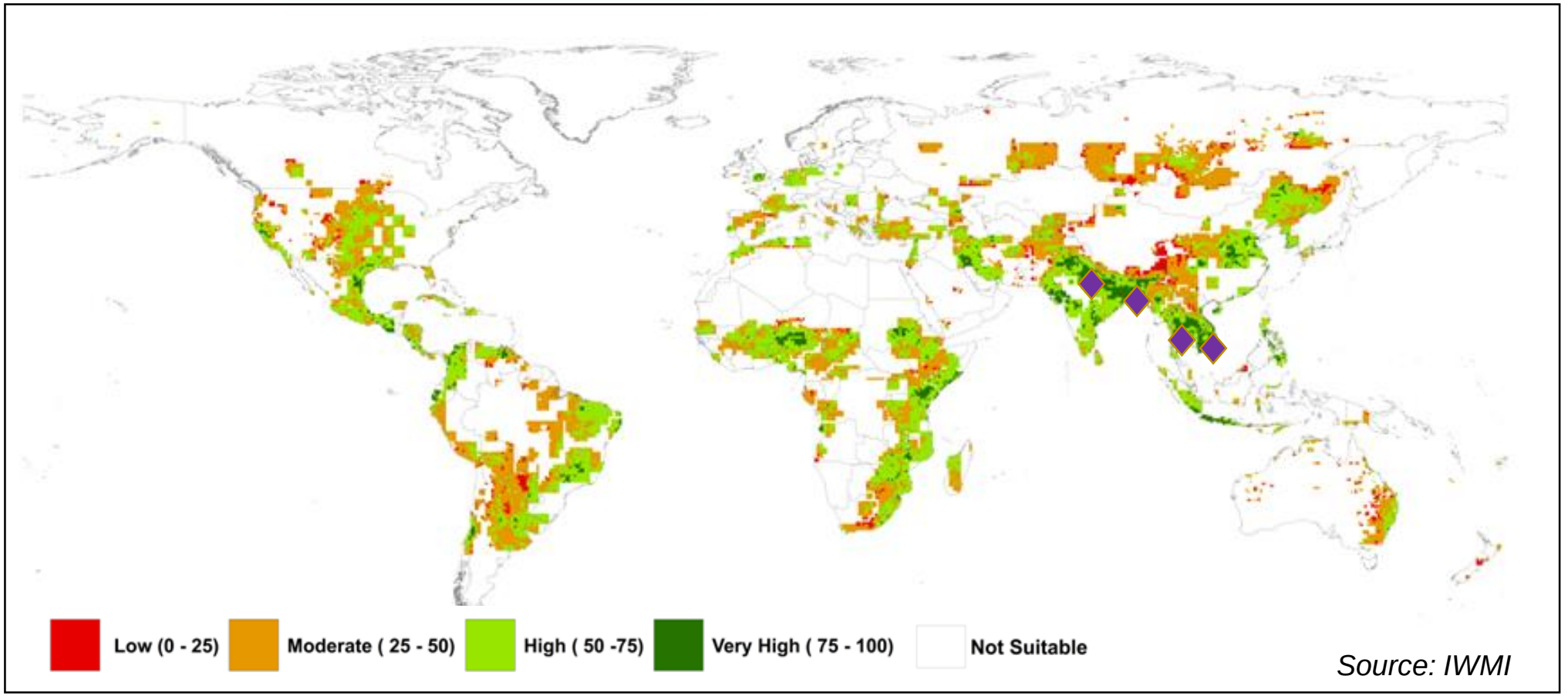
Opportunities



Green shaded areas highlight where the scope for UTFI is promising. These areas account for 50% of the global population and 40% of the crop area.

Areas where research has taken place are highlighted by diamonds (◆) above.

Opportunities



Green shaded areas highlight where the scope for UTFI is promising. These areas account for 50% of the global population and 40% of the crop area.

Areas where research has taken place are highlighted by diamonds (◆) above.

Stormwater harvesting via brackish aquifers

Andrew Ross, Fenner School of Environment and Society, Australian National University

on behalf of Peter Dillon, Peter Kretschmer, Declan Page, Joanne Vanderzalm Karen Barry, Dennis Gonzalez, Russell Martin, Nabil Gerges, Zac Sibenaler, Danni Haworth, and Paul Pavelic

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NATIONAL CENTRE FOR GROUNDWATER RESEARCH AND TRAINING

CSIRO

CITY OF Salisbury

GOYDER INSTITUTE FOR WATER RESEARCH

Government of South Australia
Department of Environment, Water and Natural Resources

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Background and rationale

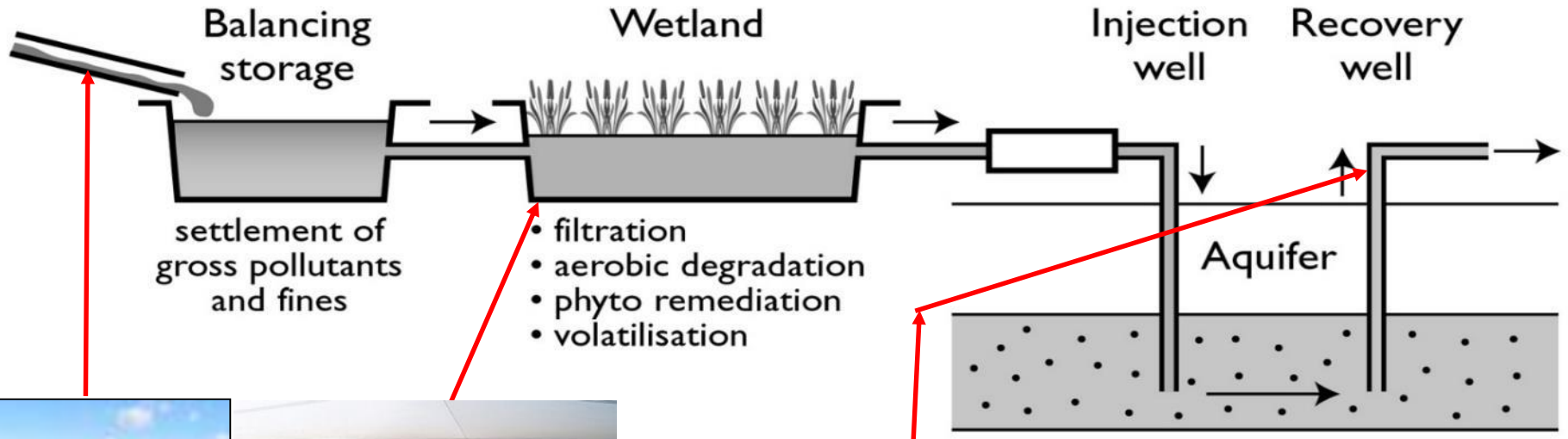
- In semi-arid urban areas, stormwater in the wet winter season is often considered a nuisance

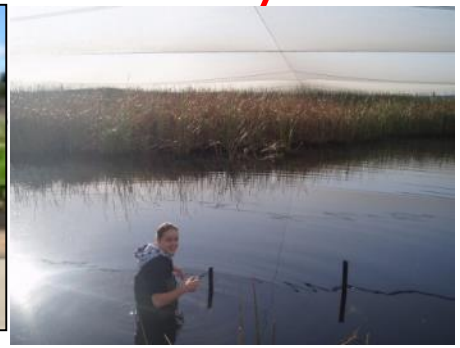
- Urban stormwater can be collected to provide a reliable summer water supply for urban green spaces and peri-urban agriculture
  - and injected into and stored in brackish aquifers

