

***Enhancing Groundwater
Resilience by Harvesting
Glacial Meltwater with
Managed Aquifer Recharge***

***IWRA Groundwater – Climate
Conference***

29-30 October 2020

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THE WATER KING



Talk Organization

Glacial Meltwater & MAR
How Did We Think of This?

Where Can This Be Done?

Early Snowmelt

Issues

Things to Accomplish

Yakima River Basin Project



Maria Gibson, doctoral student, Oregon State University

What is MAR?

Managed Aquifer Recharge is the intentional recharge of water to suitable aquifers for subsequent recovery or to achieve environmental benefits. The managed process assures adequate protection of human health and the environment.

Western Australia Government: <http://bit.ly/2eLyLoF>

For terminology see: <https://bit.ly/2OyXxeU>

What Can MAR Do?

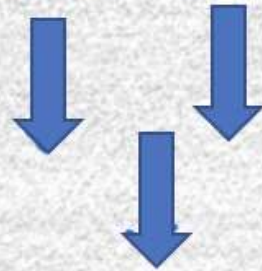
It can *reduce vulnerability to climate change* and *hydrological variability*. It can help *control overpumping* and *restore groundwater balance*. It can *recharge aquifers, control saltwater intrusion* or *prevent land subsidence*. It can also *sustain* or *improve the functioning of ecosystems* and *groundwater quality; mitigate floods*.

[IGRAC: <http://bit.ly/2s0tzEm>]

