مؤتمر الخليج الثالث عشر للمياه
The 13th Gulf Water Conference

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INOWAS
MAR Junior Research Group

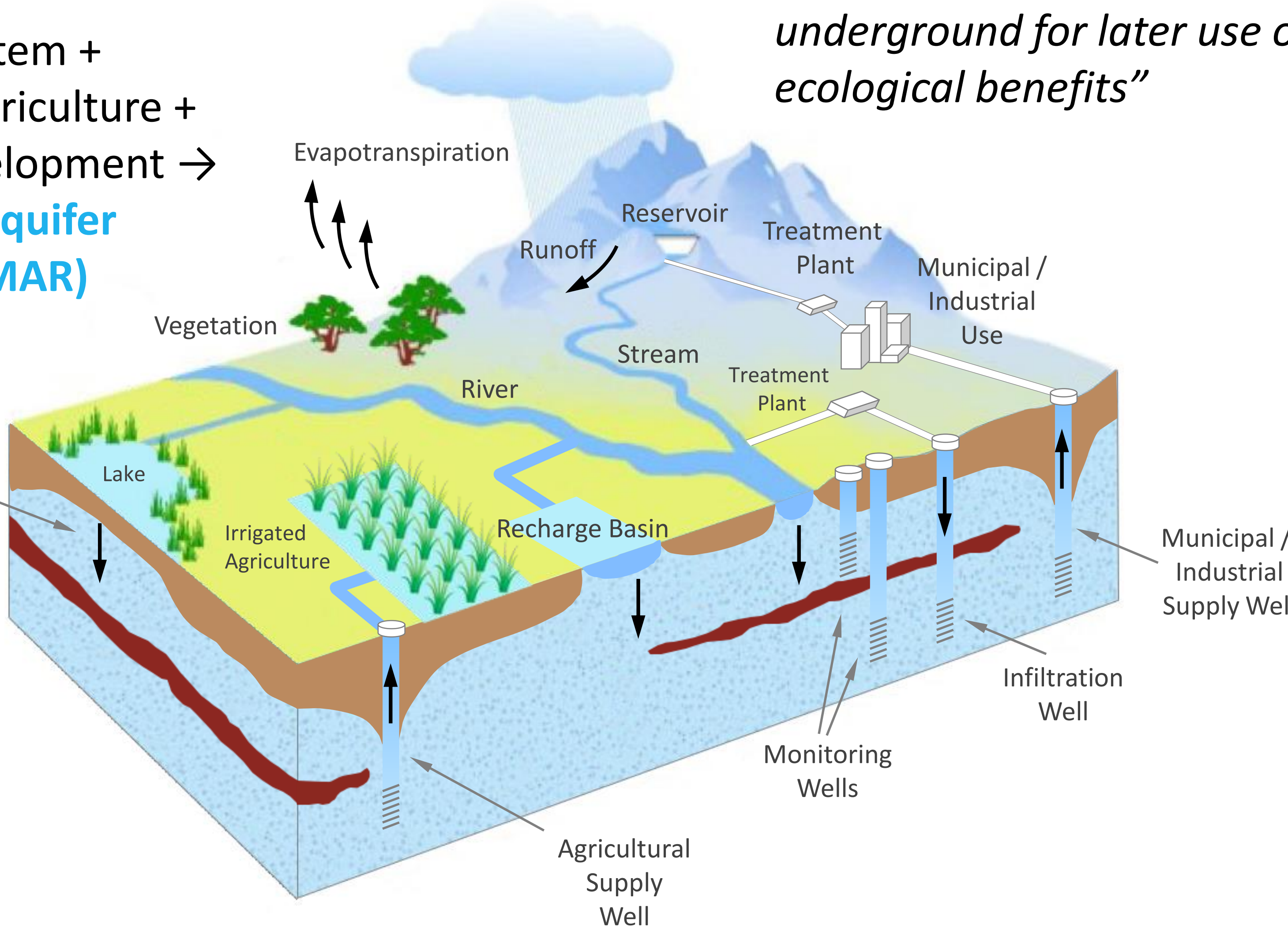
Managed Aquifer Recharge: from Global Perspective to Local Planning

Dr. Catalin Stefan
Head of MAR Research Group “INOWAS”
Technische Universität Dresden, Germany

Introduction

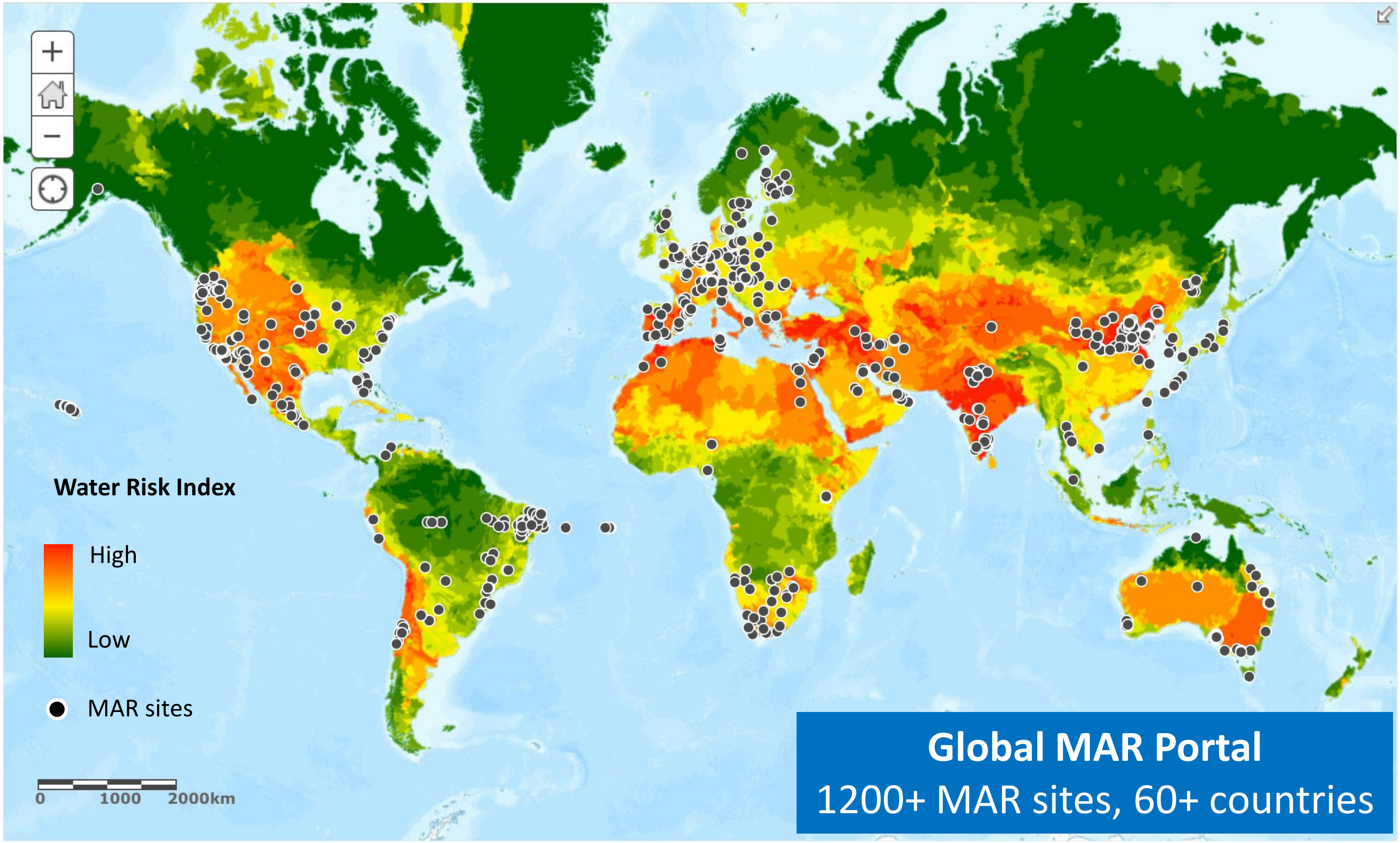
Natural system +
Irrigated agriculture +
Urban development →
Managed aquifer recharge (MAR)

“Intentional storage of surplus surface water in underground for later use of ecological benefits”



Attribute	Storage above ground	Storage below ground
Land area required	large	very small
Proximity to the city	far	within
Capital costs	high	low
Investigations costs	high	low
Intake and supply rate	high	low
Evaporation losses	moderate	low
Algal problems	moderate	low
Mosquitos	moderate	low
Mixing loses	none	none to high
Pathogen removal	some	substantial
Recontamination potential	moderate	none to moderate
Relief requirements	suitable valley	suitable aquifer