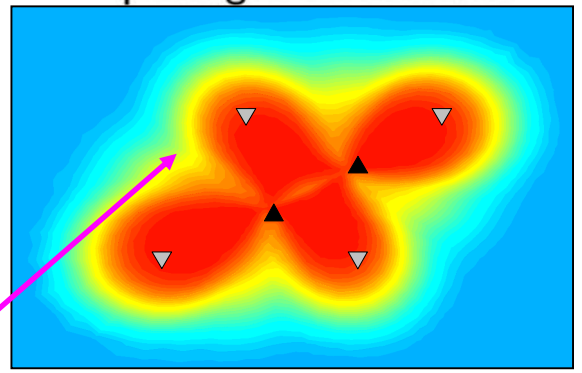
- These systems are called Aquifer Storage and Recovery (ASR) schemes.
  - In Adelaide South Australia (SA), ASR schemes were developed through government funded research and pilot operations

Approach: ASR with suburban stormwater, Andrews Farm, SA

ASR: MAR and Stormwater Use Options





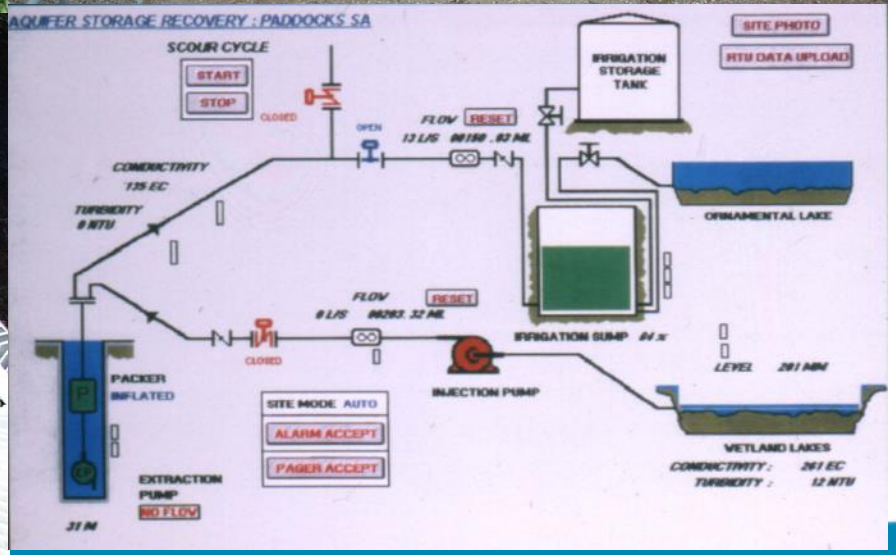


www.clw.csiro.au/astr

astr
aquifer storage transfer & recovery

Engagement: ASR with suburban stormwater: The Paddocks, City of Salisbury SA

water level conductivity & turbidity intake controls



SCADA operation

Impact and Lessons learned

In Adelaide, stormwater harvesting via ASR has been practiced since 1989

- in 2017 58 ASR schemes with stormwater and recycled water around Adelaide (10-1000 ML/year)
- currently meet ~10% of the city's water supplies.

Total recharge capacity exceeds 20 million cubic meters per year.

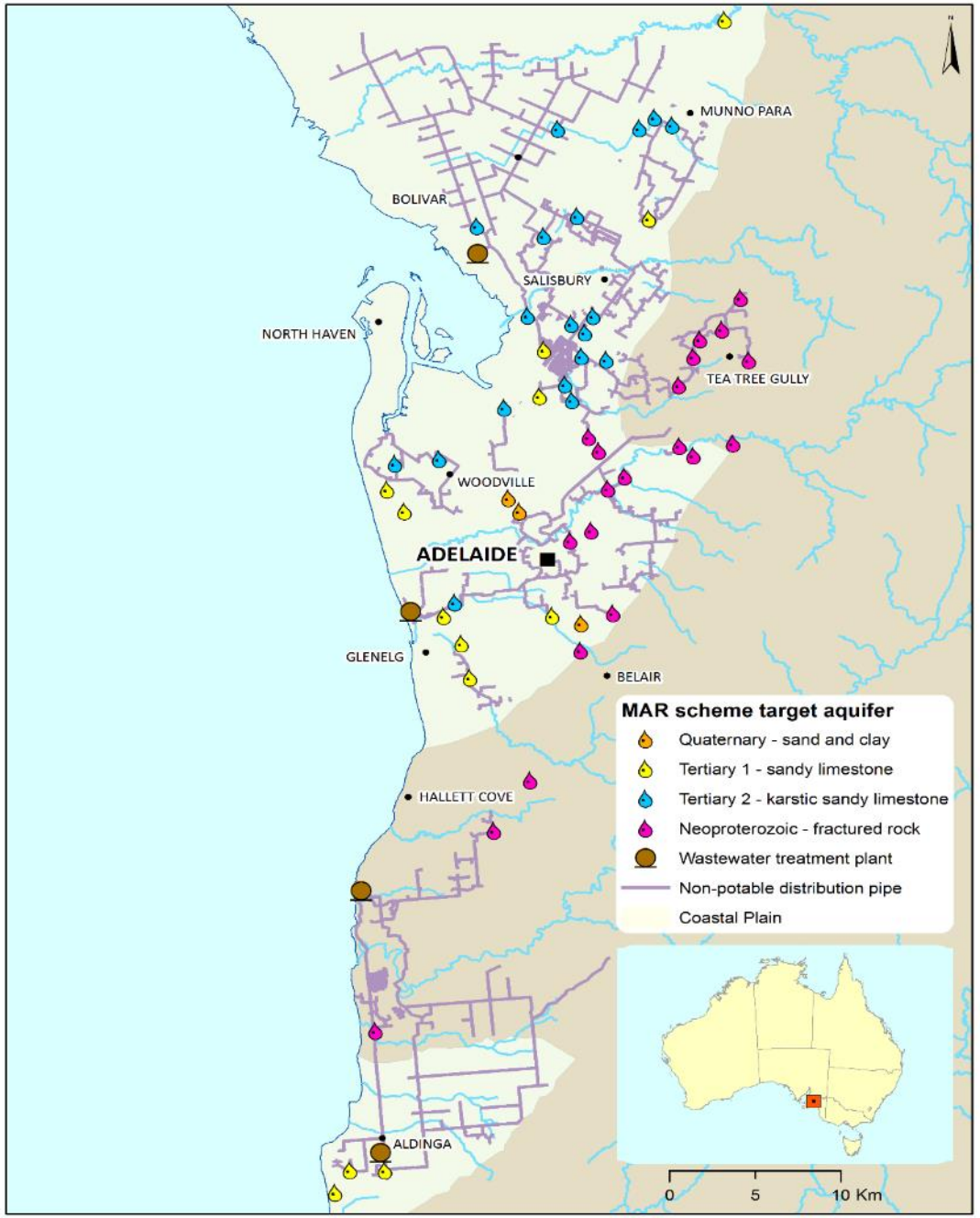
- 750 km of pipelines transfer water from pumping wells to place of use

Most Sites are operating successfully

- a few schemes had issues with equipment specification, water quality, operations or governance

Schemes based on recovered stormwater generally much cheaper than other sources

- and have higher public acceptance than desalination



Kretschmer, P. (2017) Managed aquifer recharge schemes in the Adelaide metropolitan area. DEWNR Technical Report 2017/22, Govt. of South Australia.
https://apps.geodan.nl/igrac/ggis-viewer/mim/documents/view/13201498
Dillon P., et al (2014). *Managed Aquifer Recharge Stormwater Use Options: Summary of Research Findings*, Goyder Institute for Water Research, Technical Report 14/13.