and *Increase Resilience!*

Infiltration Basin

Unconfined Aquifer



Water Table

Water Table Mounding

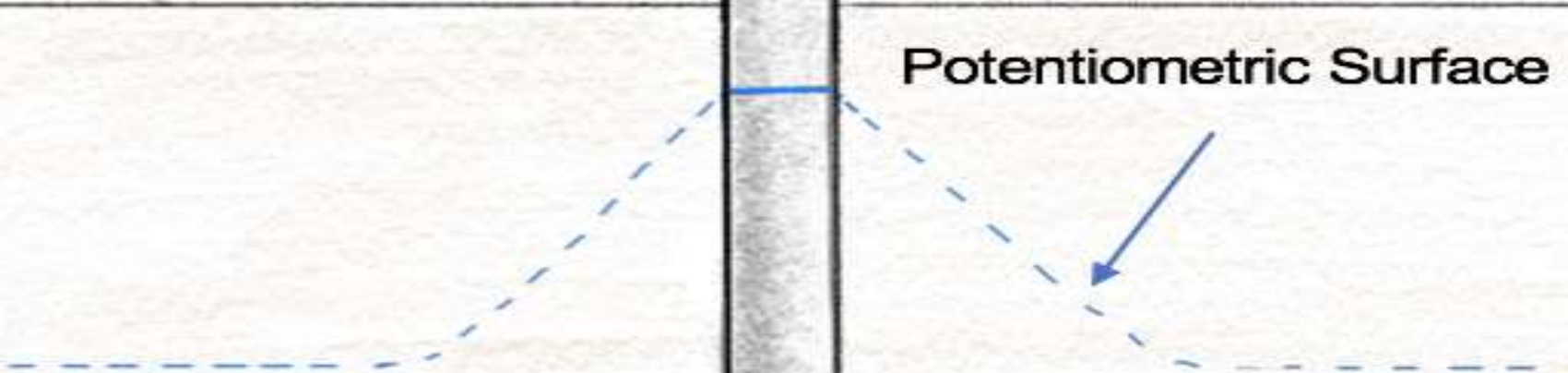