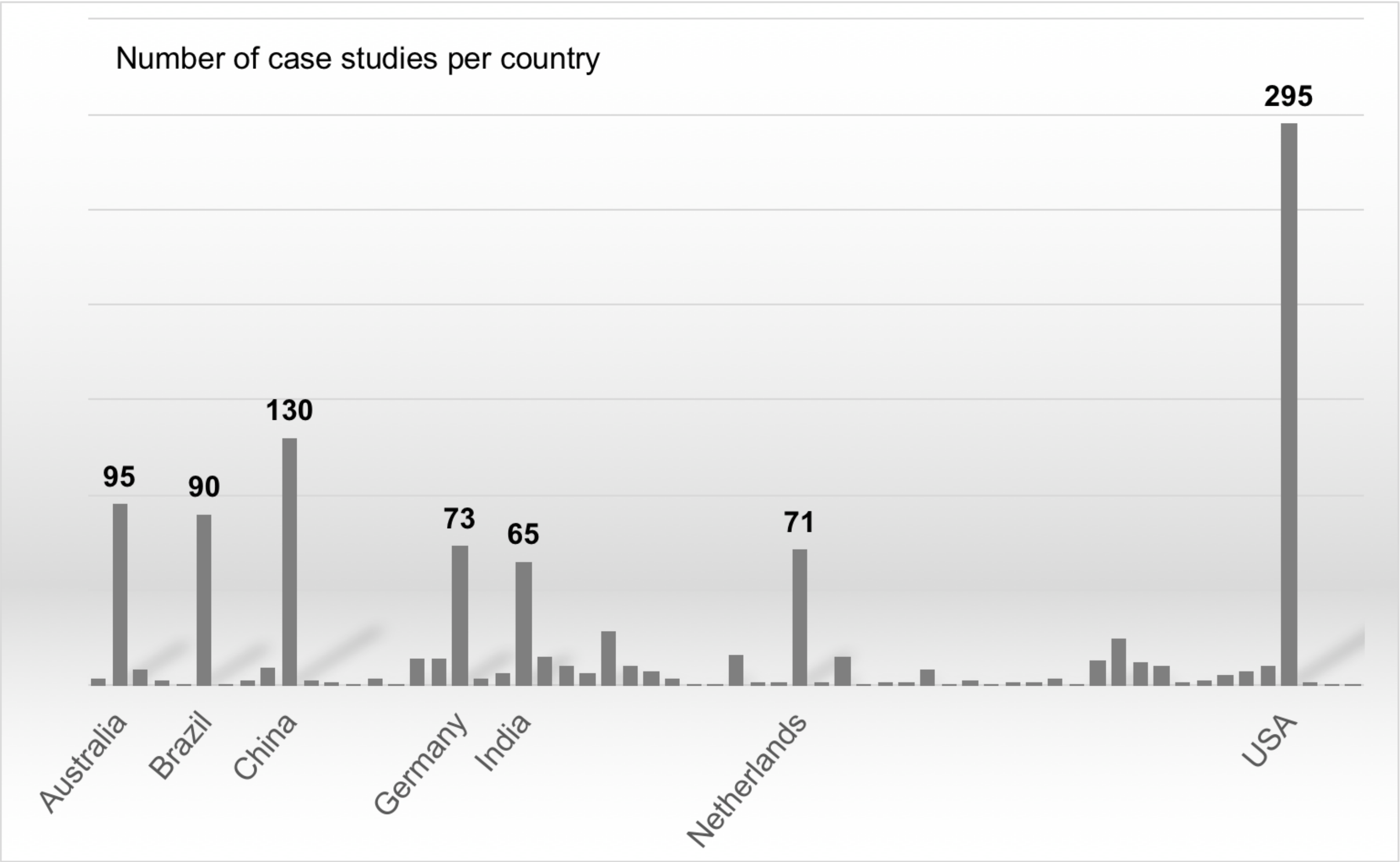
Source: adapted from Dillon et al., 2009



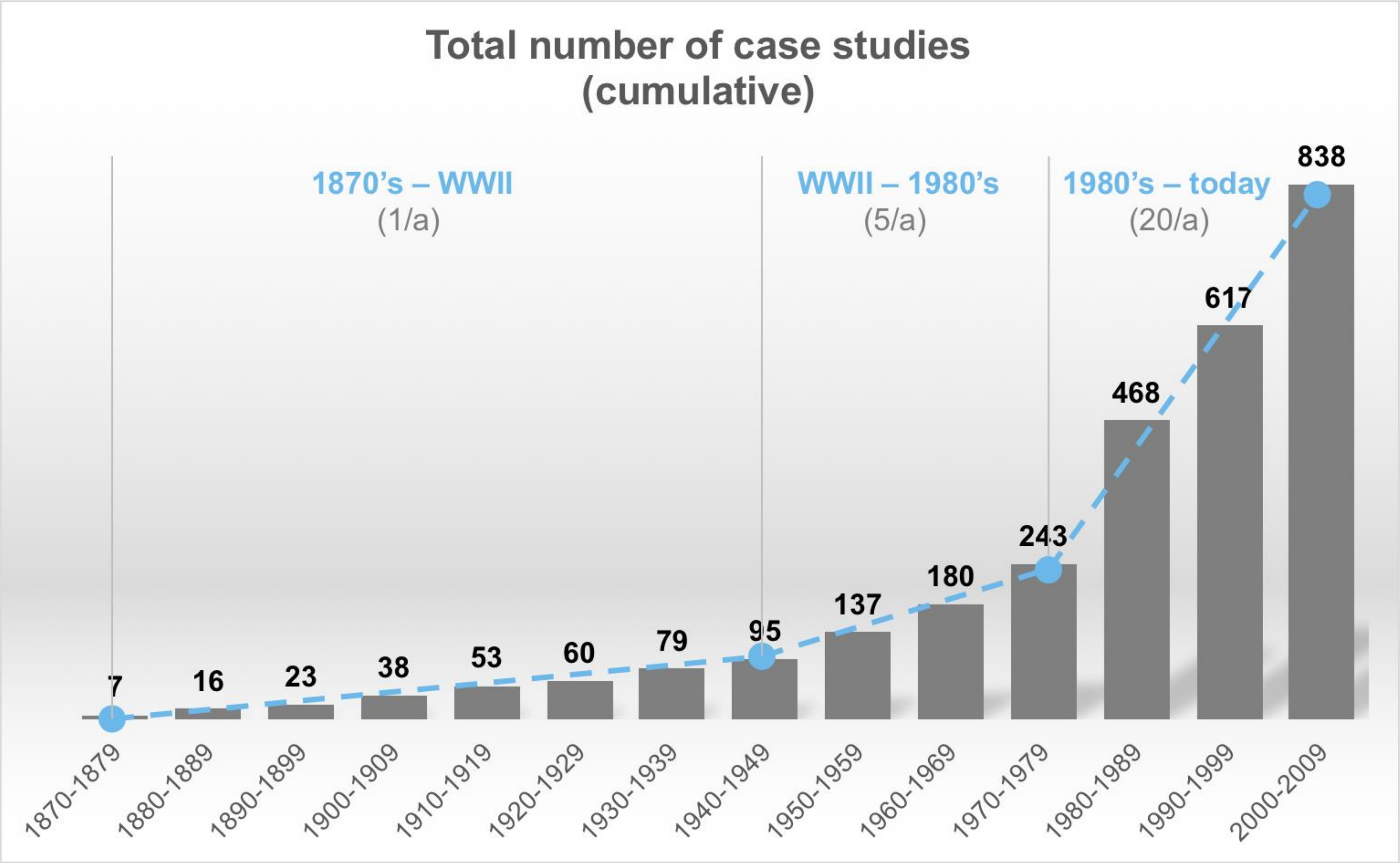
Stefan and Ansems, 2018 | http://marportal.un-igrac.org