Green Roads for Water

Frank van Steenbergen/ Jesper Hornberg, MetaMeta/
Global Resilience Partnership Incubator

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Water for Food
ROBERT B. DAUGHERTY INSTITUTE
at the University of Nebraska

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Case Load

Why Green Roads: Big Scale and Big Impact

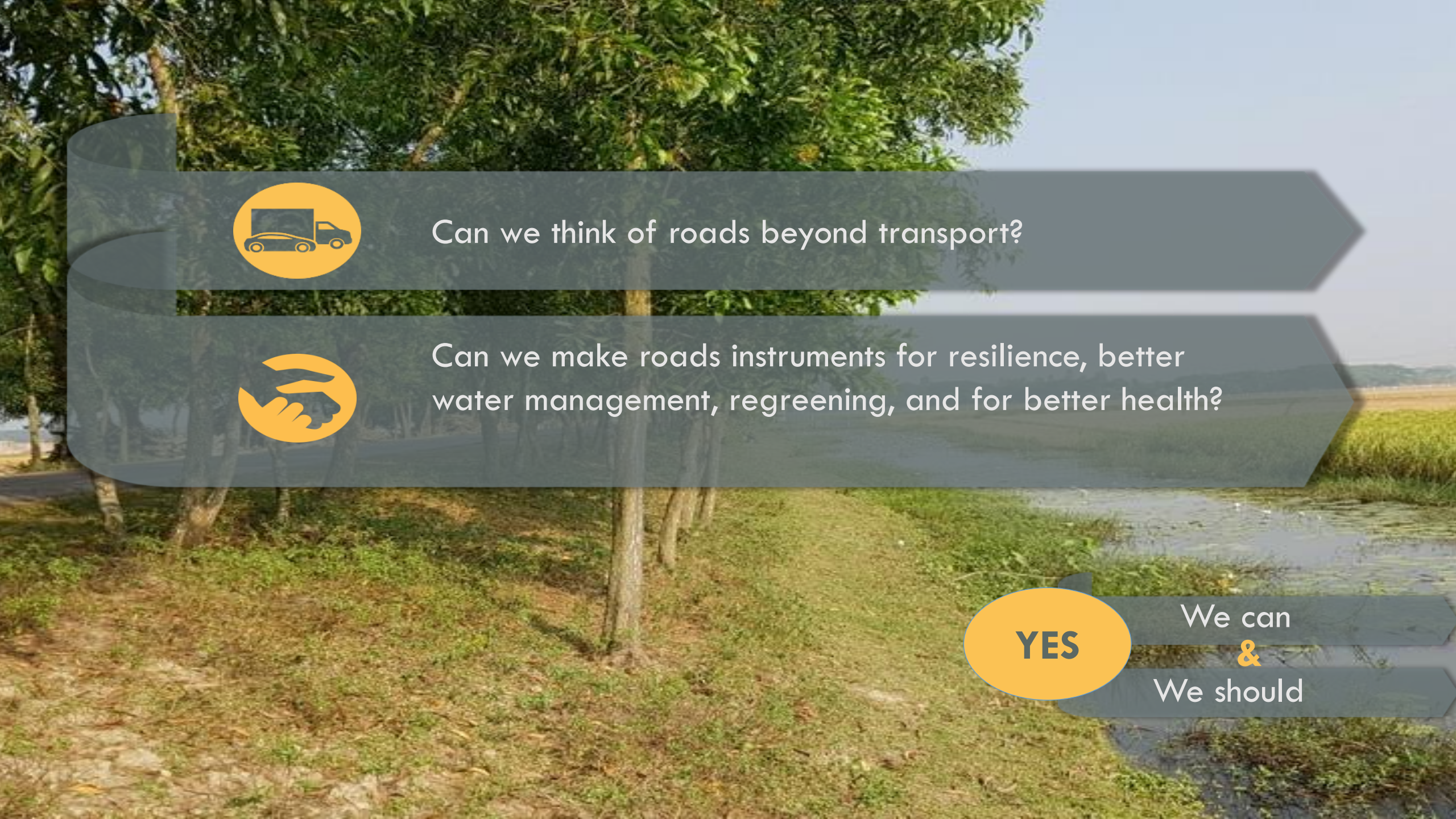
Roads are major investment globally (1-2 Tr USD/year)

For instance: road network in SSA is to increase to 2.8 million kilometer by 2025 (up 80%)

Roads are one of the major impacts on (surface and subsurface) hydrology and flood patterns and air quality

At same water causes 35-80% of road damage

Impact now often negative: turn around ‘green roads’ as instruments for (climate) resilience, beneficial water management and dust control


Can we think of roads beyond transport?
Can we make roads instruments for resilience, better water management, regreening, and for better health?
YES
We can
&
We should

Yes = many things are done:

Retaining water with road drifts

Feeding soil moisture with road drainage

Road side tree planting

Gardening with road side wells

Borrow pit converted to water storage

Road embankment creating storage reservoir

The Green Roads Initiative: what are the ambitions?

- To promote Green Roads: to have roads for systematically used for water management, regreening and climate resilience as an industry standard in at least 50% of countries in the world by 2025
- To fast track climate change adaptation by retooling roads for water and regreening and at the same time have more reliable transport connections

- Global Road Achievement Award 2015
- Runner Up Resilience Award 2018
- Active in 12 countries
- World Bank Global Guidelines in preparation
- Road for Water Campaigns since 2015

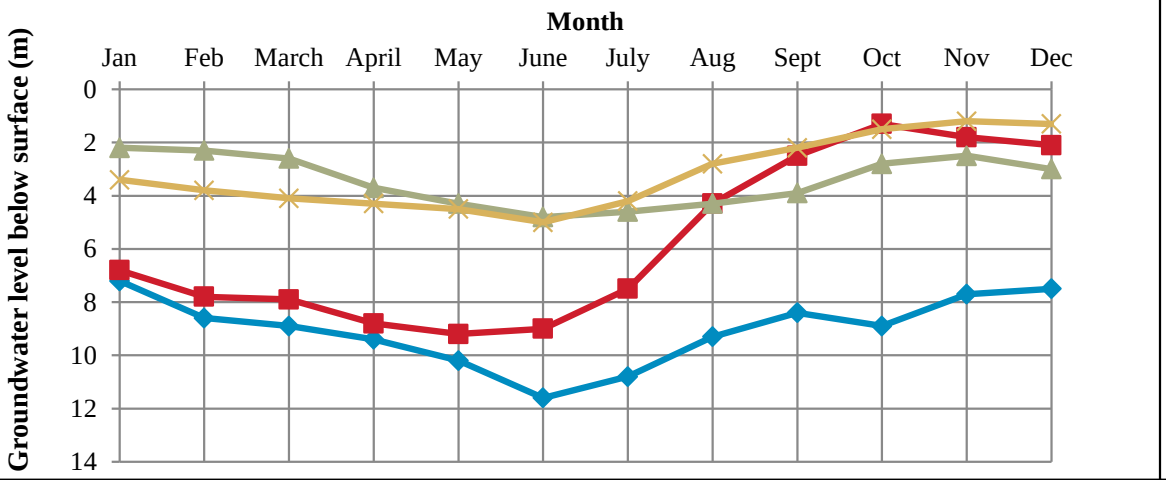
Where are we?