ASR Well



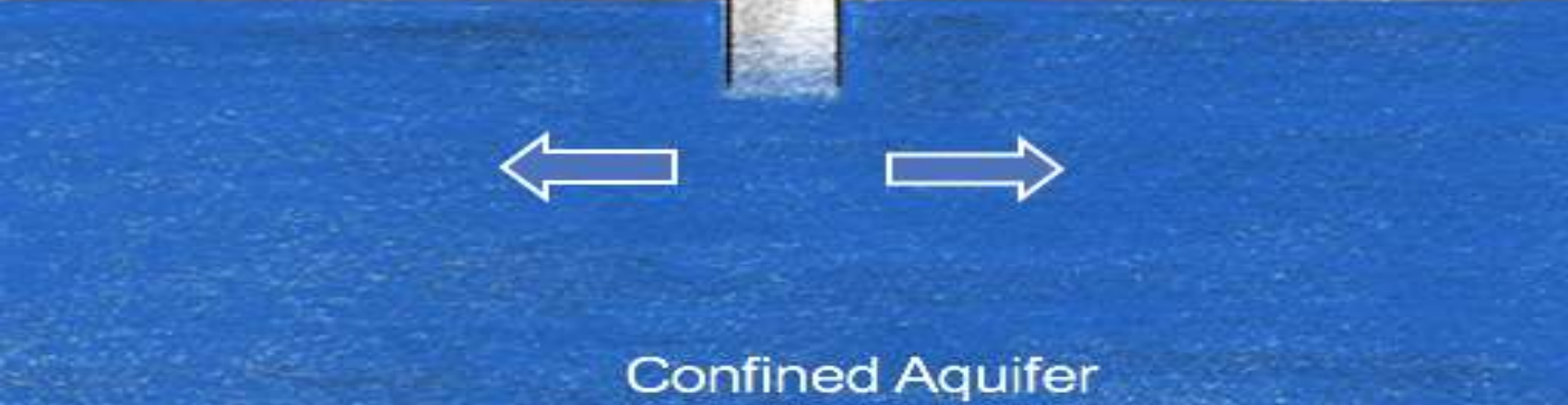
Potentiometric Surface

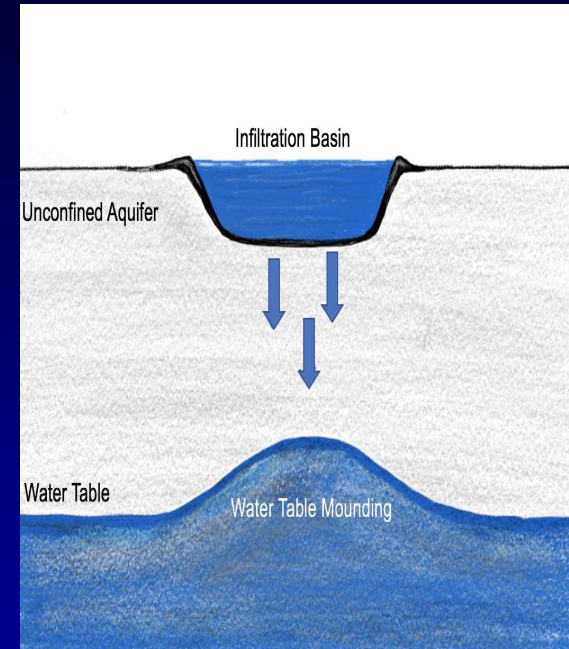
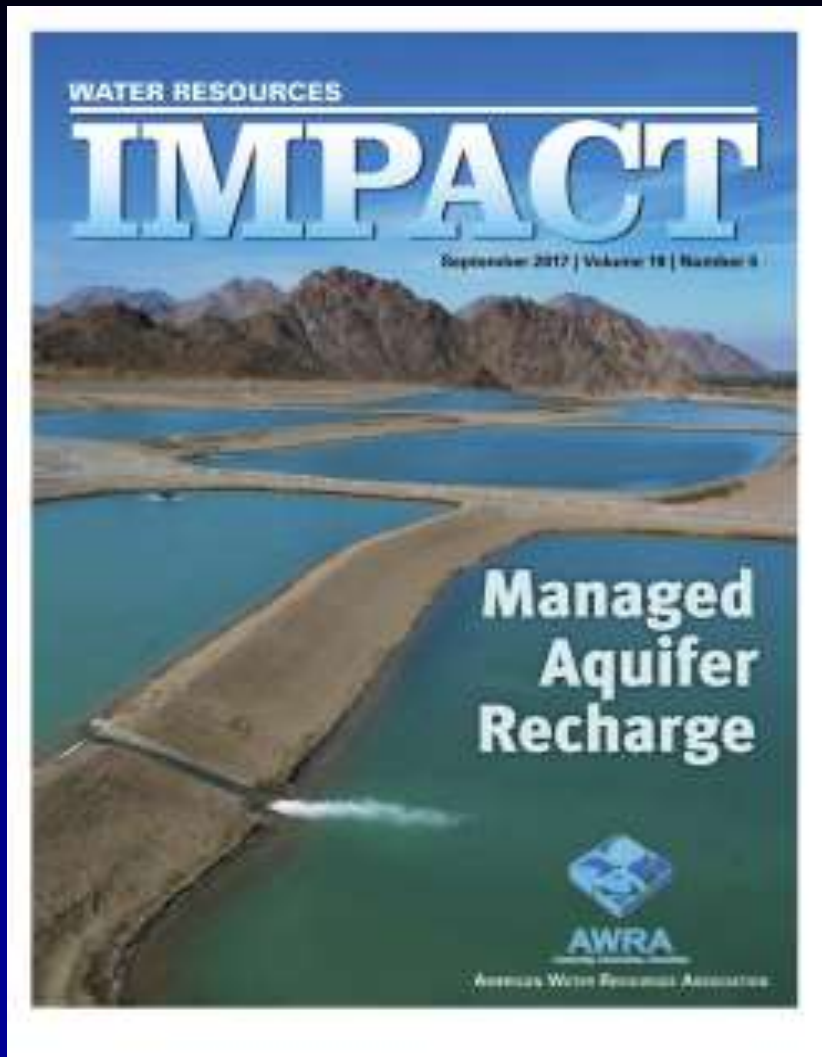