https://doi.org/10.1007/s40899-017-0212-6

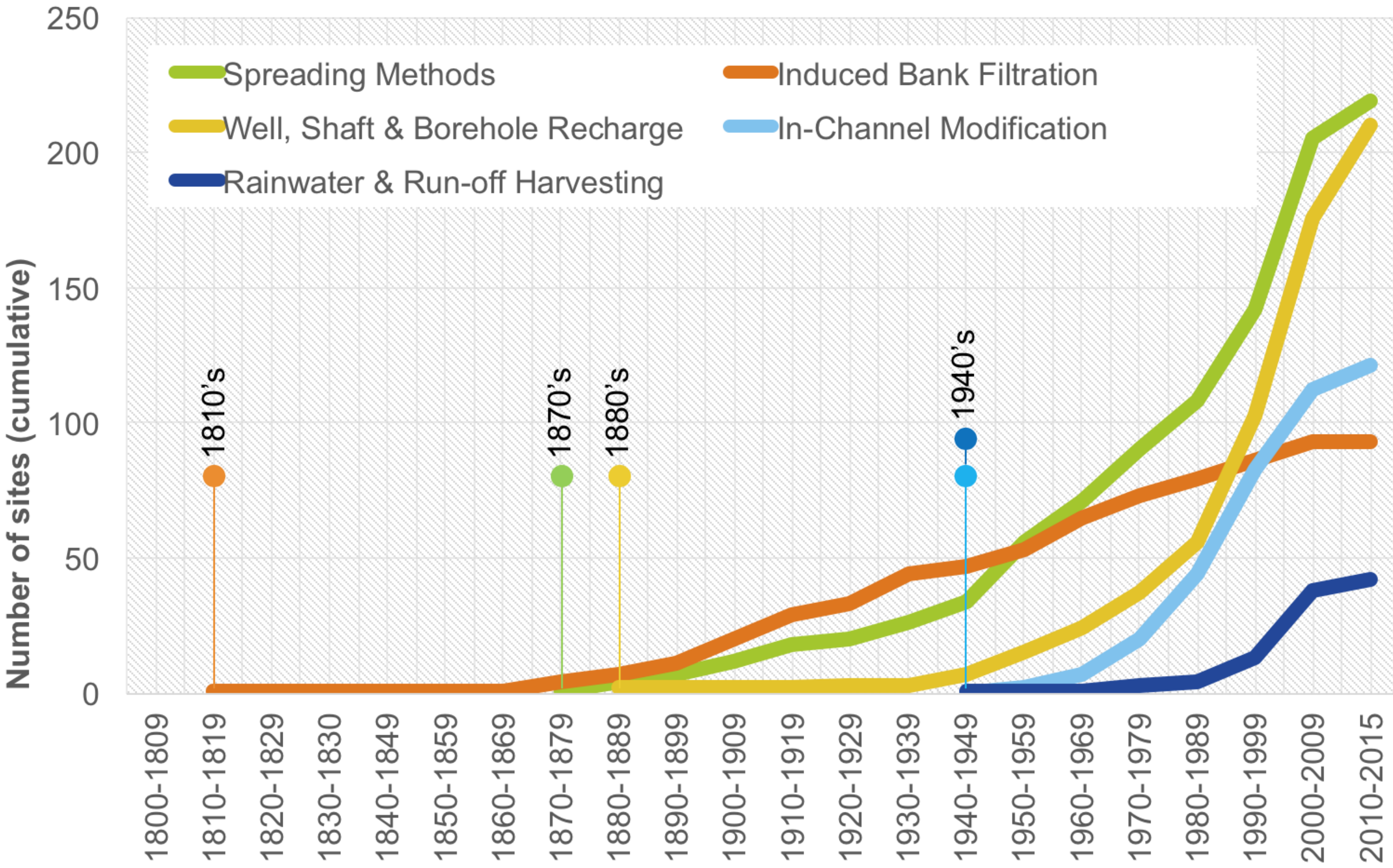
MAR case studies by country



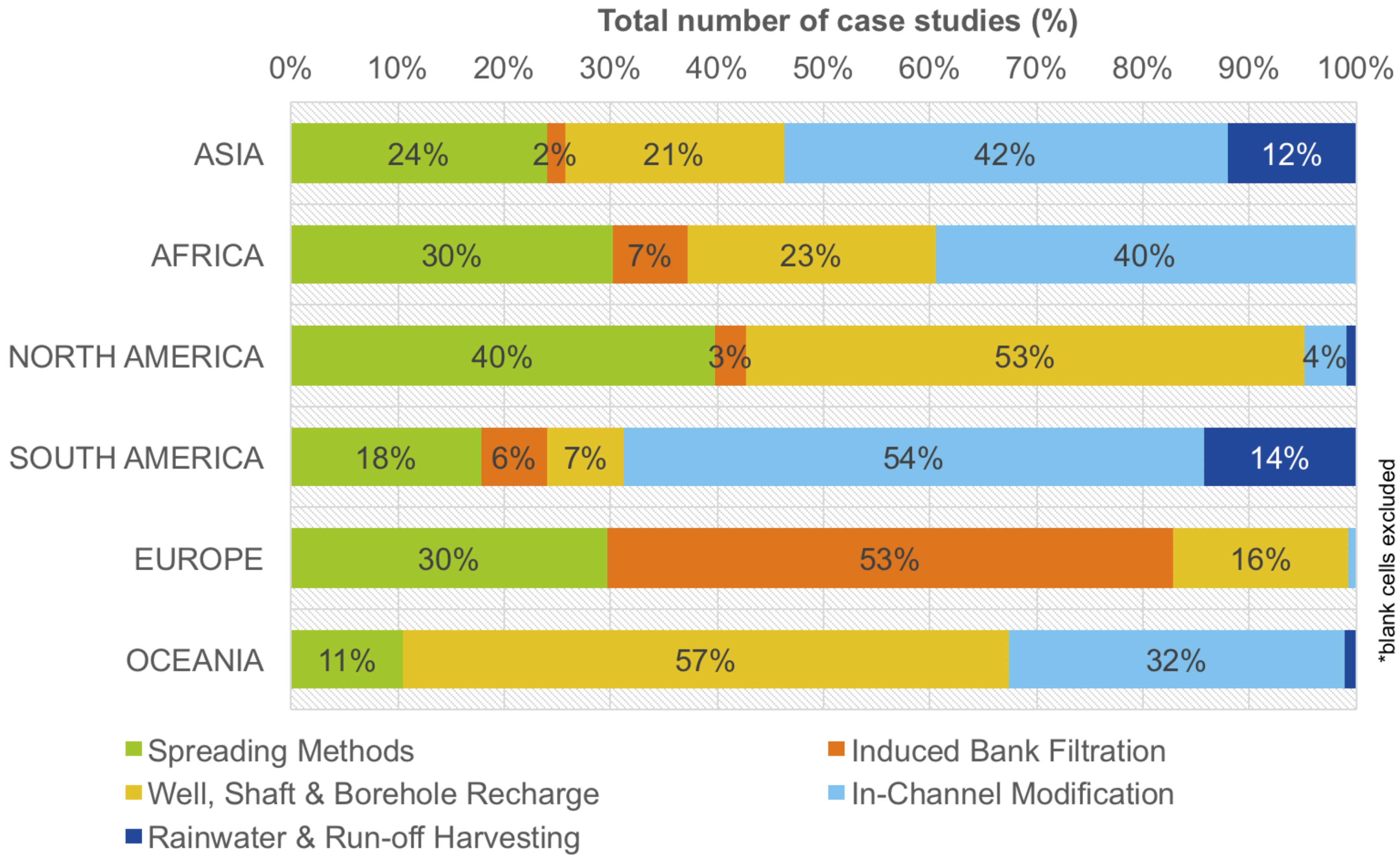
MAR historical development



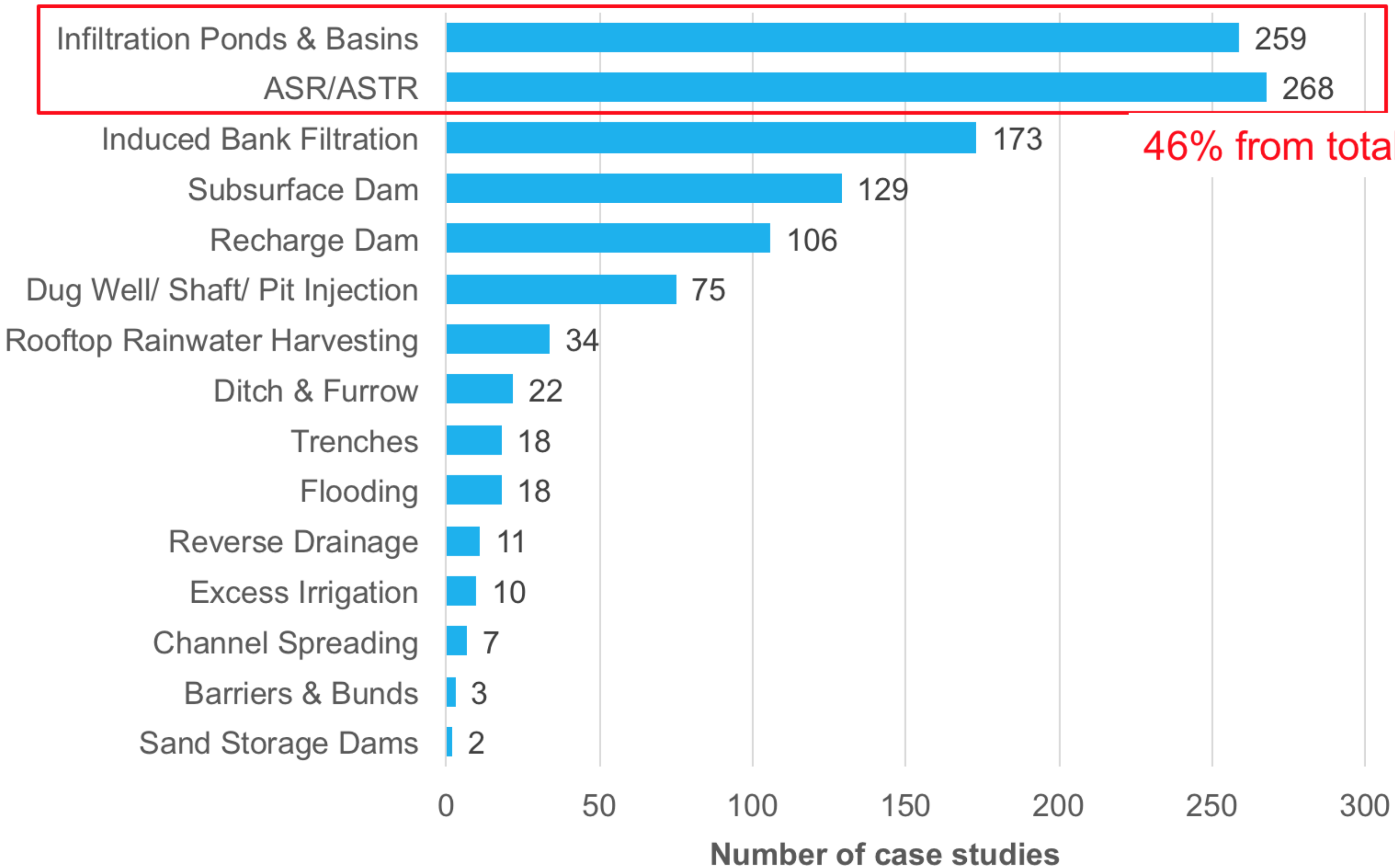