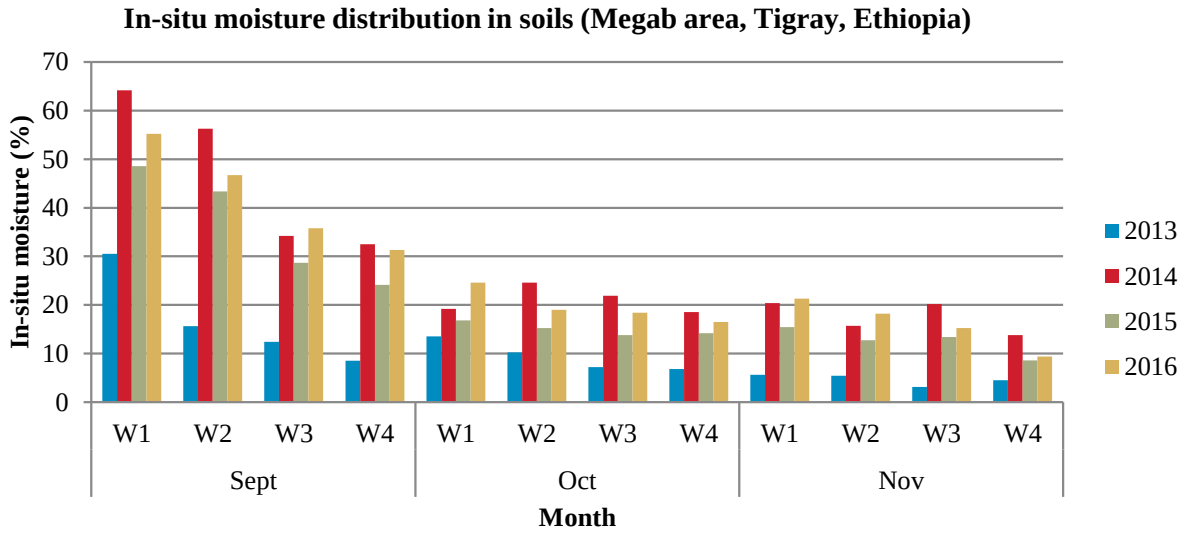
Road Water harvesting campaigns

> 3 Million people benefitted since 2015

Impacts

Effects on soil moisture from road spreader





Unmanaged recharge with poor outcomes, India

Jenny Grönwall, SIWI

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Textile production

Wet processing (bleaching, dyeing, finishing steps)
→ heavy metals, inorganic compounds

Wastewater treatment primary, secondary (tertiary = reuse)

Intervention/approach

Effluent discharge standards

allowing discharge for ‘irrigation’

with *treated* effluents

रजिस्ट्री सं० डी० एल०-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

असाधारण
EXTRAORDINARY
भाग II—खण्ड 3—उप-खण्ड (i)
PART II—Section 3—Sub-section (i)
प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

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No. 719] NEW DELHI, MONDAY, OCTOBER 10, 2016/ASVINA 18, 1938

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 10th October, 2016

G.S.R. 978(E).—In exercise of the powers conferred by sections 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Environment (Protection) Rules, 1986, namely:-

1. (1) These rules may be called the Environment (Protection) Fifth Amendment Rules, 2016.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Environment (Protection) Rules, 1986, in Schedule-I.–

STANDARDS FOR DISCHARGE OF EFFLUENTS FROM TEXTILE INDUSTRY

S. No.	Industry	Parameter	Standard (applicable for all modes of disposal*)
1	2	3	4
"6	All Integrated textile units, units of Cotton / Woollen / Carpets / Polyester, Units having Printing / Dyeing / Bleaching process or manufacturing and Garment units.	**TREATED EFFLUENTS**	Maximum concentration values in mg/l except for pH, colour, and SAR
		pH	6.5 to 8.5
		Suspended Solids	100
		Colour, P.C.U (Platinum Cobalt Units)	150
		Bio-Chemical Oxygen Demand [3days at 27°C] (BOD_3)	30
		Oil and Grease	10
		Chemical Oxygen Demand (COD)	250
		Total Chromium as (Cr)	2.0
		Sulphide (as S)	2.0
		Phenolic Compounds (as C_6H_5OH)	1.0
		Total Dissolved Solids , Inorganic (TDS)	2100**
		Sodium Absorption Ratio (SAR)	26**
		Ammonical Nitrogen (as N)	50

NOTES:

3. The treated effluent shall be allowed to be discharged in the ambient environment only after exhausting options for reuse in industrial process / irrigation in order to minimise freshwater usage.

Discharge to percolation ponds = ‘irrigation’?

… or misuse of GBNI?

© J. Grönwall

Impact

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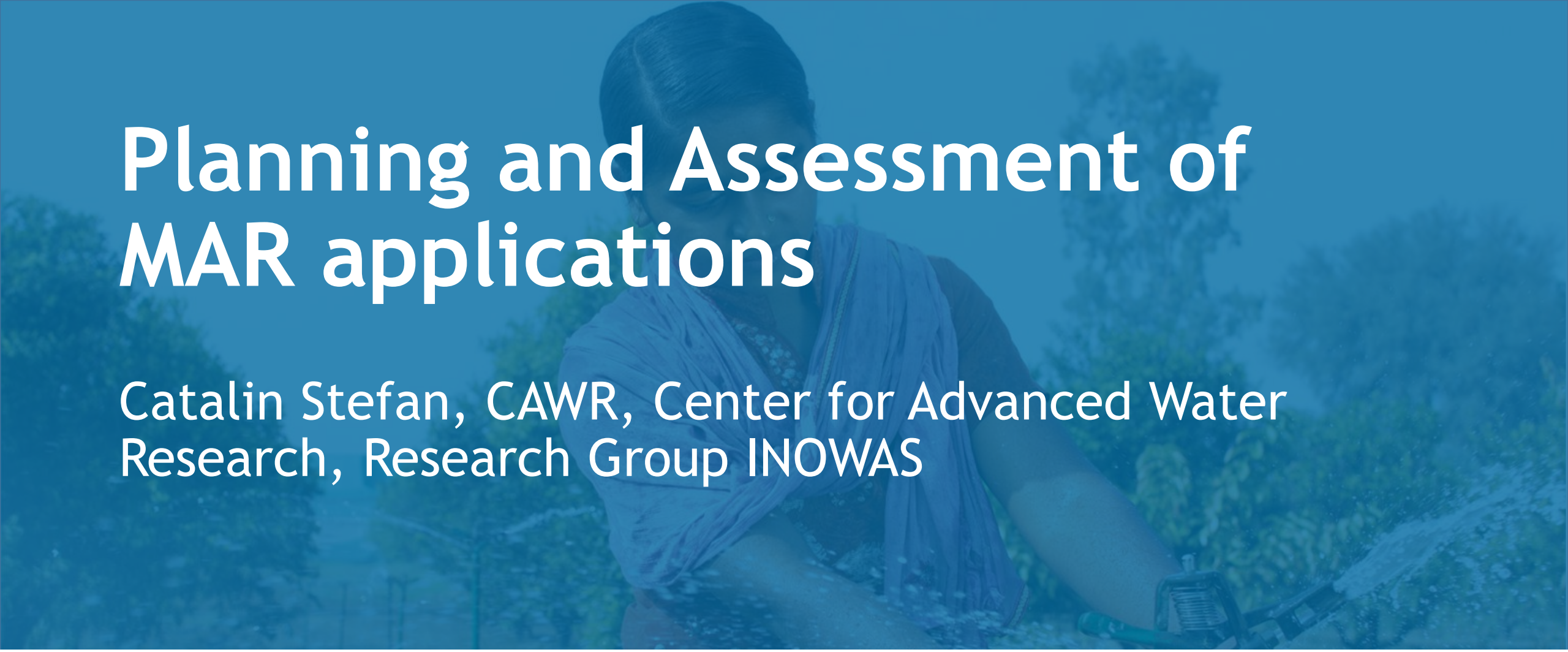
© *P. Mathew*
https://www.thenewsminute.com/article/does-tn-environment-minister-live-bubble-blames-soap-toxic-foam-noyyal-river-68900