Aquitard



Confined Aquifer





<https://bit.ly/2TVBCV0>

Refill the hidden tank

The benefits of managing the recharge of aquifers

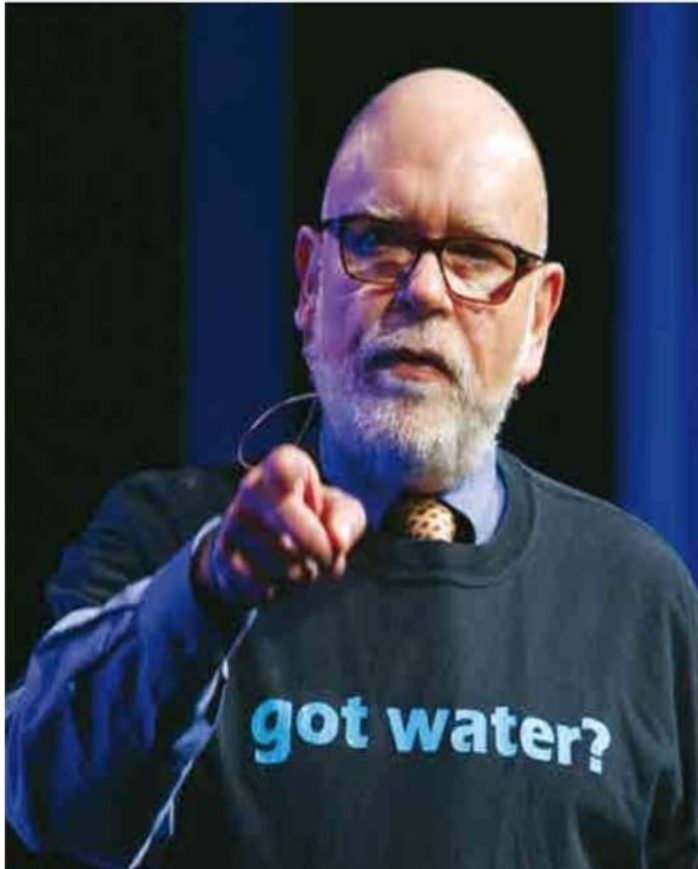
By Michael Campana

When I was eight, wandering my suburban Long Island, New York neighbourhood, I noticed large areas surrounded by chain-link fences with culverts on one side. After a storm, they filled with runoff and provided great playgrounds. They were called sumps, but remained a mystery. No adult could adequately explain their purpose, except that they collected rainwater and bred mosquitoes.