MAR historical development



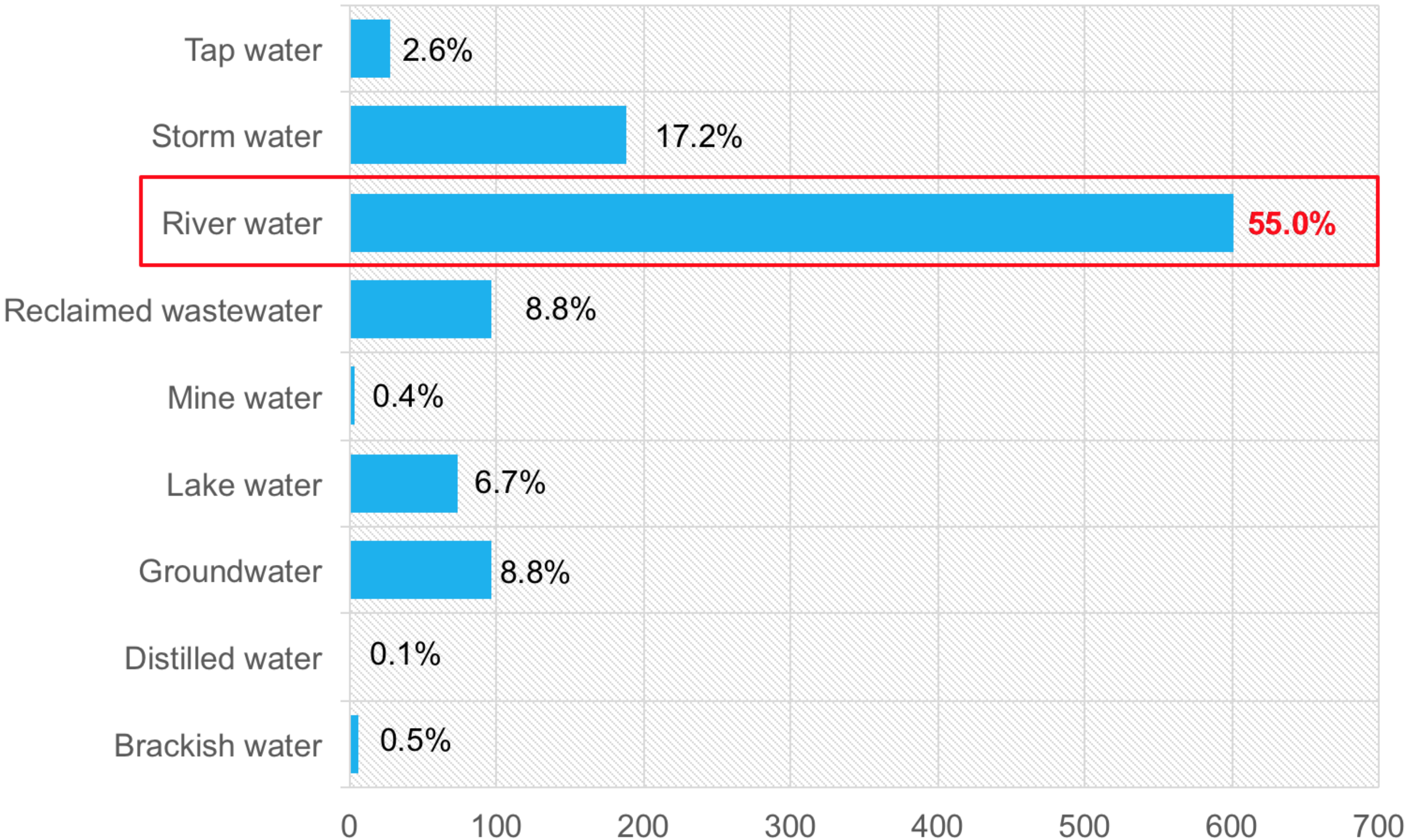
Main MAR types



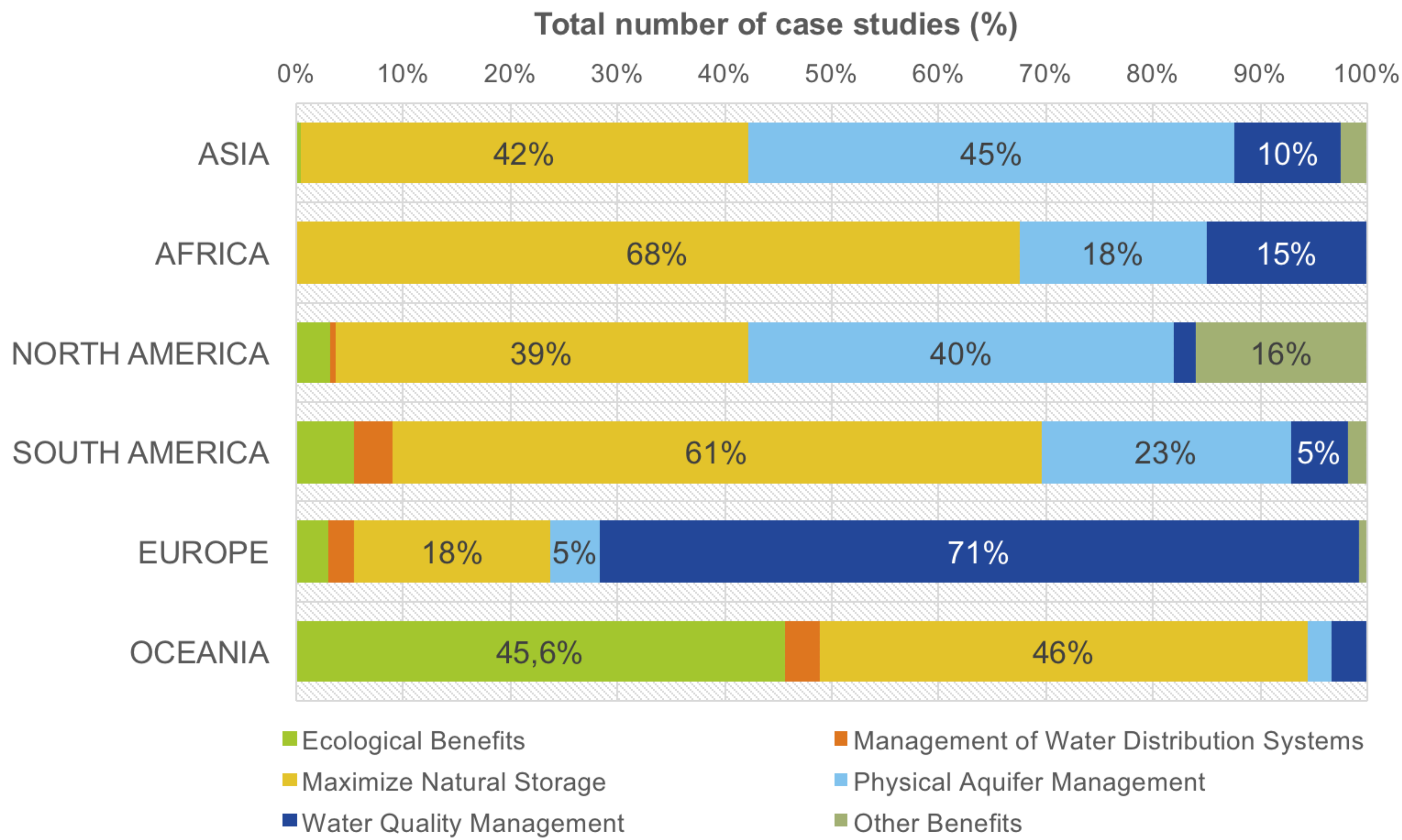
Specific MAR types



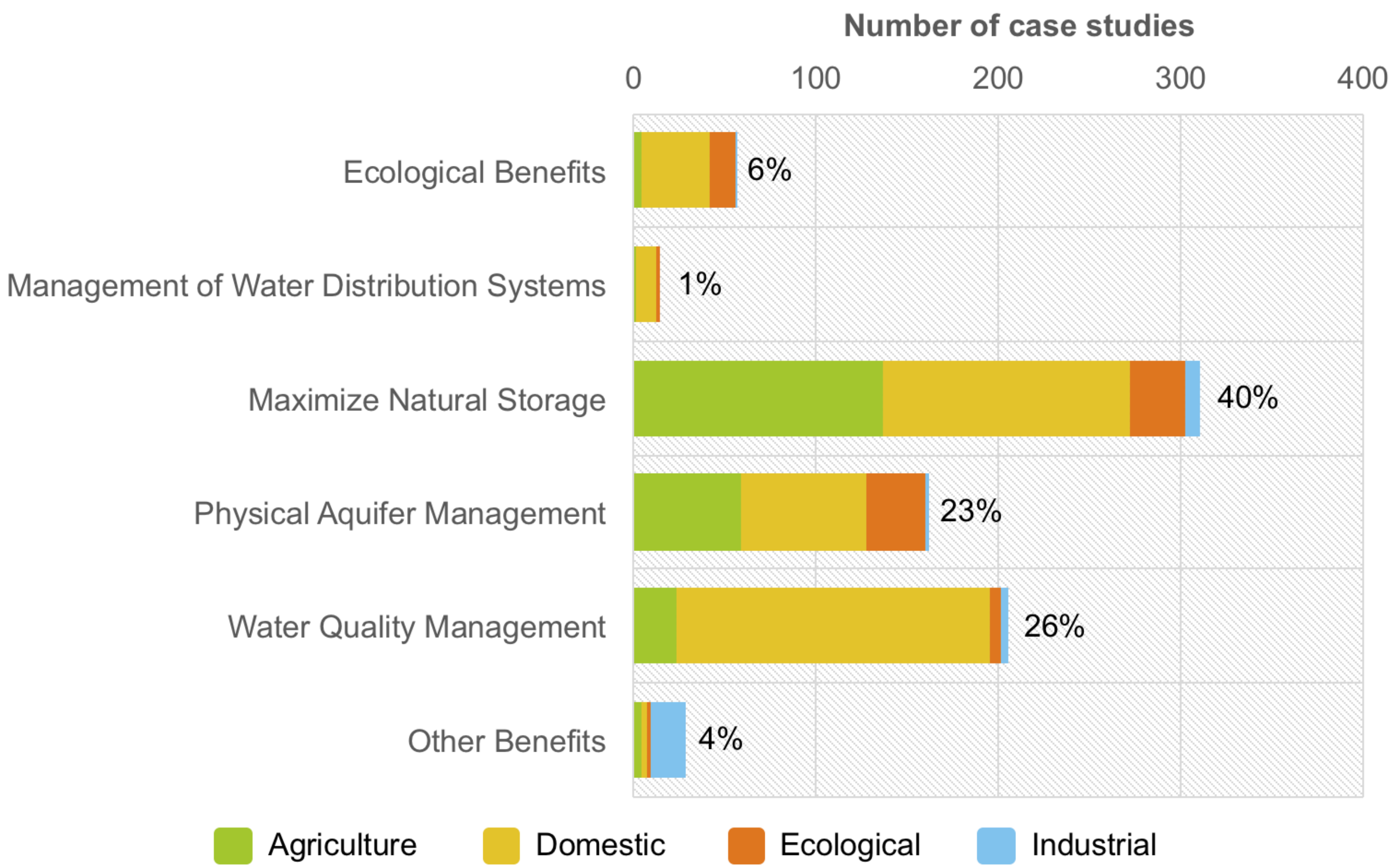
Types of water source for MAR



