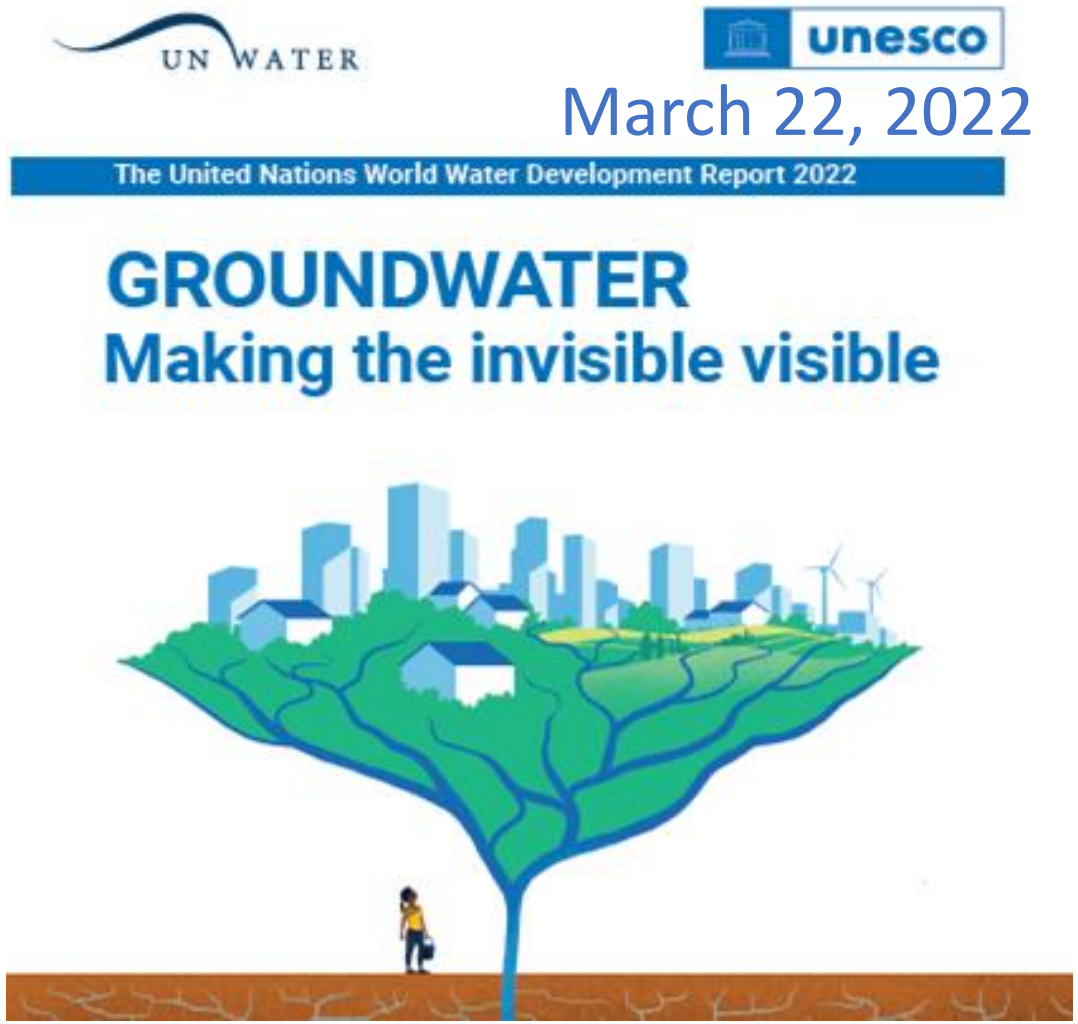
Low-Cost Water Wells for Eradicating Water Poverty

John Cherry

UN 2023 Water Conference

Virtual Side Event: Self Supply

March 23 at 9 AM EST

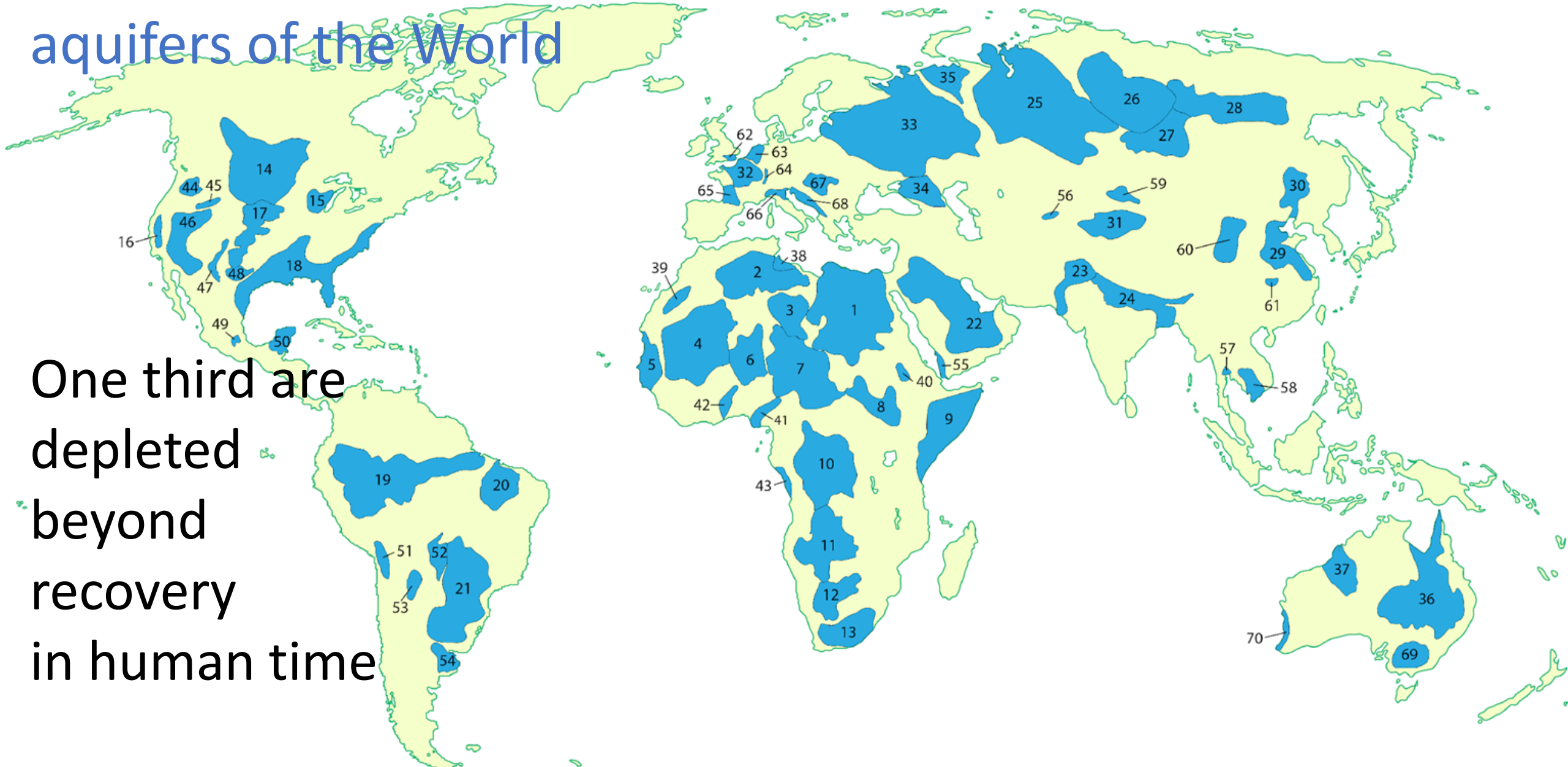


Groundwater is 99 % of all liquid freshwater

"Groundwater is central to the *fight* against poverty, to food and water security"

Irrigation is *draining* aquifers to grow mostly *wrong* types of food for the mostly affluent