Fifteen years later, as a University of Arizona hydrology graduate student, I discovered a bit more. In the 1930s my county built sumps to manage floodwaters, but soon realised they also recharged valuable aquifer groundwater basins.

Most of those sumps are now dry, replaced by a 'modern' storm sewer system, but my county was ahead of its time in terms of artificial-managed-aquifer recharge (MAR). It even recognised one downside of its recharge operations: the poor quality when water ran off from the growing sprawl of streets, parking lots, and industrial sites.

Managed recharge is the increase in groundwater recharge over natural



Michael Campana

The Source
Magazine
View article at:
<http://bit.ly/2dytvnj>

How Did We Think of This?

*MEC visited Copiapó, Chile,
in the Atacama Desert, in 2008*



Where Can This Be Done?

Some Places Where MAR of Glacial Meltwater ***Might***
Work (Sufficient Water Available)

**Andes; Karakoram, Pamir, Himalaya, and related
mountain ranges and Tibetan Plateau; Rocky
Mountains; Alps;
Zagros and Caucasus Mountains;
Pyrenees; Cascade Range**

Note: Annual glacial runoff *just to the Gulf of Alaska*
is 57 cubic km (> 46 MAF ~ 2 full Lake Meads!)

See: <https://bit.ly/2UmflK4>

**Annual loss of snow & ice: 369B tons, > 50% from
North America. See <http://strib.mn/2WYL5bp>**

WORLD Physical





UNICEF Haiti Hurricane Relief - Children Need Your Help


Donate and help us reach critical aid to children in Haiti. Act Now.



TELEVISION 1/5 >

John Oliver says Donald Trump is 'medically incapable of accepting ...

Warm temperatures eroding Rocky Mountain glaciers

 *COLETTE DERWORIZ, CALGARY HERALD*
[More from Colette Derworiz, Calgary Herald](#)

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Receding glaciers in Bolivia leave communities at risk

October 20, 2016



Glacier and lake near the villages of Pelechuco and Agua Blanca in the Apolobamba region, northern Bolivia. Credit: Simon Cook

pricelin



★★★★☆



★★★★☆

Chinese Glacier's Retreat Signals Trouble for Asian Water Supply

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By EDWARD WONG DEC. 8, 2015



Glaciers Guardian Environment Network

Alpine glacier retreat pushing Europe closer to water crisis

IPS: Future glacier retreat in the Alps could affect the hydrology of large streams more strongly than previously assumed, a new study shows