- ***Managed* Aquifer Recharge**
  –not ‘accidental’ infiltration, (un)intentional percolation or coconut tree irrigation

- **Good water governance imperative**
  Improved capacities & tech-skills,
  ‘proper’ regulation,
  closing of the implementation gap,
  additional incentives & pressure
  (incl. from end-consumers?!)



Planning and Assessment of MAR applications

Catalin Stefan, CAWR, Center for Advanced Water Research, Research Group INOWAS

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CAWR Center for Advanced Water Research

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Managed aquifer recharge

"Intentional recharge of water to aquifers for subsequent recovery and/or environmental benefit"

CHALLENGES

achieving the qualitative and quantitative development goals

TOOLS

- Guidelines
- Case studies
- Modeling
- Piloting
- Regulations
- Good practices
- Monitoring
- Policies
- Lessons learned
- Smart ICT

SUSTAINABILITY

adequate protection of human health and environment

INOWAS DSS

Free, web-based modeling platform for planning, management and optimisation of managed aquifer recharge (MAR) applications

- Web-based interface
- Worldwide accessibility
- Cloud modelling
- Online collaboration
- Detailed documentation
- Open source > FREE

Funded by:
Federal Ministry of Education and Research

https://inowas.hydro.tu-dresden.de

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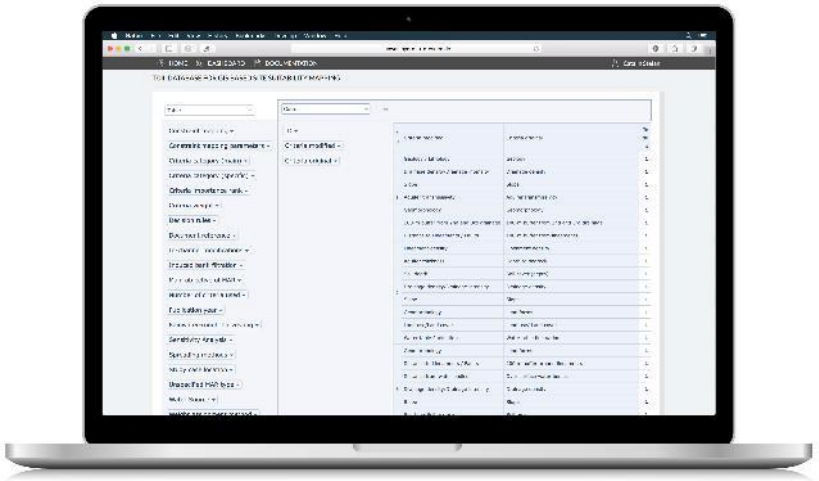
Engagement

EASY

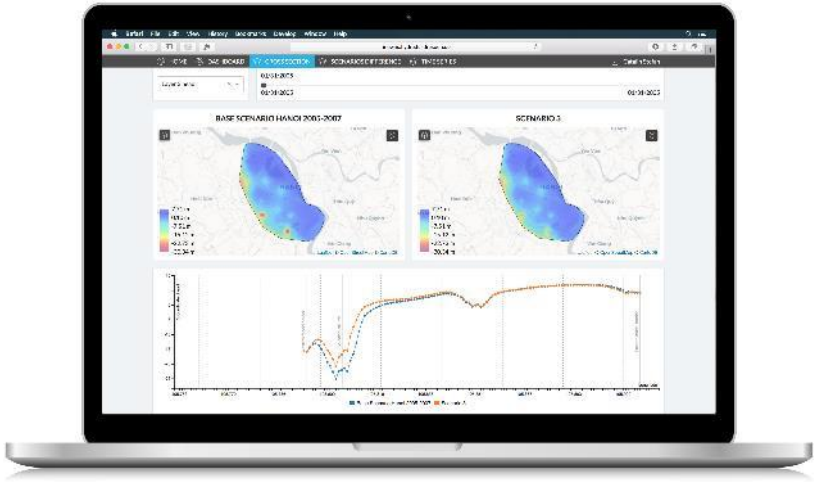


Database MAR site selection
Selection of MAR method
MAR basins design
Global MAR Portal

MEDIUM

Saltwater intrusion
Travel time calculator
Solute transport equations
Groundwater mounding