40% of all groundwater is extracted from the 68 Largest aquifers of the World



One third are depleted beyond recovery in human time

Global Water Crisis

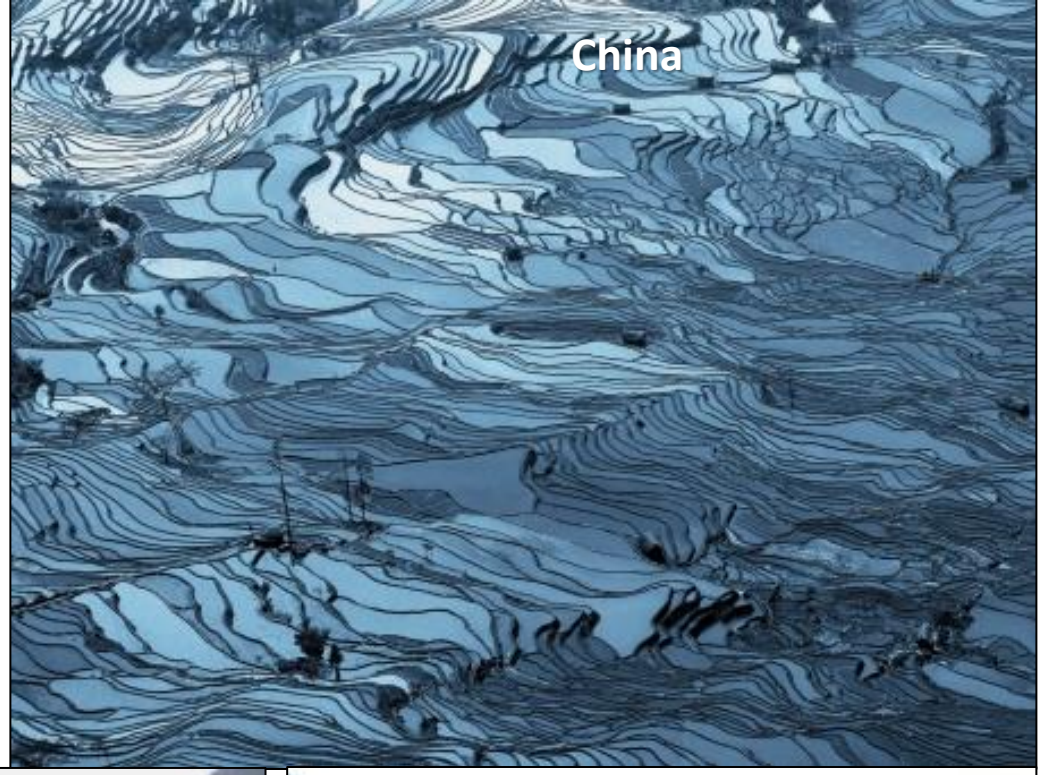
Groundwater…over extracted and mismanaged for globalized agriculture. ……less pumping of many aquifers is needed

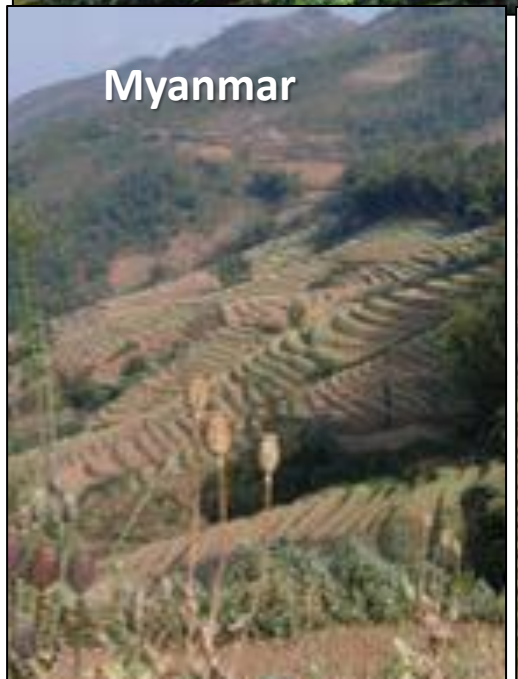
Global Water Crisis

……the paradox

- Groundwater…over extracted and mismanaged……less pumping of many aquifers is needed for globalizd agriculture
- Groundwater… under extracted …many more wells are needed for more than a billion rural people in water poverty

100’s of millions of people live in hills and mountains engaged in agriculture





….many rely on springs……with fecal contamination

Even at "improved" spring sources,
E. Coli concentrations are commonly high

….*at surface* improvements generally do not reduce pathogens because they travel in the shallow subsurface into the spring water

Wells need to be drilled beside the springs
to draw deeper unconttaminated water

250 million rural people in India drink spring water

Much of global water poverty is in Africa

Slide from David Kreamer

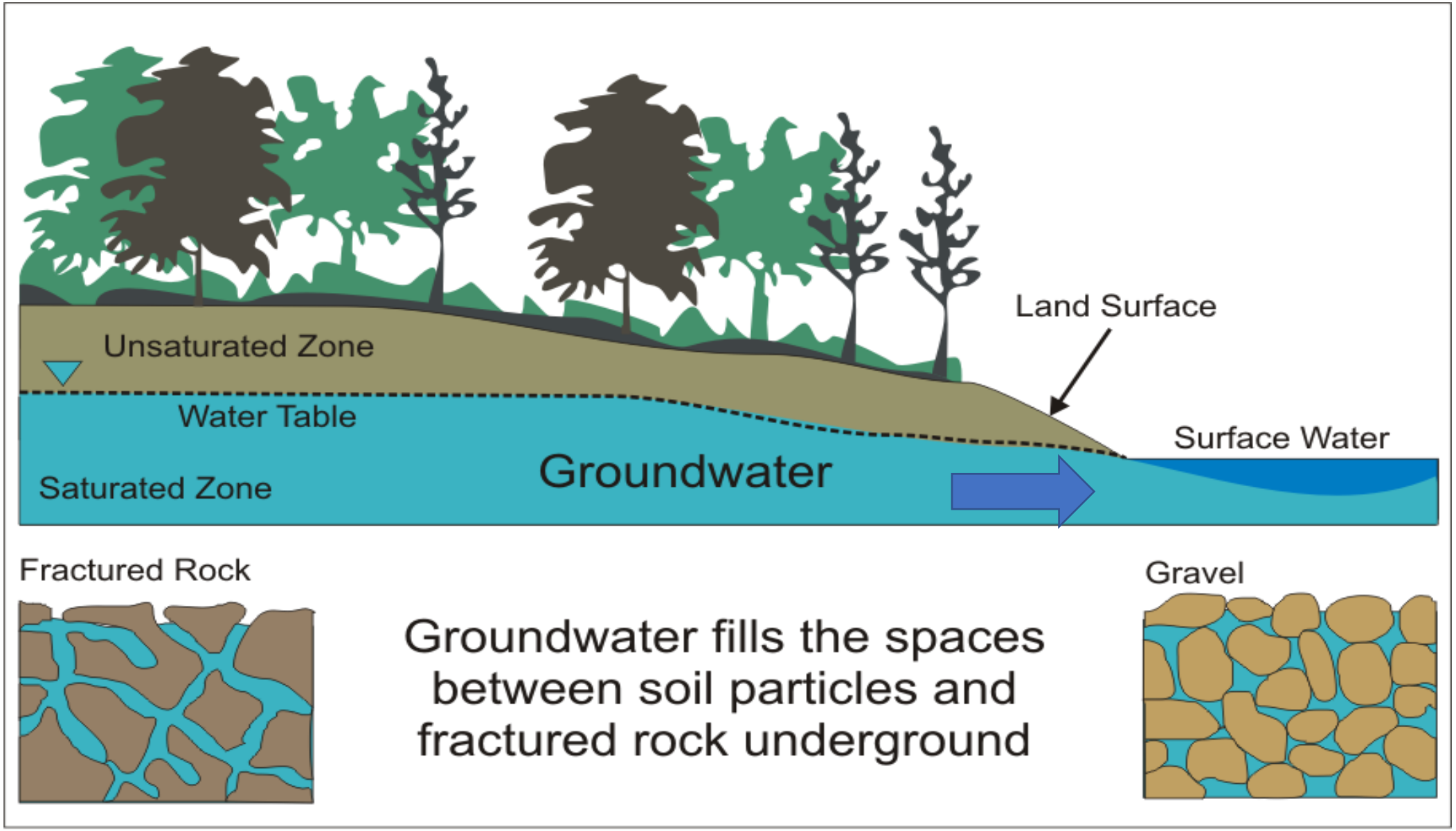
When we include those who drink unsafe water from wells and springs,

more than one third of humanity lives in water poverty……..the largest and most shameful failure of our civilization……..