Water Power

& DAM CONSTRUCTION



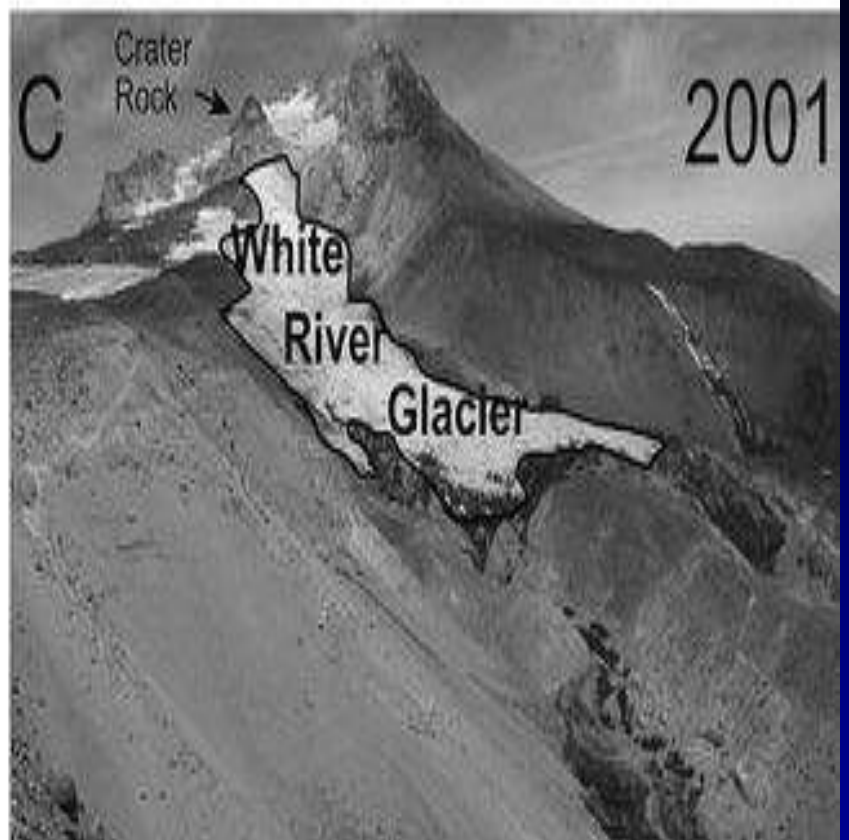
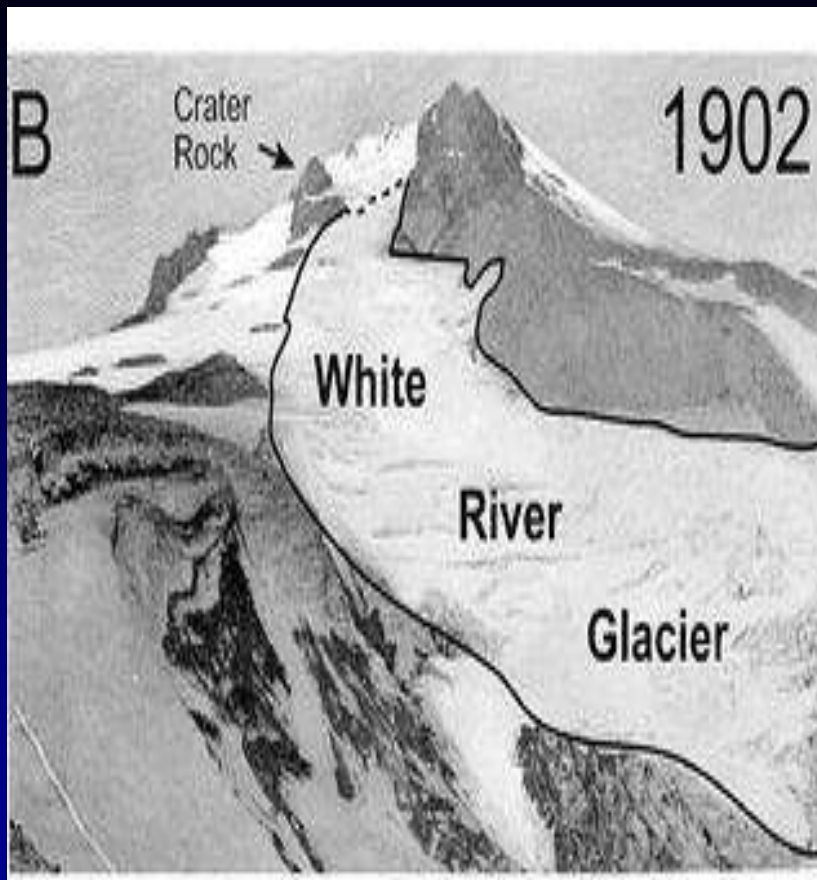
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Could dams replace melting European glaciers?