ADVANCED

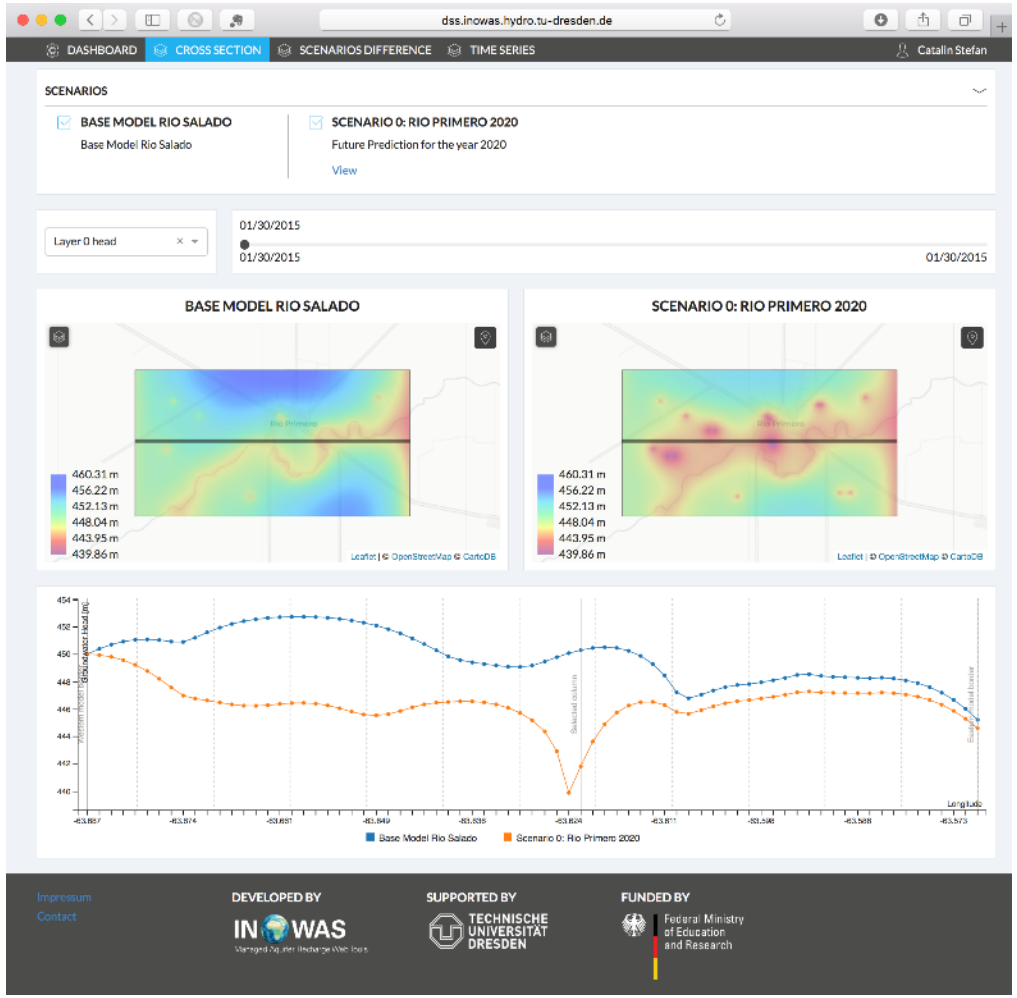


Groundwater flow modeling
Advanced scenarios analysis
MAR numerical optimisation

https://inowas.hydro.tu-dresden.de

INOWAS
MAR Junior Research Group

Opportunities



- Enable quick decision-making by sharing ready-to-use MAR solutions via internet;
- Easily modify MAR components and assess their impact on groundwater;
- Increase system performance by applying automatic optimisation tools;
- Side-by-side comparison of different MAR approaches;
- Plan and assess MAR schemes before starting detailed investigations.

https://inowas.hydro.tu-dresden.de

INOWAS
MAR Junior Research Group

Join us!

- **International Association of Hydrogeologists (IAH), Commission on Managed Aquifer Recharge (MAR)**

  Symposia and Workshops, MAR Working Groups, International MAR Networks, Training Events and so much more...

Photo: ISMAR9, Mexico City, 2016

Upcoming

ISMAR10 in Madrid, Spain, 20-24 May 2019

The Global MAR Portal

Arnaud Sterckx, IGRAC, International Groundwater Resources Assessment Centre

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igrac

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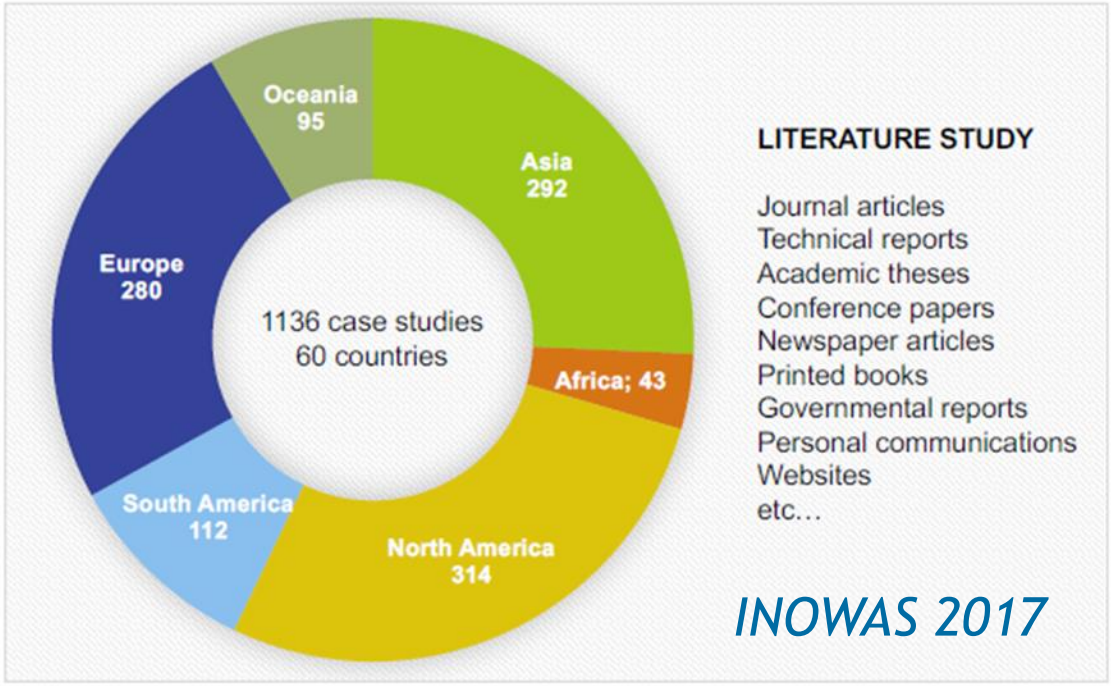
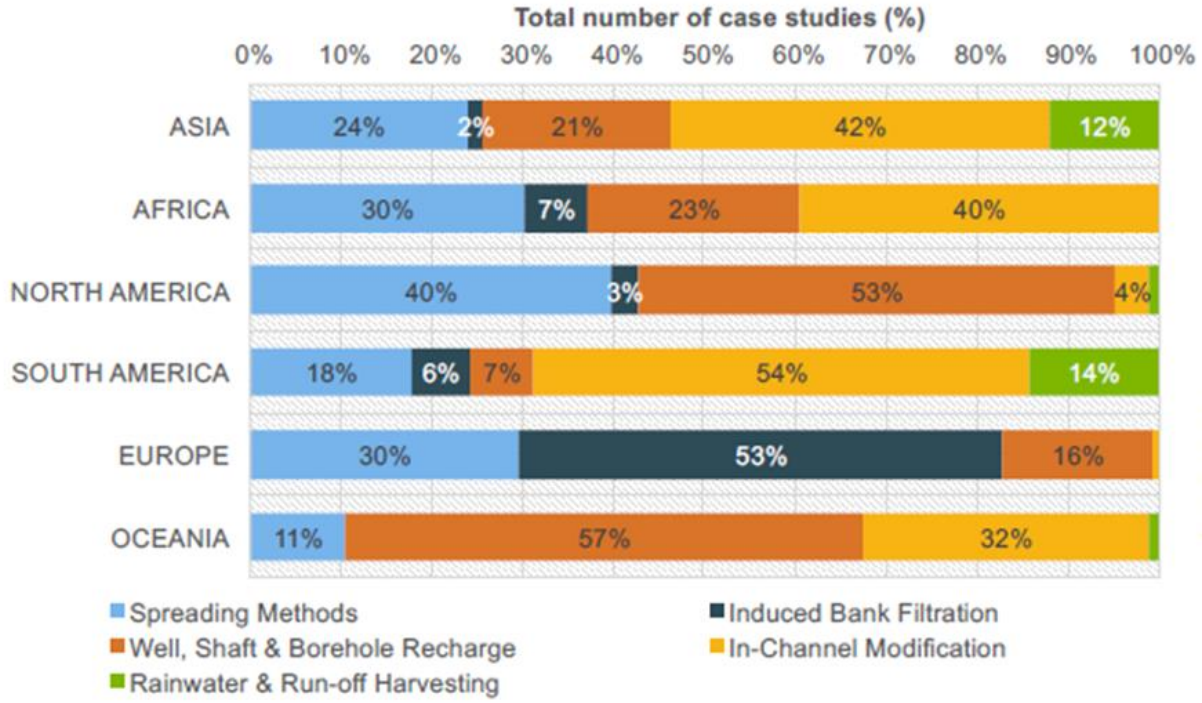
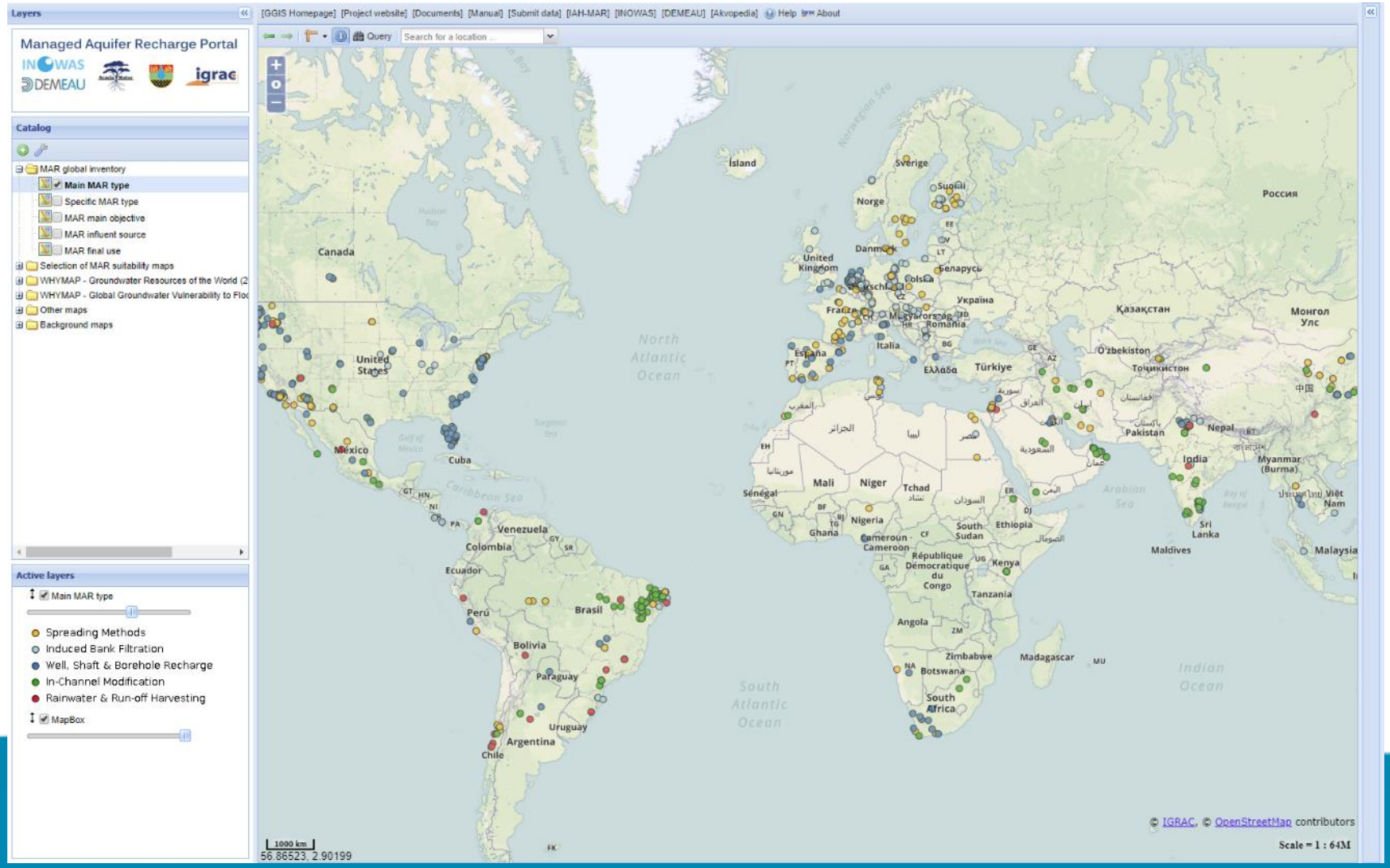
MAR Global Inventory