Piped water is not the solution for most…… solutions at the household are the only feasible path for most

……..the households in need are mostly spread out …many in rough terrain ……..small well drilling methods are essential to access where the wells are needed

Groundwater is everywhere beneath us

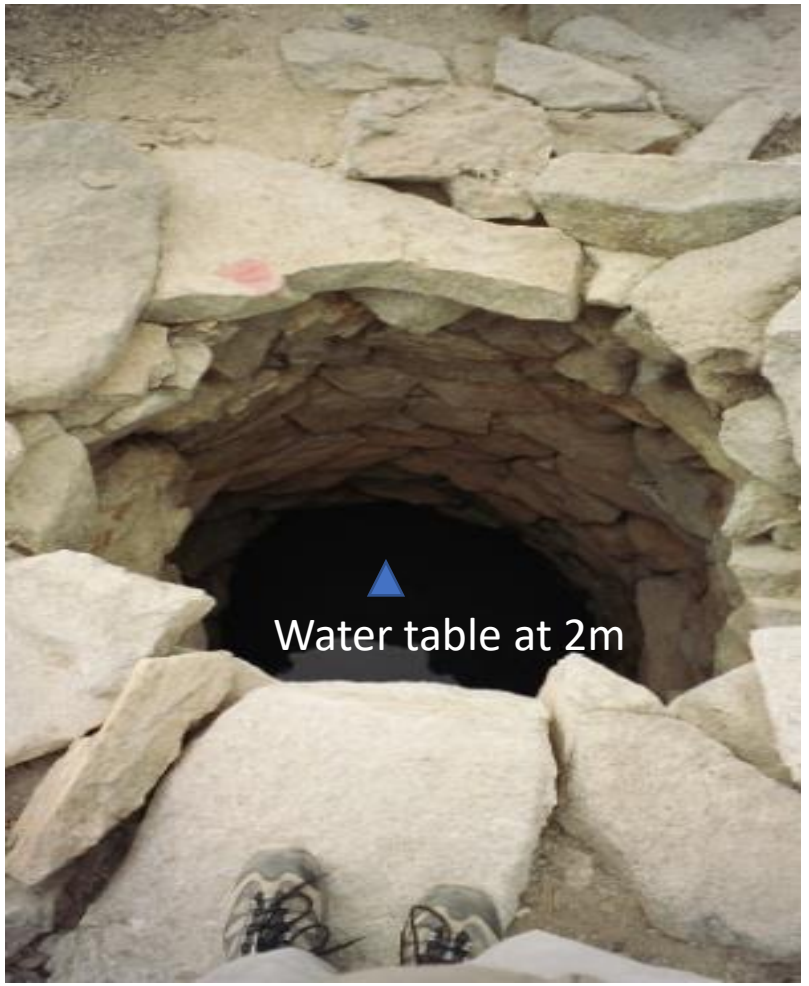


Adapted From the US Geological Survey

Fresh Groundwater Is Nearly Everywhere

Ancient Hand Dug Well In The Gobi Desert

Field trip, China 2005



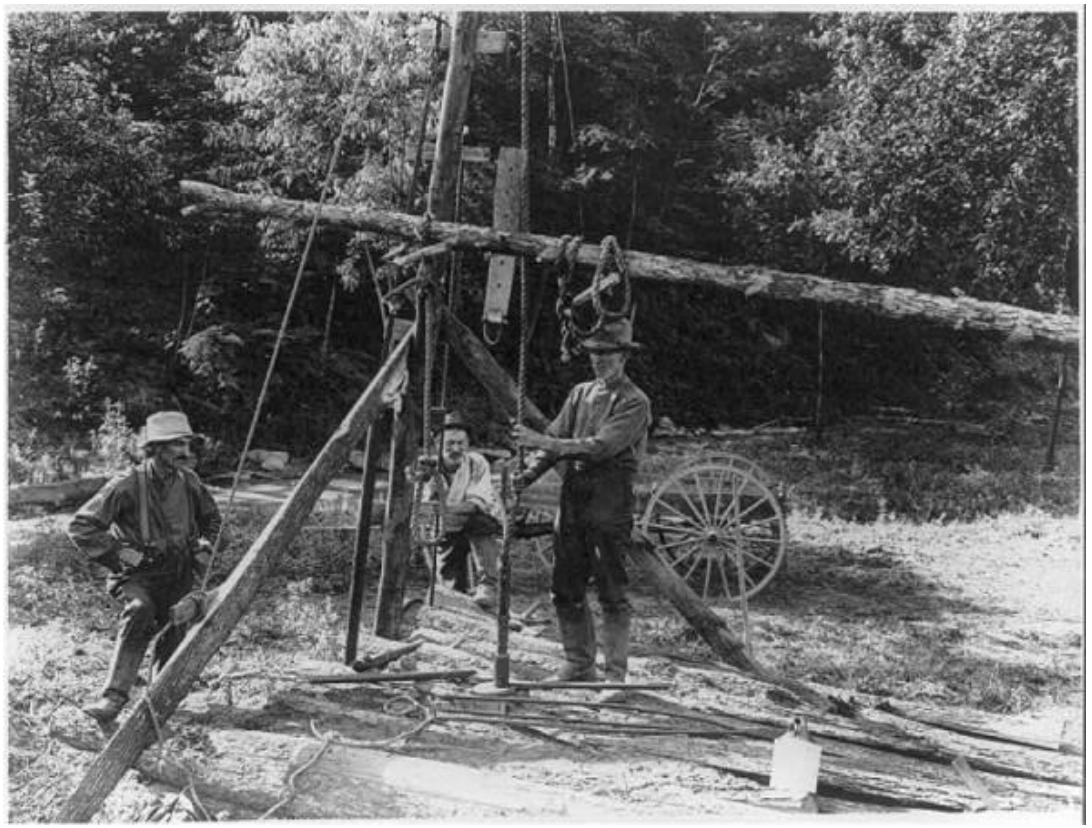
Wells dug by nomads with camels for transportation

Much water poverty existed in America <100 years ago

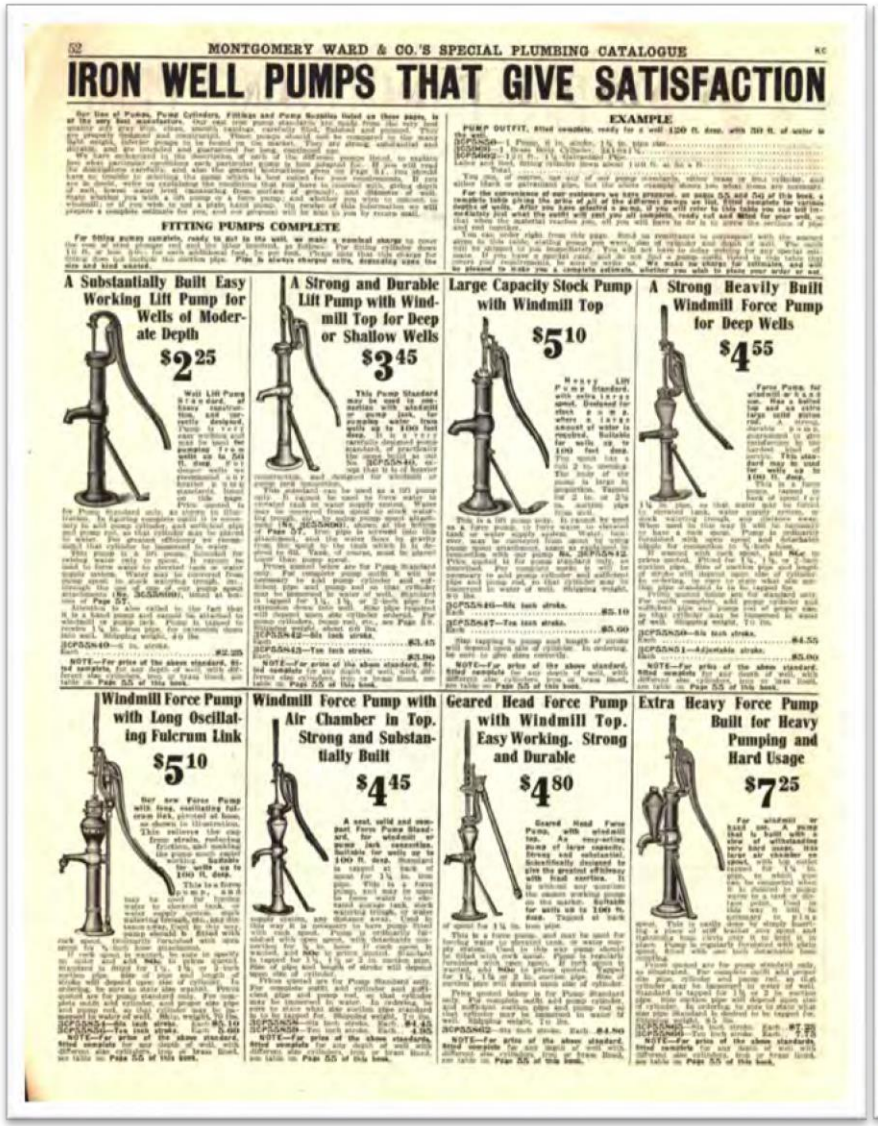
Water poverty was eradicated from America by self supply initiated locally with lowest cost methods