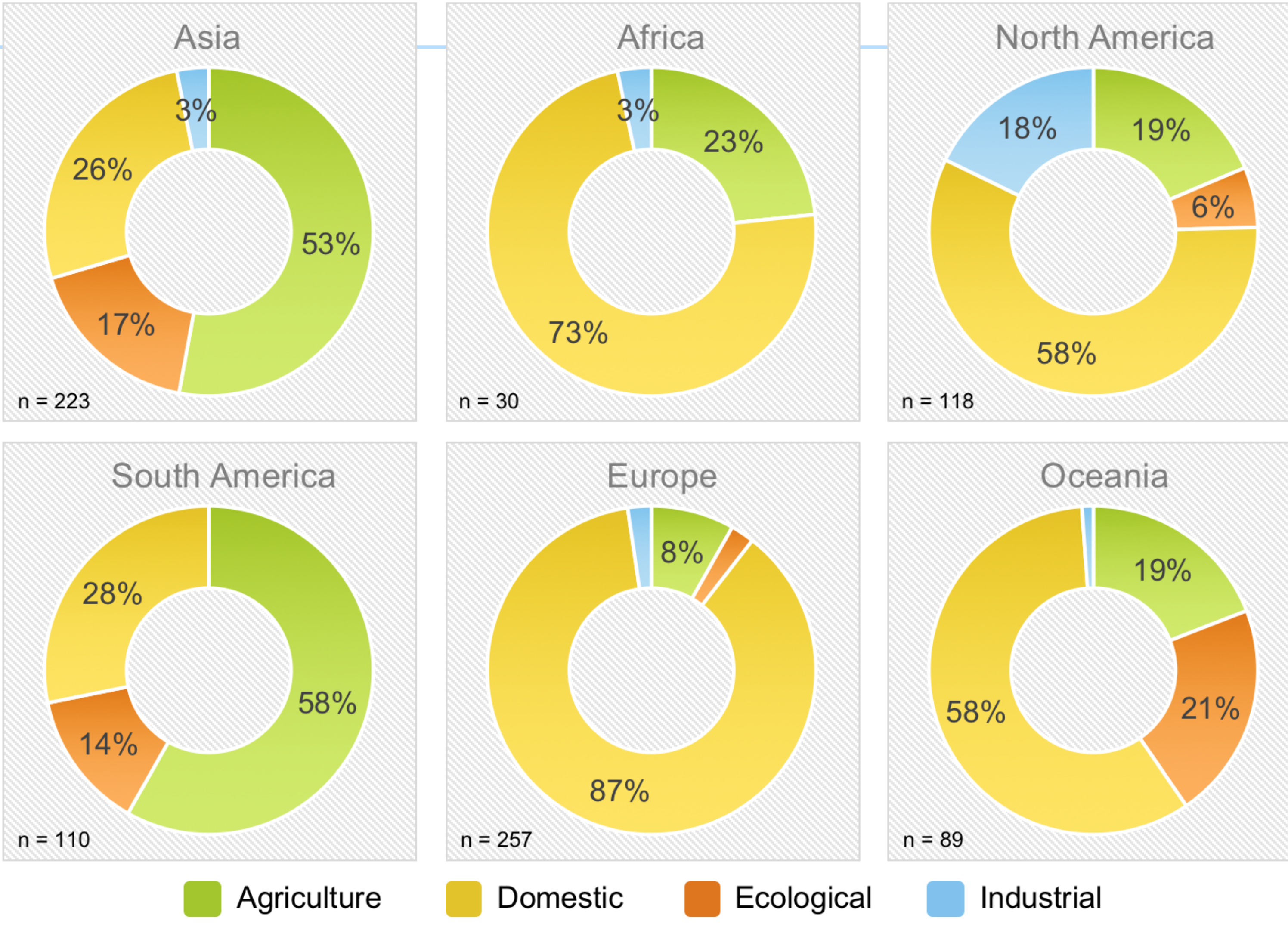
MAR objectives



MAR objectives vs. final water source



MAR beneficiary sector



Further readings

Sustainable Water Resources Management (2018) 4:153–162
https://doi.org/10.1007/s40899-017-0212-6