- IAH working group (since 2015)
- DEMEAU project: over 280 sites in Europe *(Sprenger et al. 2017)*
- INOWAS research group: about 1200 sites worldwide *(Stefan & Ansems 2018)*





MAR Portal → www.marportal.un-igrac.org



Features of *Main MAR type*

Specific MAR type	Link to more inf...	Influent source	Final use	Main objective	References (author and year)
Recharge Dam	Recharge dams	River water	Ecological	Maximize Natural Storage	Powell, B., J. Loi, and N. G. Christiano Lockyer Valley Alluvial Plains, South-E Bulletin, Queensland, Australia: Depar https://qldgov.softlinkhosting.com.au/li mode=BASIC&corporation=DERM&lin East+Queensland&resourceCollection
ASR/ASTR	ASR/ASTR	Storm water	Agricultural	Water Quality Management	Malik, R. S., B. S. Jhorar, R. K. Jhorar. Successful Operation of Existing Brack Irrigation by Indian Farmers. In Manag Proceedings of the 4th International Sy ISAR-4, Adelaide, South Australia, 22- Lisse ; Exton, PA: A.A. Balkema.
ASR/ASTR	ASR/ASTR	Storm water	Domestic	Ecological Benefits	Pavelic, P., Dillon, P., Barry, K., Armstr (2006) Lessons Drawn from Attempts t Aquifer https://www.researchgate.net/publicati
Infiltration Ponds and Basins	Infiltration ponds (SAT)	River water	Agricultural	Physical Aquifer Management	Locher Rd, 2015. Walla Walla Watersh projects/39-locher-road-aquifer-rechar
ASR/ASTR	ASR/ASTR	no data	no data	no data	Pyne, R. D. G. 2007. Overview of Aqui Presentation presented at the Confere Recharge in Oregon, "Overcoming Tec November 7. water.oregonstate.edu/as
ASR/ASTR	ASR/ASTR	no data	no data	no data	Brown, D. L., and W. D. Silvey. 1977. A Brackish-Water Sand Aquifer, Norfolk, Washington, D.C.: U.S. Geological Sur
Recharge Dam	Recharge dams	River water	Agricultural	Physical Aquifer Management	Wang, X.-Q., J.-X. Chen, and J.-F. Ten River flood plain area (in Chinese: 从 Water 23 (1): 44–45.
Infiltration Ponds and Basins	Infiltration ponds (SAT)	Storm water	no data	no data	Wildermuth, M., W. Wang, K. Manning Water Recharge Location and Magnitu Basin. Presentation presented at the I Irvine, California. http://www.nwri-usa.o
Infiltration Ponds and Basins	Infiltration ponds (SAT)	River water	no data	no data	Tuinhof, A., Heederik, J.P., 2003. Mana Storage.
Subsurface Dam	Subsurface dams	River water	Agricultural	Maximize Natural Storage	Campos, J. D., J. R. Neto, O. B. Sampa uma alternativa de captação e barram Simpósio Brasileiro de Captação de Á Brazilian Rainwater Catchment and M http://www.abcmac.org.br/files/simposi
Dug Well/ Shaft/ Pit Injection	Shallow well/shaft/pit infiltration	River water	Domestic	Maximize Natural Storage	Zhang, Y., Y. Sun, and X. Wang. 2013. Beijing (in Chinese: 北京地区地下水人 0051-03.
Infiltration Ponds and Basins	Infiltration ponds (SAT)	Reclaimed wastewater	no data	no data	Crook, J., J. A. MacDonald, and R. R. American Water Works Association Jo
Recharge Dam	Recharge dams	River water	Ecological	Maximize Natural Storage	Powell, B., J. Loi, and N. G. Christiano Lockyer Valley Alluvial Plains, South-E Bulletin, Queensland, Australia: Depar https://qldgov.softlinkhosting.com.au/li mode=BASIC&corporation=DERM&lin East+Queensland&resourceCollection
Infiltration Ponds and Basins	Infiltration ponds (SAT)	Storm water	Domestic	Maximize Natural Storage	Su, D., G. Liu, and T. Shong. 1996. A c areas (in Chinese: 沈阳地区人工回灌 University 12 (52-54): 3.
Infiltration Ponds and Basins	Infiltration ponds (SAT)	Reclaimed wastewater	no data	no data	Wildermuth, M., W. Wang, K. Manning Water Recharge Location and Magnitu Basin. Presentation presented at the I Irvine, California. http://www.nwri-usa.o
Infiltration Ponds and Basins	Infiltration ponds (SAT)	Storm water	no data	no data	Wildermuth Environmental, Inc. 2015. 2014 State of the Basin Report. 007-0 Watermaster. http://www.cbwm.org/docs/engdocs/St a-Cover%20and%20Table%20of%20C