….proved that enough freshwater for household wells exists nearly everywhere

Dug wells and manual drilled wells…America.. 1600’s to 1940’s



Estimated that up to 45,000,000 handpumps made between 1600s and 1970



52 MONTGOMERY WARD & CO.'S SPECIAL PLUMBING CATALOGUE

IRON WELL PUMPS THAT GIVE SATISFACTION

EXAMPLE

FITTING PUMPS COMPLETE

A Substantially Built Easy Working Lift Pump for Wells of Moderate Depth $2.25

A Strong and Durable Lift Pump with Windmill Top for Deep or Shallow Wells $3.45

Large Capacity Stock Pump with Windmill Top $5.10

A Strong Heavily Built Windmill Force Pump for Deep Wells $4.55

Windmill Force Pump with Long Oscillating Fulcrum Link $5.10

Windmill Force Pump with Air Chamber in Top. Strong and Substantially Built $4.45

Geared Head Force Pump with Windmill Top. Easy Working. Strong and Durable $4.80

Extra Heavy Force Pump Built for Heavy Pumping and Hard Usage $7.25

HIGH GRADE PUMPS AT POPULAR PRIC

These Pump Outfits Are Complete, Ready to Put Into Your Well

All you need for installing them is a pipe wrench. Just screw the pipe and rod together and drop it down into your well. It is very simple; anyone can do it.

Each outfit consists of a pump, pump cylinder, suction pipe and cylinder rod. The pipe and rod are just the right length to fit down into a well of the depth for which the outfit is intended.

Outfits Nos. 42N5100¼ to 42N5106¼ raise the water from the well to the pump spout. It flows from the spout by gravity. Outfits Nos. 42N5130¼ to 42N5135¼ raise the water from the well and force it out of the spout or through the opening in the back. They can, therefore, be used for sprinkling, washing windows, etc., or for forcing the water into an elevated storage tank.

Eureka Anti-Freezing Lift Pump Outfit.
For Hand or Windmill Pumping. For Dug or Open Wells.

Triumph Windmill Force Pump Outfit.
Also for Hand Pumping.

Pages 925, 926 and 927 Tell You How to Figure Transportation Charges

58 THE S.H. BORBRIDGE CO WINNIPEG, CAN.

TWO LEADERS IN PUMP HEADS

The pump heads shown here were selected from a wide range on account of their suitability to the country. They can be used by hand power or can be attached to a wind-mill, and whether operated by hand or mechanical power they give satisfactory service. The stroke can be easily altered to suit the available power. In the installing of all pumps the size of the cylinder and piping must be graded according to the depth of the well. Wells from 15 to 30 feet take a 4½ inch cylinder and 2 inch piping; from 35 to 40 feet they take a 4 inch cylinder and 2 inch piping; from 45 to 50 feet they take a 3½ inch cylinder and 1¼ inch piping; from 55 to 75 feet they take a 3 inch cylinder and 1¼ in. piping; a ninety foot well takes a 2½ inch cylinder and 1¼ inch piping. When ordering a pumping outfit it is always well to remember this; otherwise the pump will not give satisfactory service and will be hard to operate.

OUR GASOLINE ENGINES
Turn to pages 48 to 50. There you will see our engines illustrated and described. Our prices are right.

THE STOCKMAN'S FAVORITE

Of all pumps made this is the favorite with stock raisers. It is easy to operate and lifts a large volume of water. It is made so that it not only can be pumped by hand, but it can be used as a power pump. Ordinarily it is used only to pump water for stock, but when specified can be equipped to force water through a hose attachment; movable spout can be set at the most convenient angle to the pump.

1R5800—The Stockman's Favorite, Standard only **13.50**

Cat. No.	Depth of Well	Size of Cylinder	Price
1R5801	15 feet	4½x12 in.	$31.85
1R5802	20 feet	4½x12 in.	34.60
1R5803	25 feet	4½x12 in.	37.30
1R5804	30 feet	4½x12 in.	40.05
1R5805	35 feet	4½x12 in.	40.90
1R5806	40 feet	4½x12 in.	43.60
1R5807	45 feet	3½x12 in.	42.40
1R5808	50 feet	3½x12 in.	44.55
1R5809	55 feet	3 x12 in.	45.70
1R5810	60 feet	3 x12 in.	47.85
1R5811	65 feet	3 x12 in.	50.00
1R5812	70 feet	3 x12 in.	52.15
1R5813	75 feet	3 x12 in.	54.25
1R5814	90 feet	2½x12 in.	56.65

THE STOCKMAN'S STANDBY

Generally speaking this pump is like the one to the right. The chief difference is that the one to the right has a wooden handle, while this one has an iron handle. This pump also has a somewhat different leverage. It is shown for hand use, but it can also be equipped to be operated by wind-mill or gasoline engine. It has movable spout, so that the spout can be set at any convenient angle to the pump.

1R5815A—The Stockman's Standby, Standard only **11.90**

Cat. No.	Depth of Well	Size of Cylinder	Price
1R5815	15 feet	4½x12 in.	$30.65
1R5816	20 feet	4½x12 in.	33.40
1R5817	25 feet	4½x12 in.	36.10
1R5818	30 feet	4½x12 in.	38.85
1R5819	35 feet	4 x12 in.	39.70
1R5820	40 feet	4 x12 in.	42.40
1R5821	45 feet	3½x12 in.	41.20
1R5822	50 feet	3½x12 in.	43.35
1R5823	55 feet	3 x12 in.	44.50
1R5824	60 feet	3 x12 in.	46.65
1R5825	65 feet	3 x12 in.	48.00
1R5826	70 feet	3 x12 in.	50.95
1R5827	75 feet	3 x12 in.	53.05
1R5828	90 feet	2½x12 in.	55.45