ORIGINAL ARTICLE

CrossMark

Web-based global inventory of managed aquifer recharge applications

Catalin Stefan[1] · Nienke Ansems[2]

Received: 30 October 2016 / Accepted: 18 December 2017 / Published online: 22 December 2017

Abstract
Managed aquifer recharge (MAR) is being successfully implemented worldwide for various purposes: to increase groundwater storage, improve water quality, restore groundwater levels, prevent salt water intrusion, manage water distribution systems, and enhance ecological benefits. To better understand the role of MAR in sustainable water management and adaptation to climate and land use change, about 1200 case studies from 62 countries were collected and analyzed with respect to historical development, site characterization, operational scheme, objectives and methods used, as well as quantitative and qualitative characterization of in- and outflow of water. The data harvested was used for the compilation of a global inventory of MAR schemes, whose main goal is to provide access to existing MAR projects and techniques and demonstrate their benefits. To increase the availability and facilitate continuous update of the MAR inventory, an MAR web-based portal was developed

Further readings

Hydrogeology Journal (2019) 27:1–30
https://doi.org/10.1007/s10040-018-1841-z

PAPER

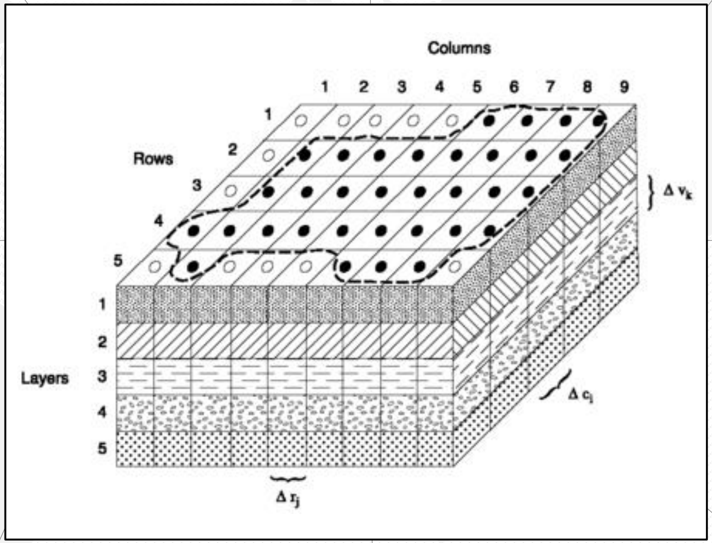
CrossMark

Sixty years of global progress in managed aquifer recharge

P. Dillon[1,2] • P. Stuyfzand[3,4] • T. Grischek[5] • M. Lluria[6] • R. D. G. Pyne[7] • R. C. Jain[8] • J. Bear[9] • J. Schwarz[10] • W. Wang[11] • E. Fernandez[12] • C. Stefan[13] • M. Pettenati[14] • J. van der Gun[15] • C. Sprenger[16] • G. Massmann[17] • B. R. Scanlon[18] • J. Xanke[19] • P. Jokela[20] • Y. Zheng[21] • R. Rossetto[22] • M. Shamrukh[23] • P. Pavelic[24] • E. Murray[25] • A. Ross[26] • J. P. Bonilla Valverde[27] • A. Palma Nava[28] • N. Ansems[29] • K. Posavec[30] • K. Ha[31] • R. Martin[32] • M. Sapiano[33]

Received: 12 March 2018 / Accepted: 27 July 2018 / Published online: 7 September 2018

Abstract
The last 60 years has seen unprecedented groundwater extraction and overdraft as well as development of new technologies for water treatment that together drive the advance in intentional groundwater replenishment known as managed aquifer recharge (MAR). This paper is the first known attempt to quantify the volume of MAR at global scale, and to illustrate the advancement of all the major types of MAR and relate these to research and regulatory advancements. Faced with changing climate and rising intensity of climate extremes, MAR is an increasingly important water management strategy, alongside demand management, to maintain, enhance and secure stressed groundwater systems and to protect and improve water quality. During this time, scientific research—on hydraulic design of facilities, tracer studies, managing clogging, recovery efficiency and water quality changes in aquifers—has underpinned practical improvements in MAR and has had broader benefits in hydrogeology. Recharge wells have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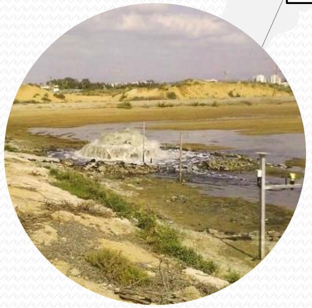
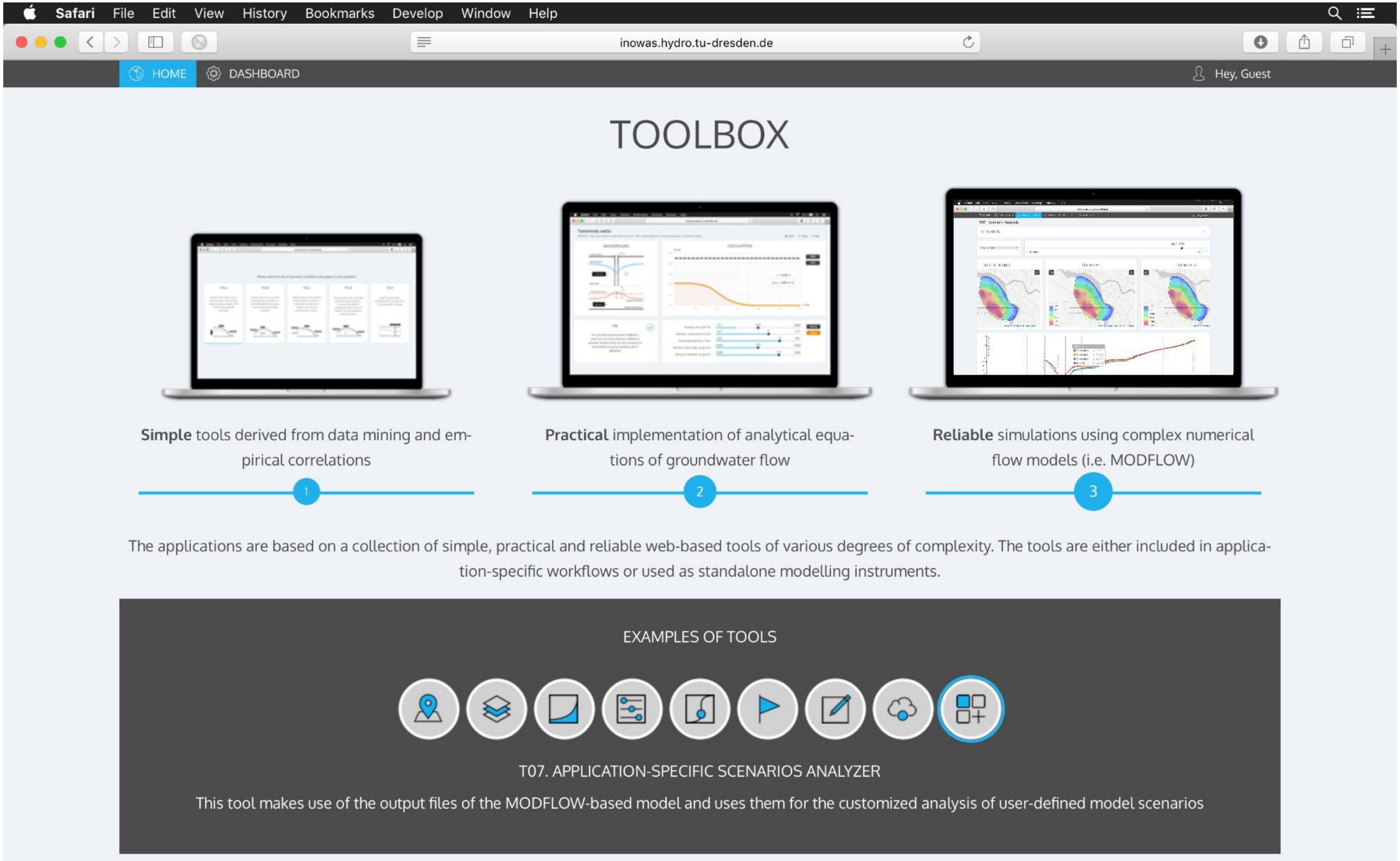