17 October 2016



Water management in reservoirs could substantially mitigate future summer water shortages which are anticipated as a consequence of ongoing glacier retreat. A recent study by Swiss and Italian researchers has begun to explore whether dams could replicate the hydrological role of glaciers, containing and storing meltwaters at high elevations in the valleys where glaciers were once located.

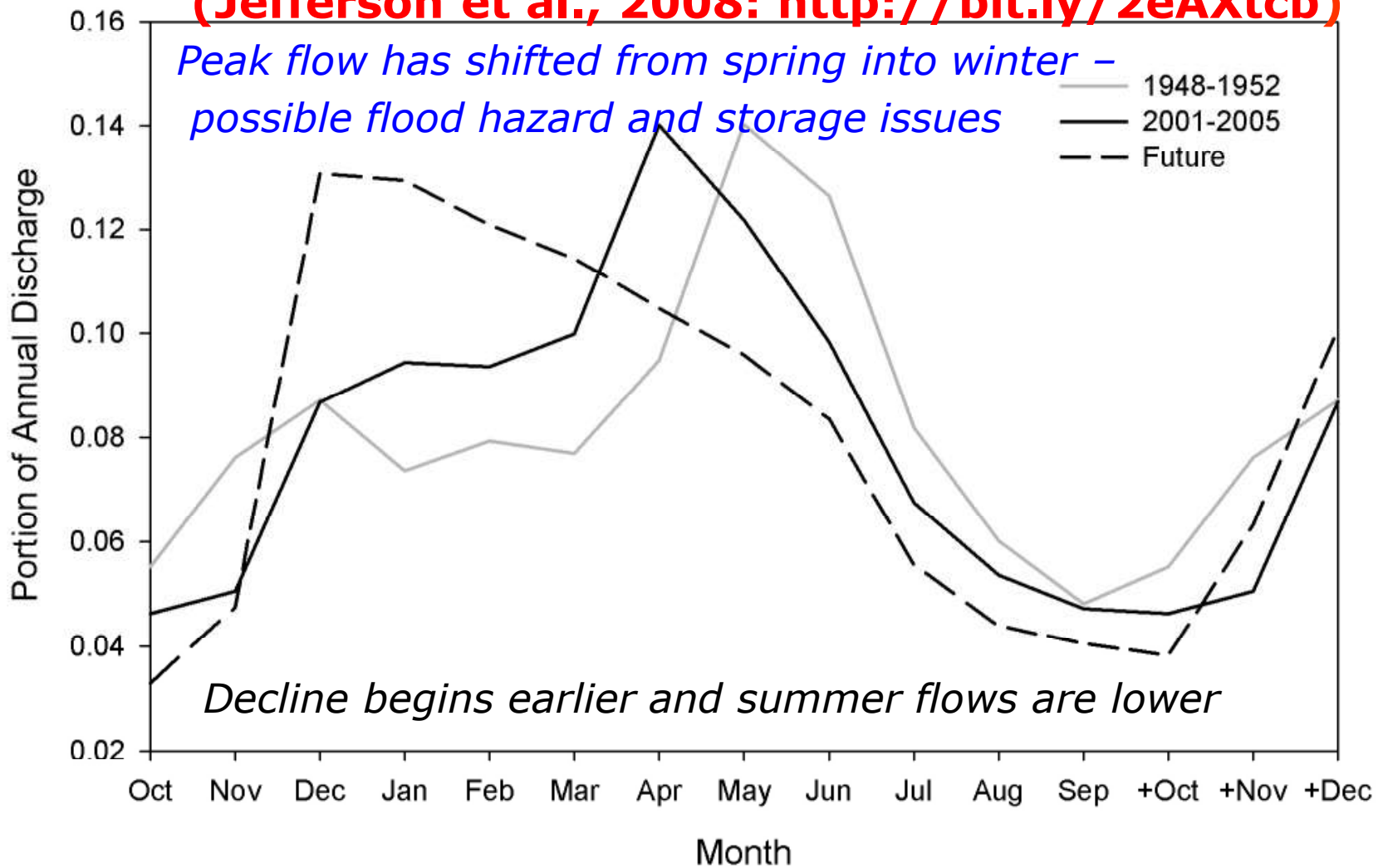


***White River Glacier,
Mt. Hood, Cascade Range, Oregon
(thanks to Anne Nolin)***

Streamflow – McKenzie River Basin

1948-52, 2001-05, Future

(Jefferson et al., 2008: <http://bit.ly/2eAXtcb>)