Montgomery Ward - 1914

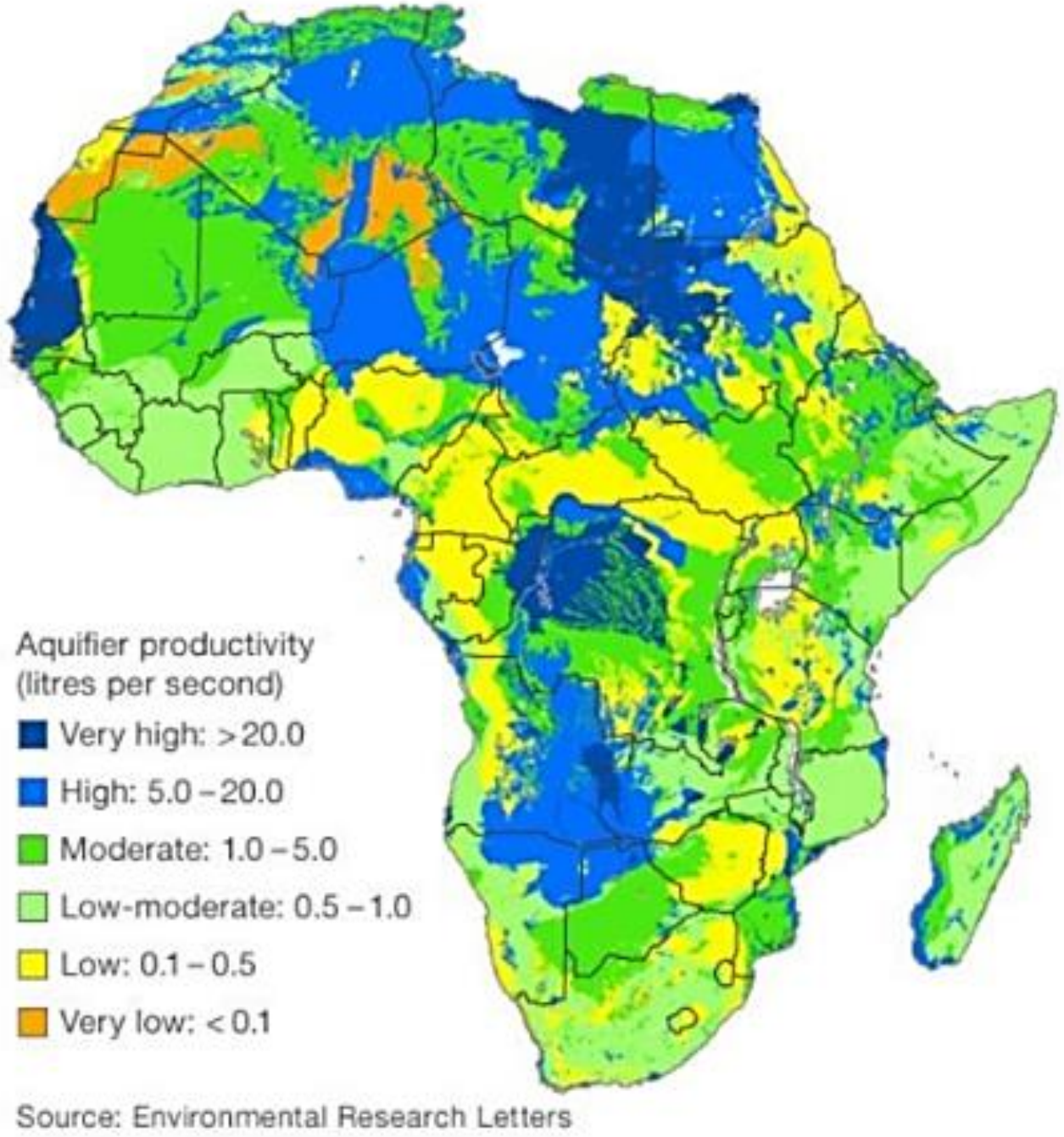
Sears Robuck and Co. - 1918

Borbridge Co. - 1918

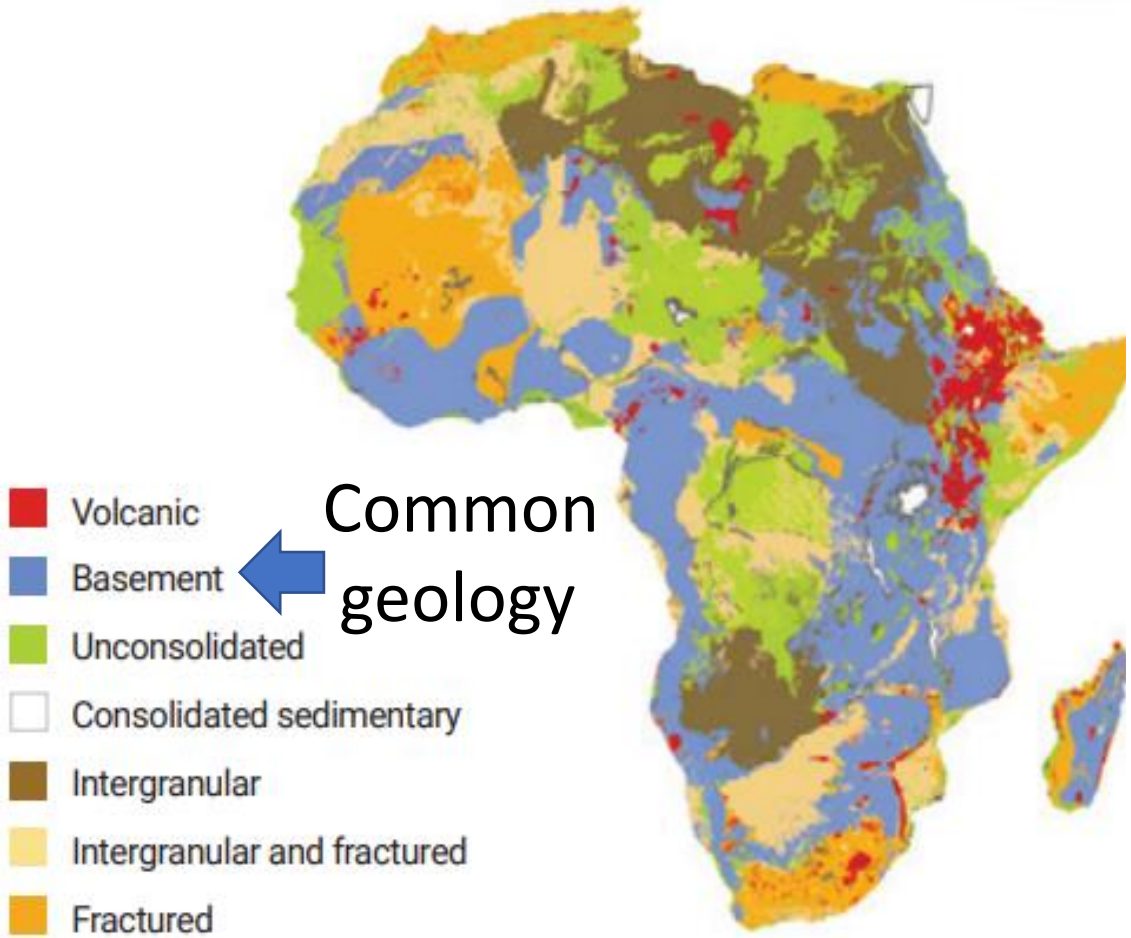
Manual well-drilling is the self supply step for household wells

Africa……

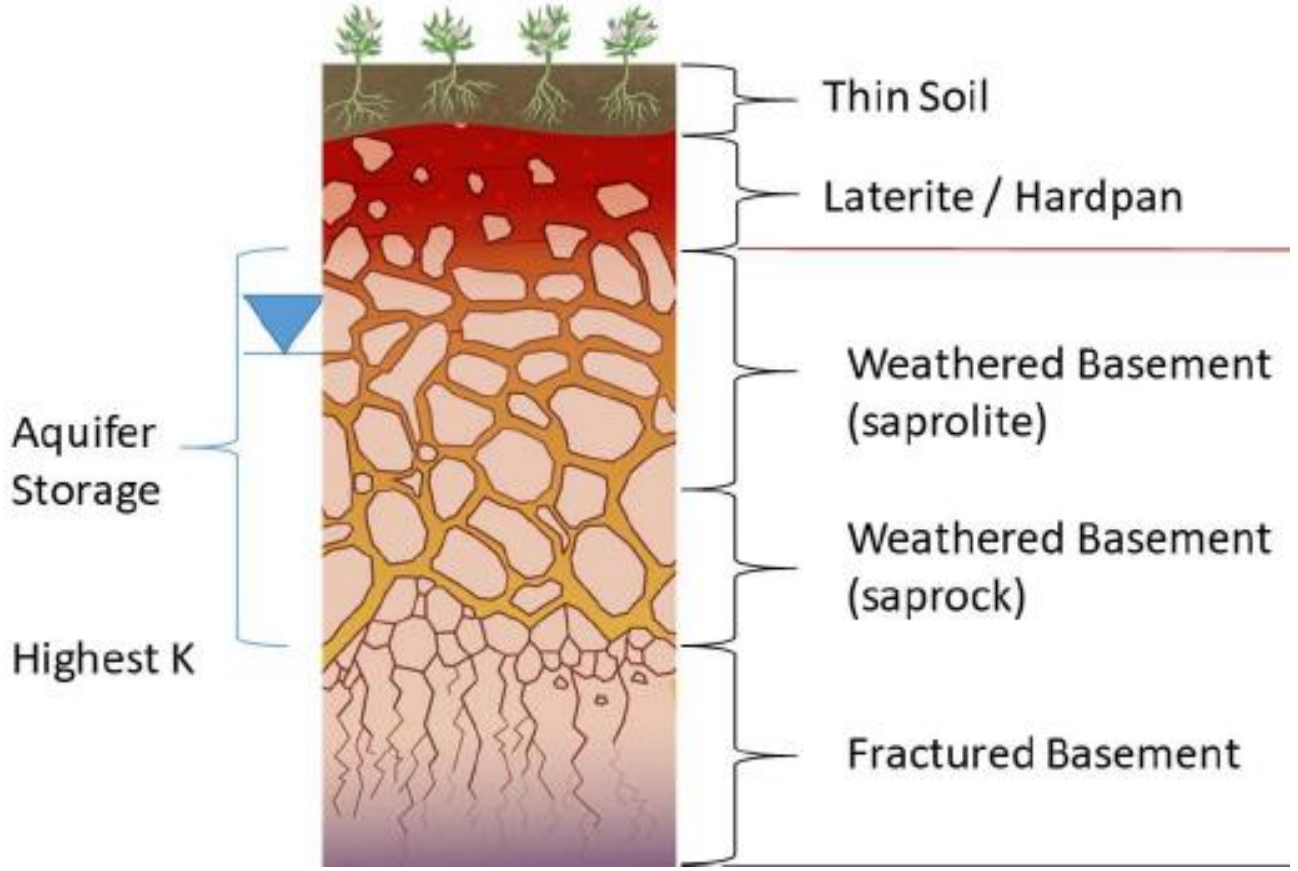
Studies indicate there is enough fresh groundwater not too deep to supply household wells just about everywhere