www.inowas.com



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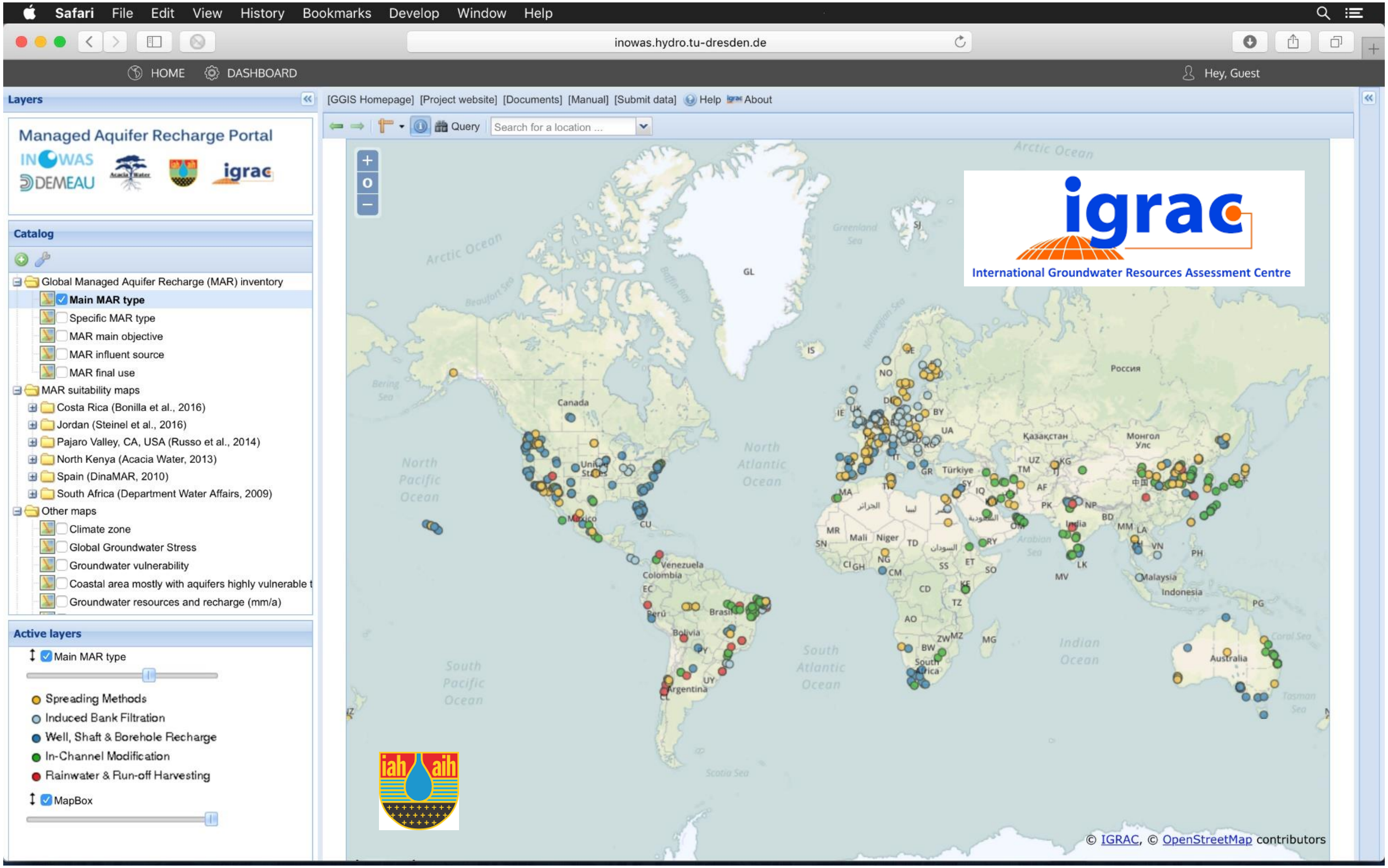
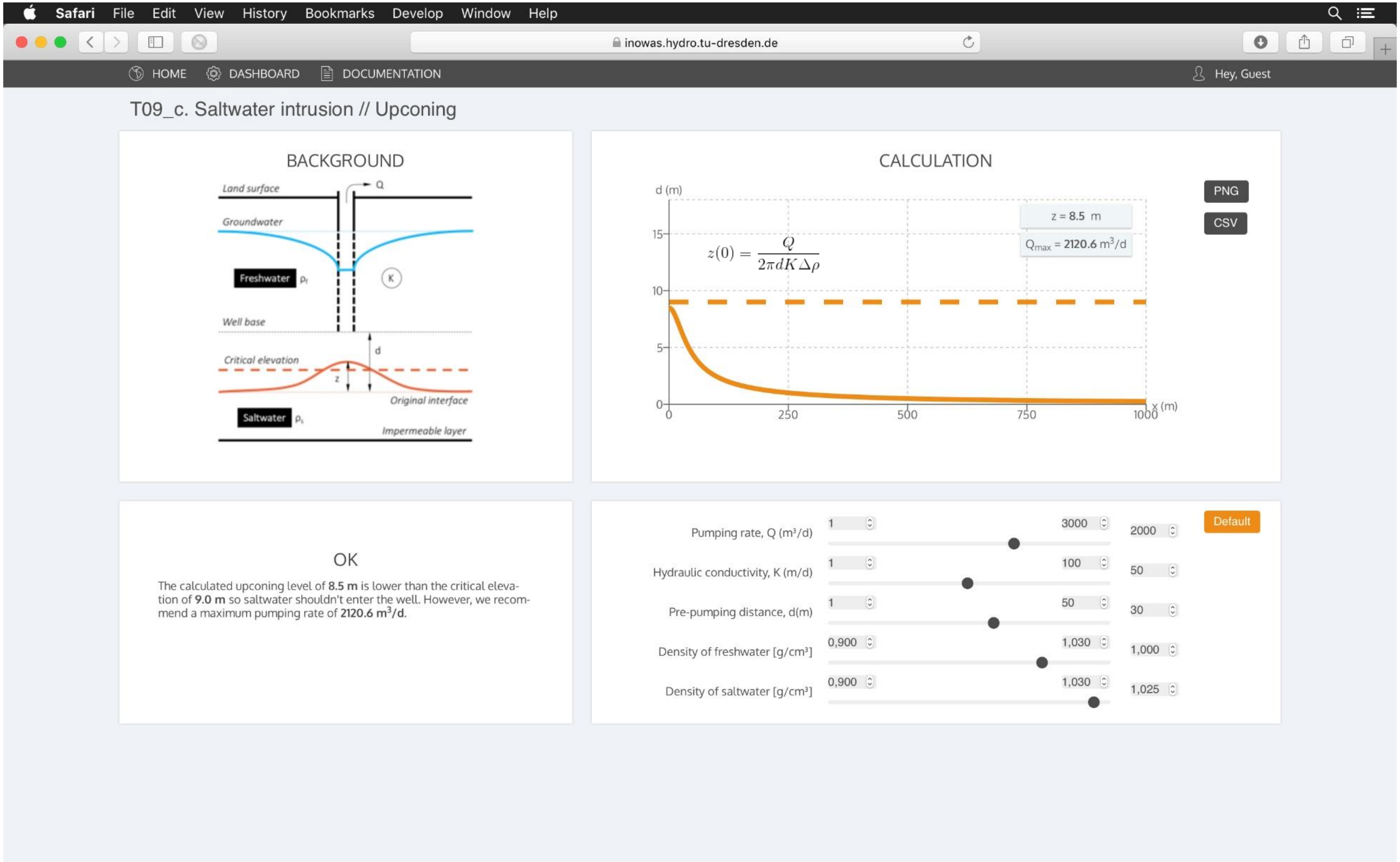
Global MAR Portal