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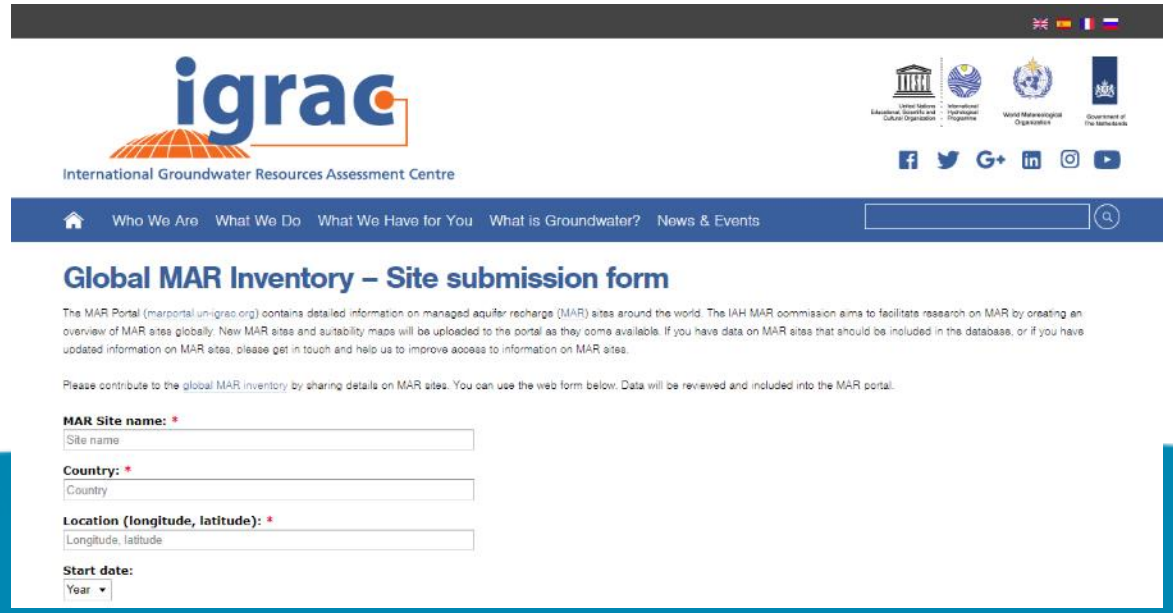
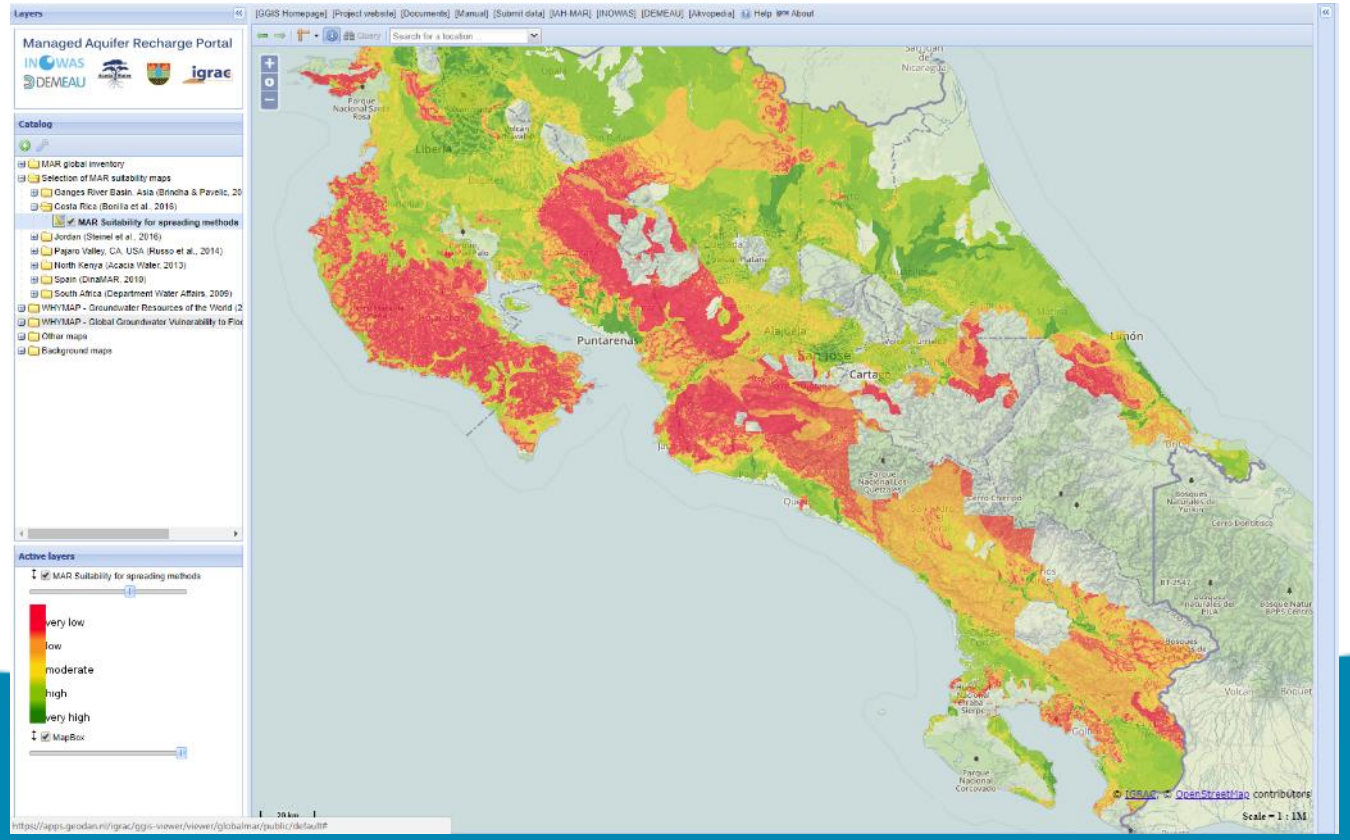
More content: how can you contribute?

- Additional MAR sites
- Selection of MAR suitability maps
- Selection of good practices?
- Any other suggestion?





The MAR Portal is a powerful tool for sharing MAR-related information,

connecting water managers, experts and non-experts,

and promoting new MAR applications.