Africa….. much of the fresh groundwater occurs in hard basement rock that requires rock drilling machines



Common geology

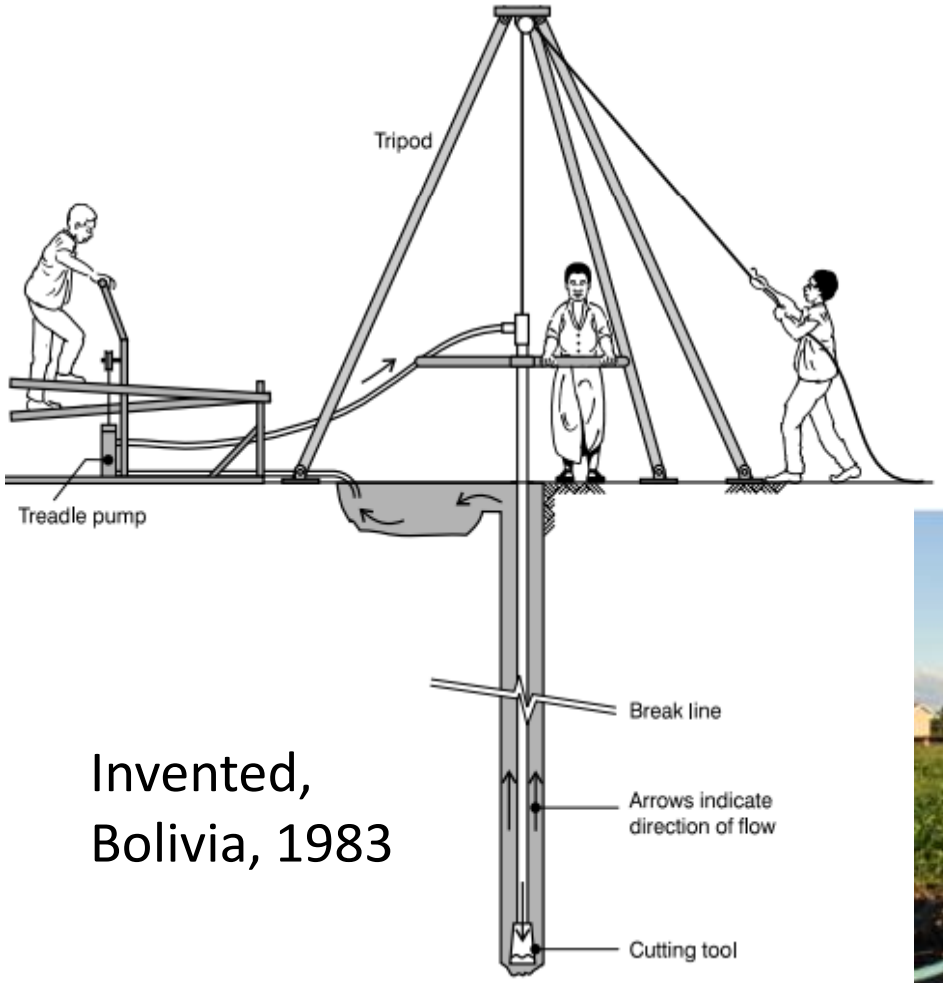


MacDonald et al, BGS, 2012

Only 500-1000 liters per day of safe water is needed to lift each family out of water poverty

Wells to supply this daily yield should be feasible just about anywhere if the appropriate well drilling methods and hydrogeologic knowledge is used

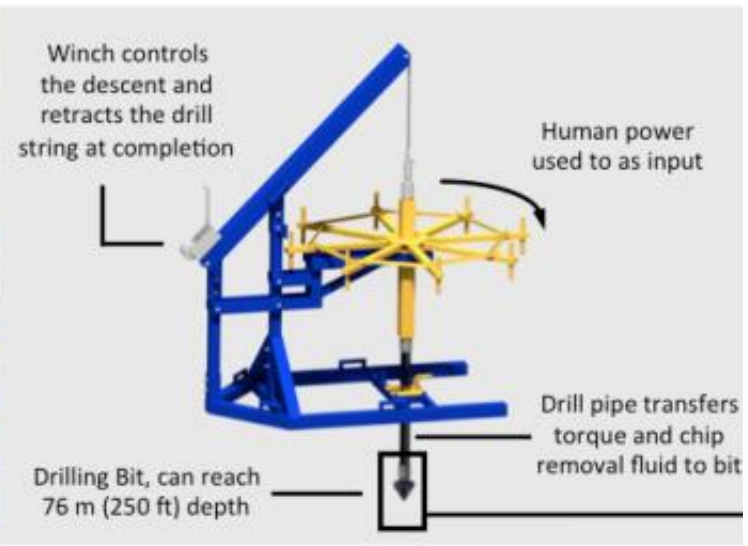
Rotary-jetting drilling….
(EMAS) method…versatile



Invented,
Bolivia, 1983

High tech manual drilling:
The Village Drill.. invented Utah, 2013
Robust and durable

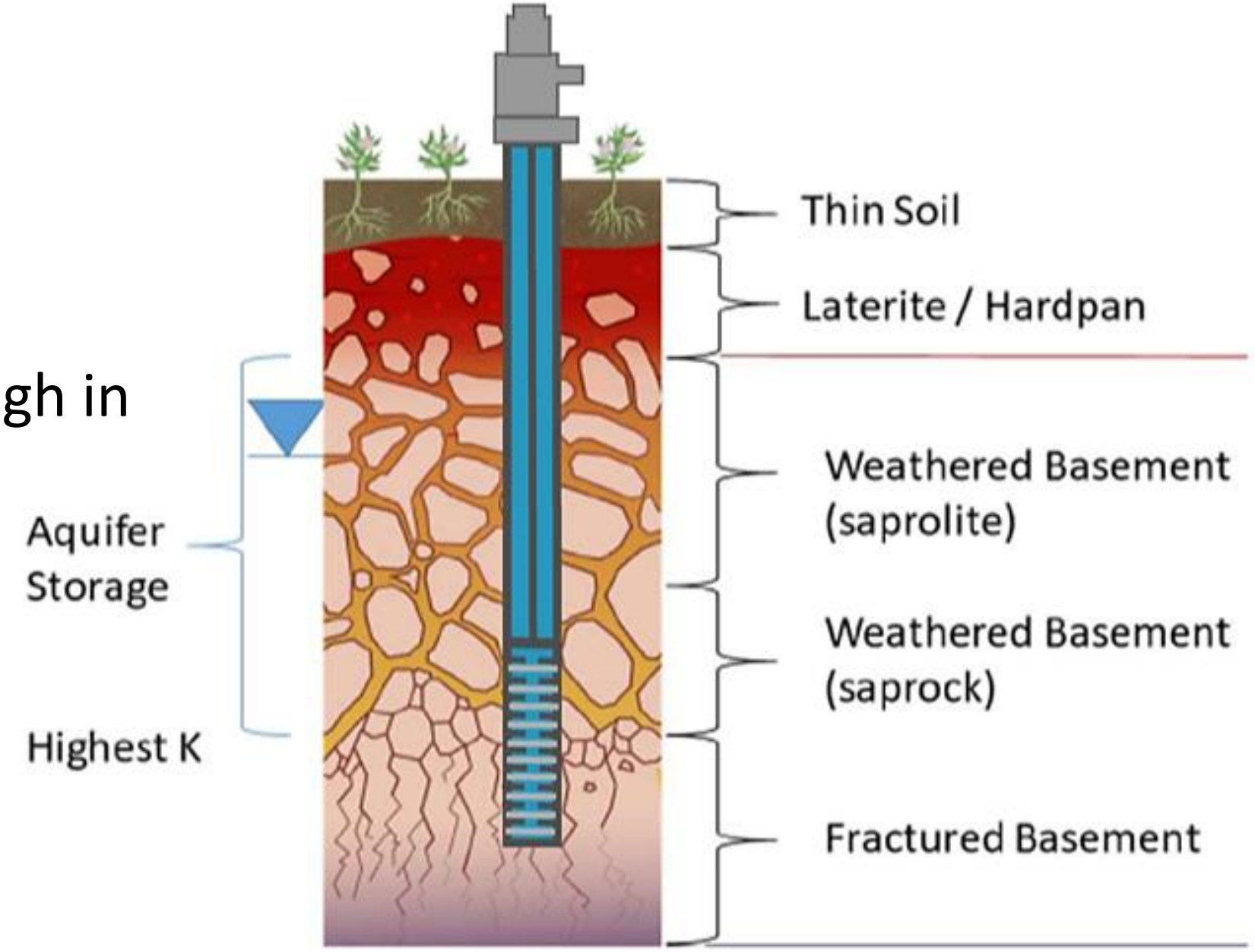
(a)