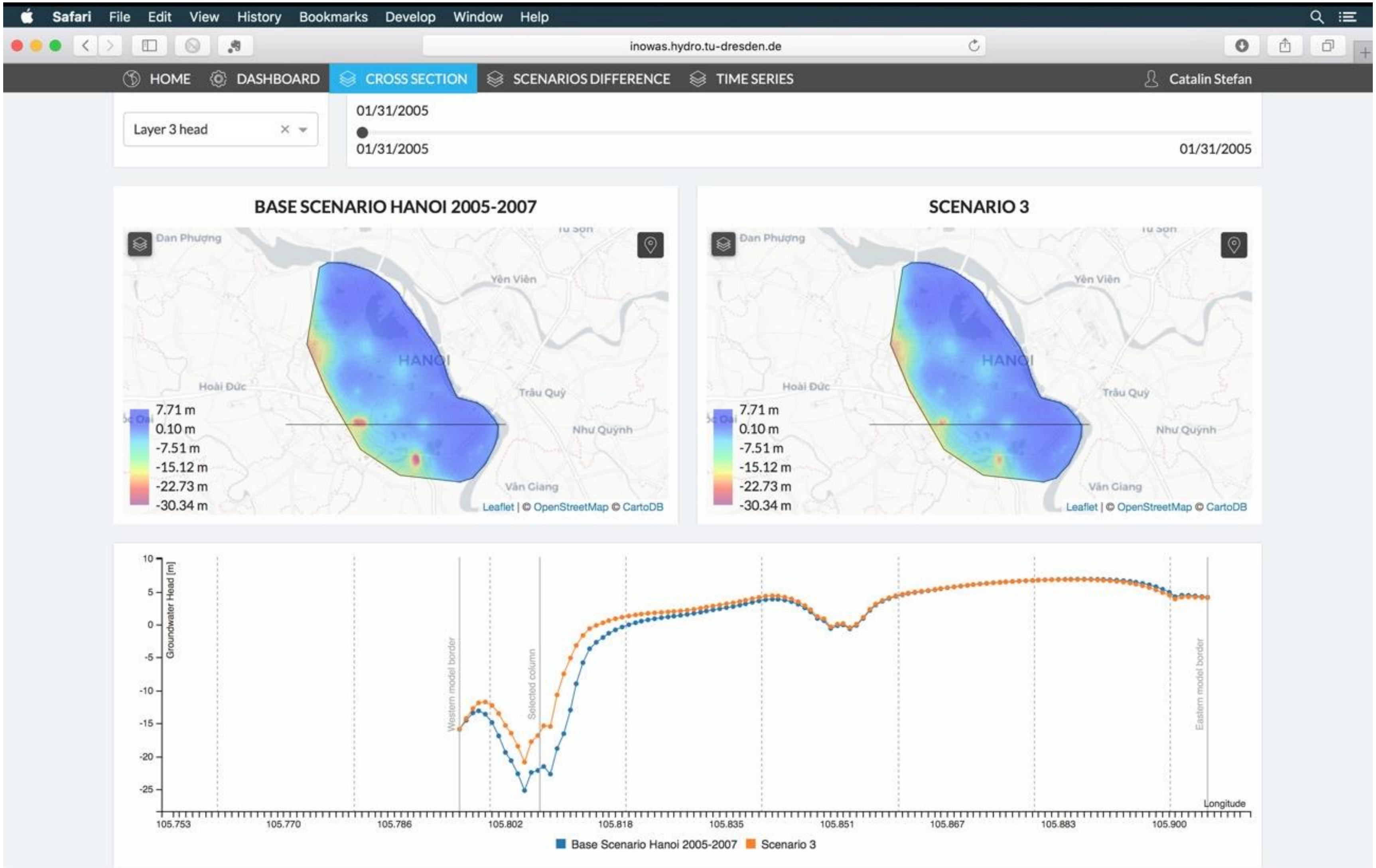
Web-GIS portal for visualization of MAR projects and suitability maps

Saltwater Intrusion Assessment



Interactive web-based implementation of analytical equations

MODFLOW-based Groundwater Modeling



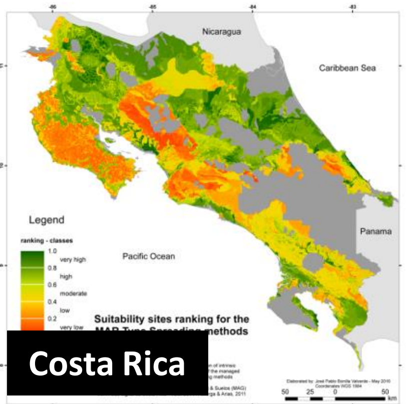
Setup, calculation, optimization and visualization of MODFLOW models

INOWAS

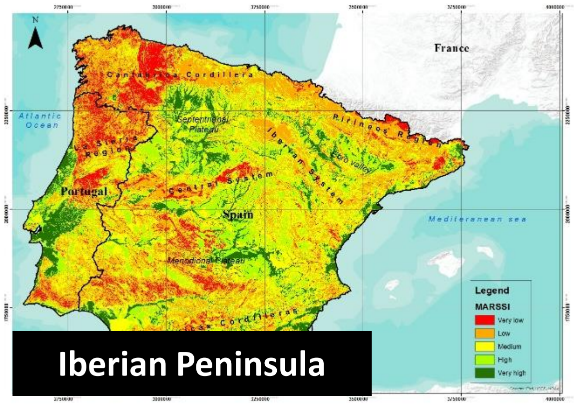
www.inowas.com

		ModelMuse	Visual MODFLOW Flex	INOWAS
SPECS	MODFLOW code	✅	✅	✅
	Pricing model	free	9,000 USD	free
	Web-based interface	🚫	🚫	✅
	Multiple tools (over 20)	🚫	🚫	✅
FEATURES	Scenarios analysis	🚫	🚫	✅
	3D visualization	🚫	✅	🚫
	Shared models	🚫	🚫	✅
	Optimization algorithms	🚫	🚫	✅
	Cloud-based scalability	🚫	🚫	✅
PACKAGES	Analytical equations	🚫	🚫	✅
	MODFLOW-2005	✅	✅	✅
	MT3DMS	✅	✅	✅
	SEAWAT	🚫	✅	in progress
	MODPATH	✅	✅	🚫

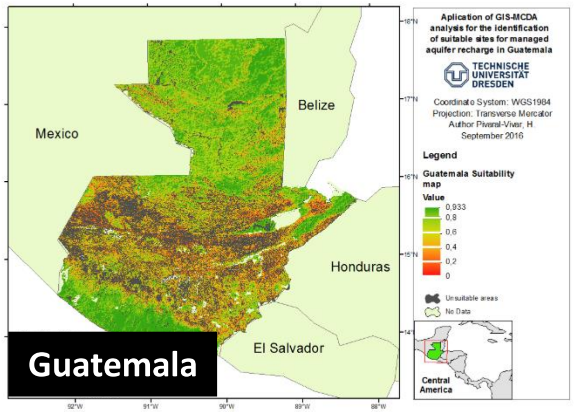
GIS-based MAR suitability mapping



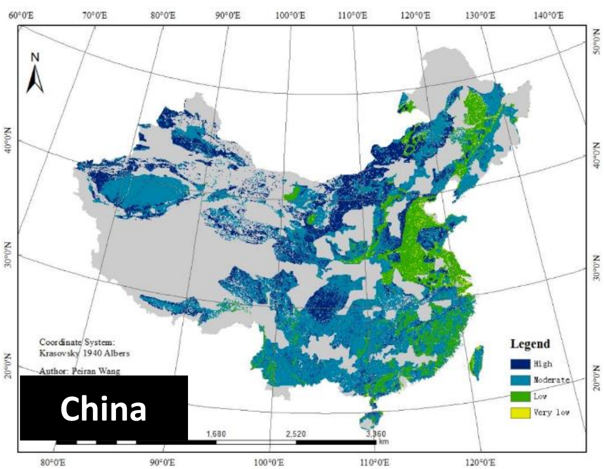
Bonilla et al., 2016



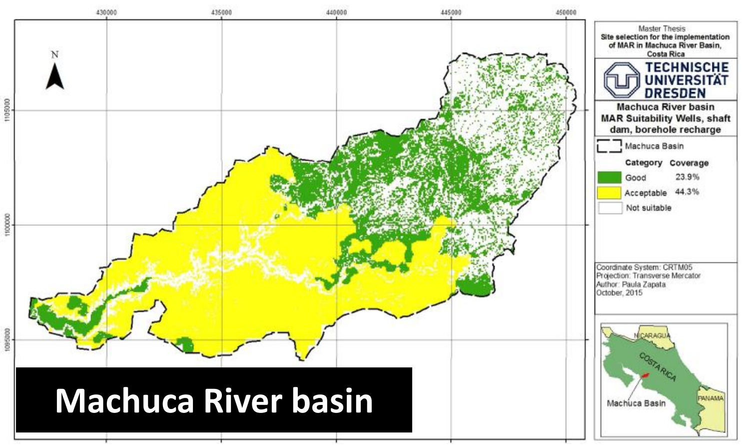
Vasquez, 2017



Pivaral, 2016



Wang, 2017



Zapata, 2015

MARSSI Index

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INTERNATIONAL SYMPOSIUM ON MANAGED AQUIFER RECHARGE

Madrid, 2019 May

www.ismar10.net

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Authors:
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Contact

TECHNISCHE UNIVERSITÄT DRESDEN

INOWAS
MAR Junior Research Group

ADDRESS

Technische Universität Dresden
Department of Hydrosciences
Pratzschwitzer Str. 15
01796 Pirna
GERMANY

Dr. Catalin Stefan

Phone: +49 351 46344144
Fax: +49 351 46344122
Email: catalin.stefan@tu-dresden.de
http://tu-dresden.de/uw/inowas
https://www.inowas.com