Issues

Not Sustainable

Legal and Institutional

Subsurface Availability & Suitability

Downstream/Ecosystem Issues

Conflict

Assorted Technical Issues

Economics

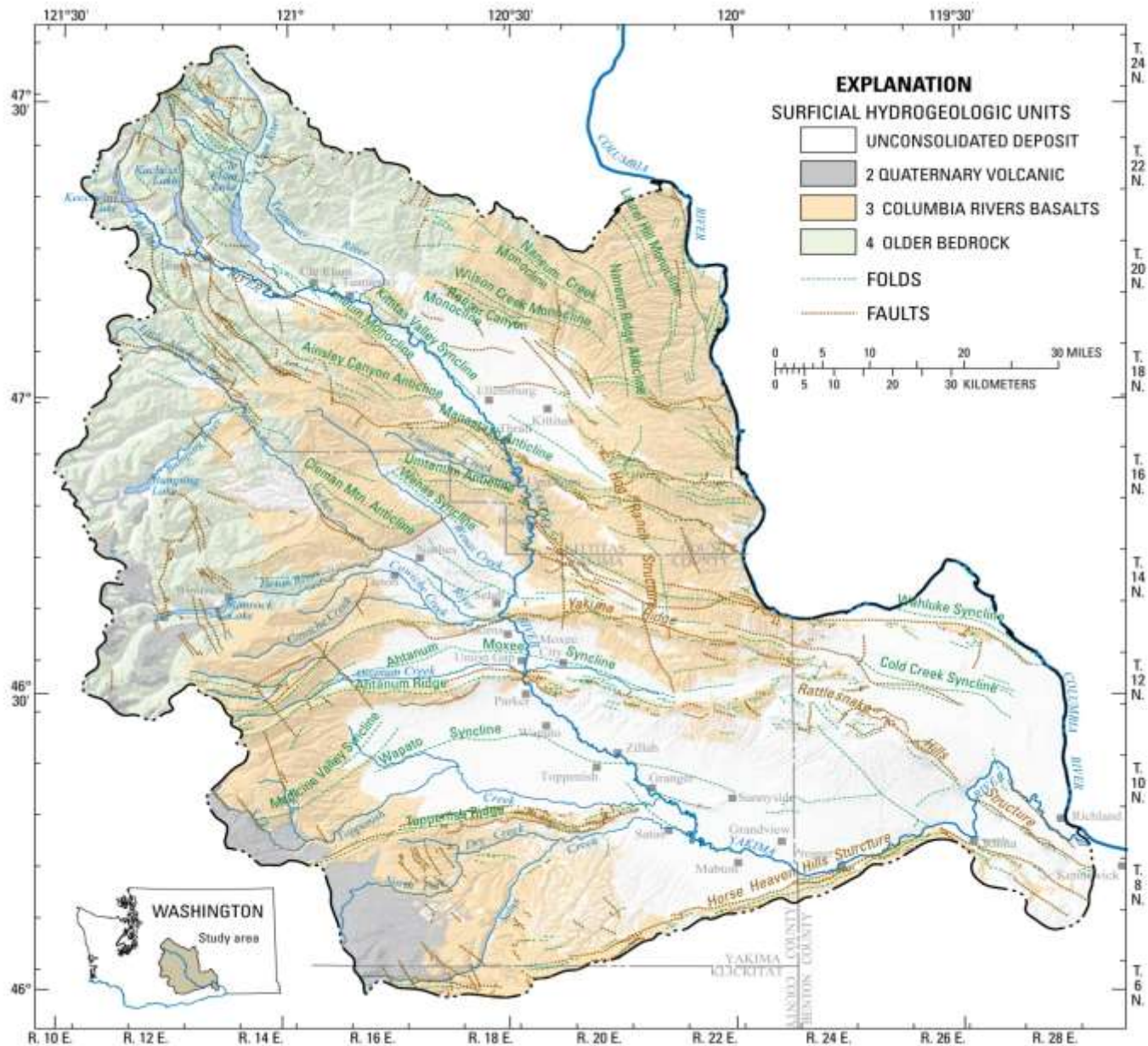
Need

Things to Accomplish

- 1) Identify Suitable Areas**
- 2) Identify Legal, Institutional & Other Issues**
- 3) Cost, Need, Local Enthusiasm**

Yakima Basin

- 1) **15,700 square km; rises in Cascade Range, flows SE to Columbia River**
- 2) **c. 360,000 people; productive agriculture - \$4B annually; IWRM plan adopted (see <https://bit.ly/2usfiTS>)**
- 3) **Tribal interests - Yakama Nation**
- 4) **Important salmon habitat (ESA)**



Base from U.S. Geological Survey digital data, 1983, 1:100,000
 Universal Transverse Mercator projection, Zone 10
 Horizontal Datum: North American Datum of 1927 (NAD 27)

Yakima River Basin (YRB) Project

- 1) Identify suitable MAR horizons in Columbia River Basalt aquifers (highly compartmentalized)**
- 2) Store 'excess' surface water via wells in CRBs or infiltration**
- 3) Withdraw water as needed to supplement irrigation and ecosystem needs**
- 4) Funded by Washington Dept. of Ecology**

Estimating Aquifer Storage and Recovery (ASR) Regional and Local Suitability: A Case Study in Washington State, USA

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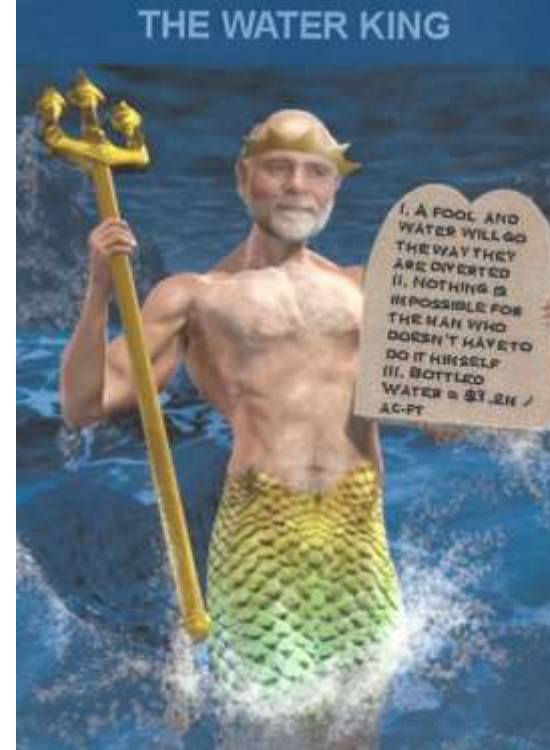
See <https://bit.ly/2TXn2MO>

The Water King's Three Commandments!

1) "A fool and water will go go the way they are diverted."
- African proverb

2) "There are lies, there are damn lies, and there are hydrologists' reports."
- Texas legislative hearing, 2 February 2016

**3) Bottled water = \$2600/cubic meter
(\$3.2M/acre-foot; see #1)**



Thank You!

WaterWired blog:

www.waterwired.org

**WaterWired Twitter: @waterwired
aquadoc@oregonstate.edu**

Comments welcomed!

**Check out the September 2017 issue of AWRA's
Water Resources IMPACT featuring
*Managed Aquifer Recharge!***

<https://bit.ly/2TVBCV0>

***“If climate change is a shark, water is its teeth.”
- Gemma Boag***