(b)

However….

manual drilling has limited prospects to penetrate deep enough in rock to access the freshwater in the fractures



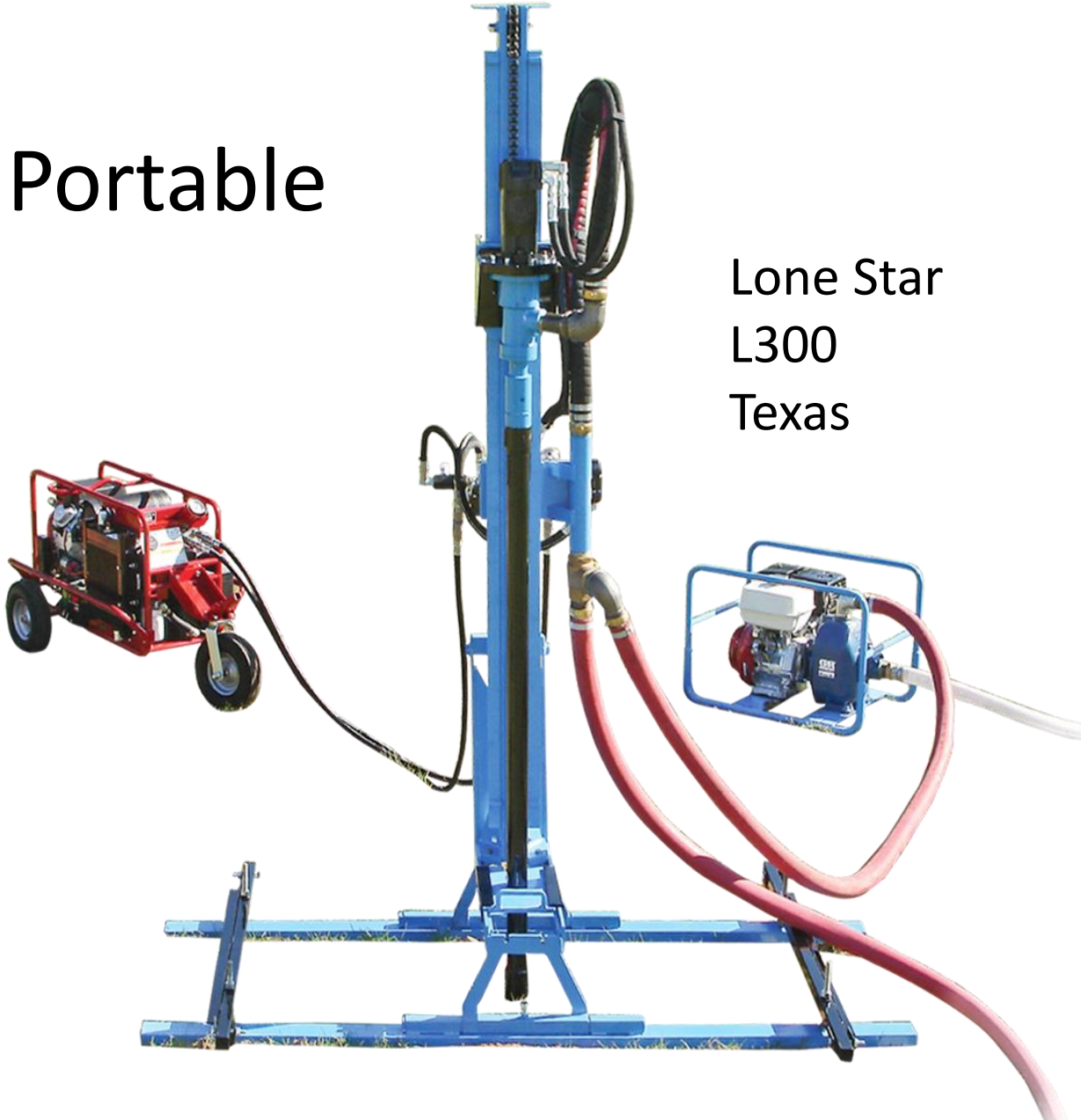
Small cable-tool drill for developing countries

rugged
easy to use
effective
but nothard rock

Rhino Drill invented by Rotary Club project, California, 2012

Mud rotary drilling

Portable

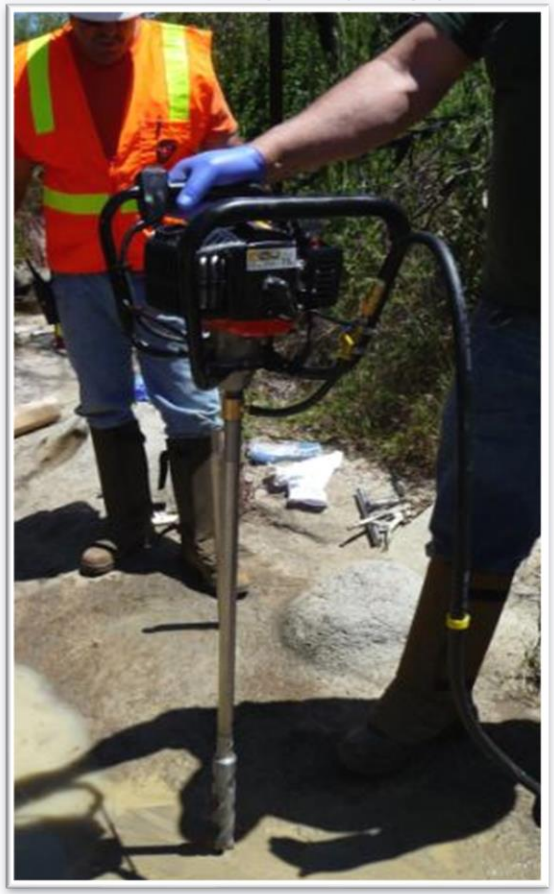


Lone Star
L300
Texas

Portable rock core drills made for **finding minerals** offer greatest potential for water well drilling in hard bedrock

Field demonstrations using these drills for water wells are urgently needed……

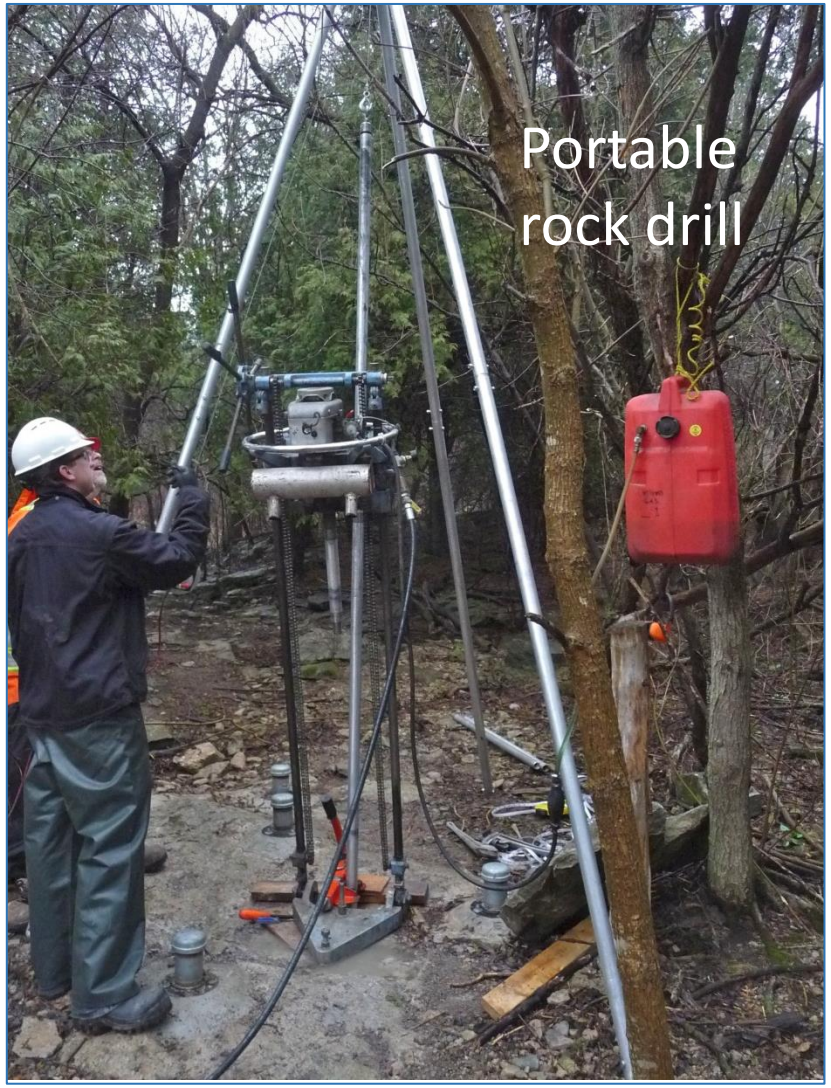
Smallest

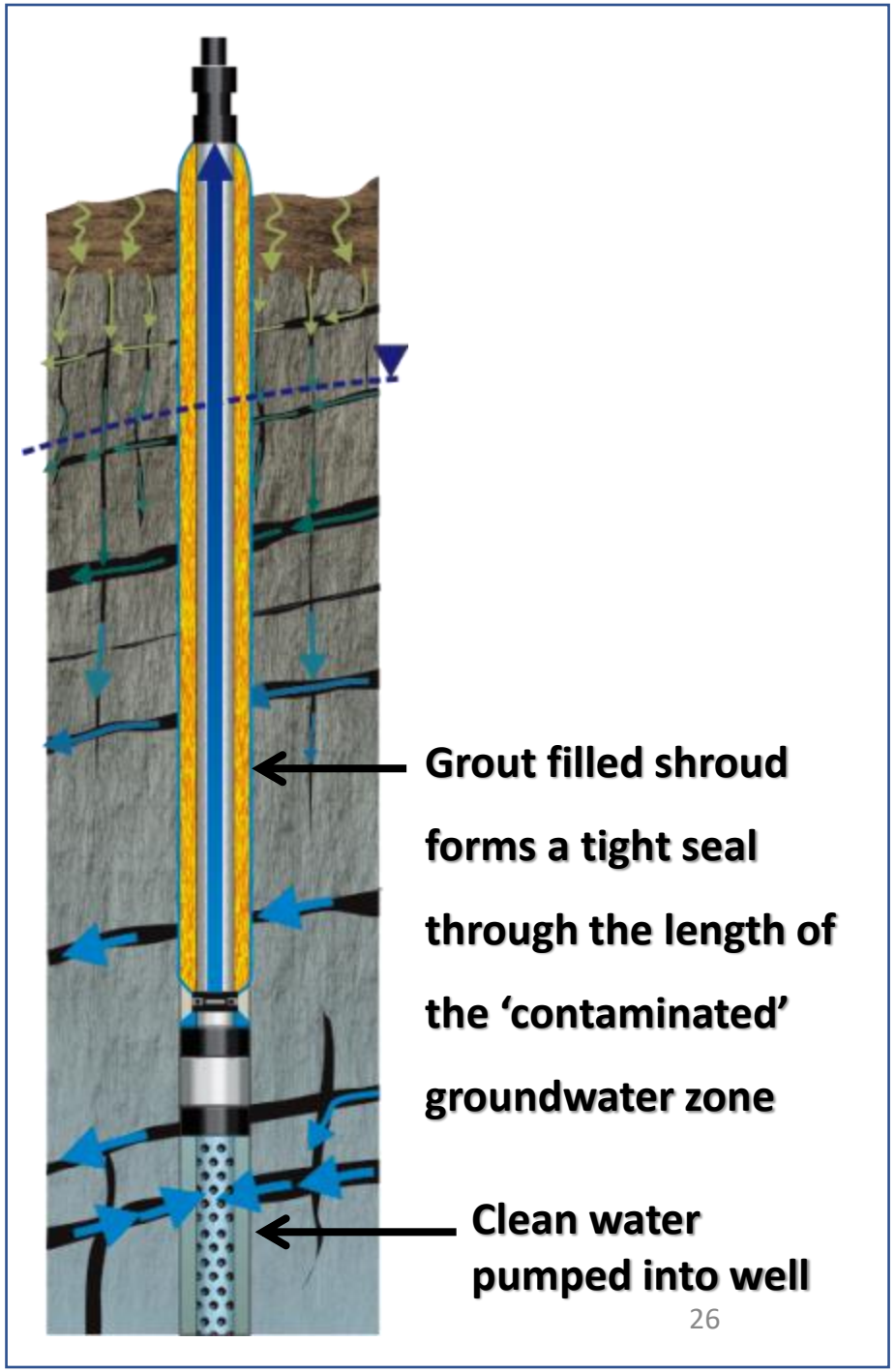


Slightly larger

Innovation is essential

Creating a small diameter well using a portable rock drill and a clay grout seal inside a flexible sleeve





Lowest Cost Wells in Hard Rock

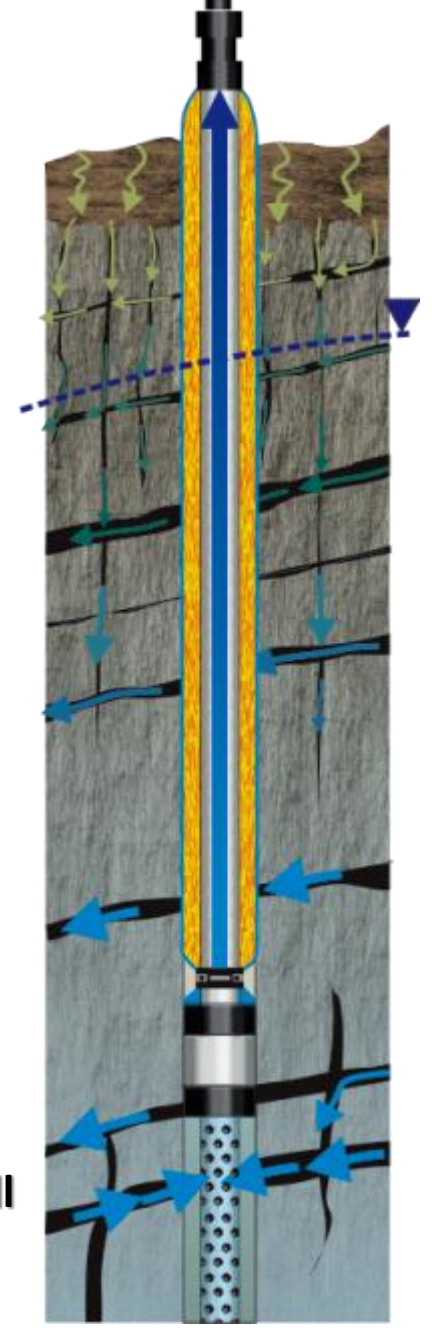
Better way to make seals in small diameter holes in rock

Tubing forms forms the well casing

Experimental method being field tested

Multiple Seals spaced through entire length

Clean water pumped into well



Example of extreme innovation:

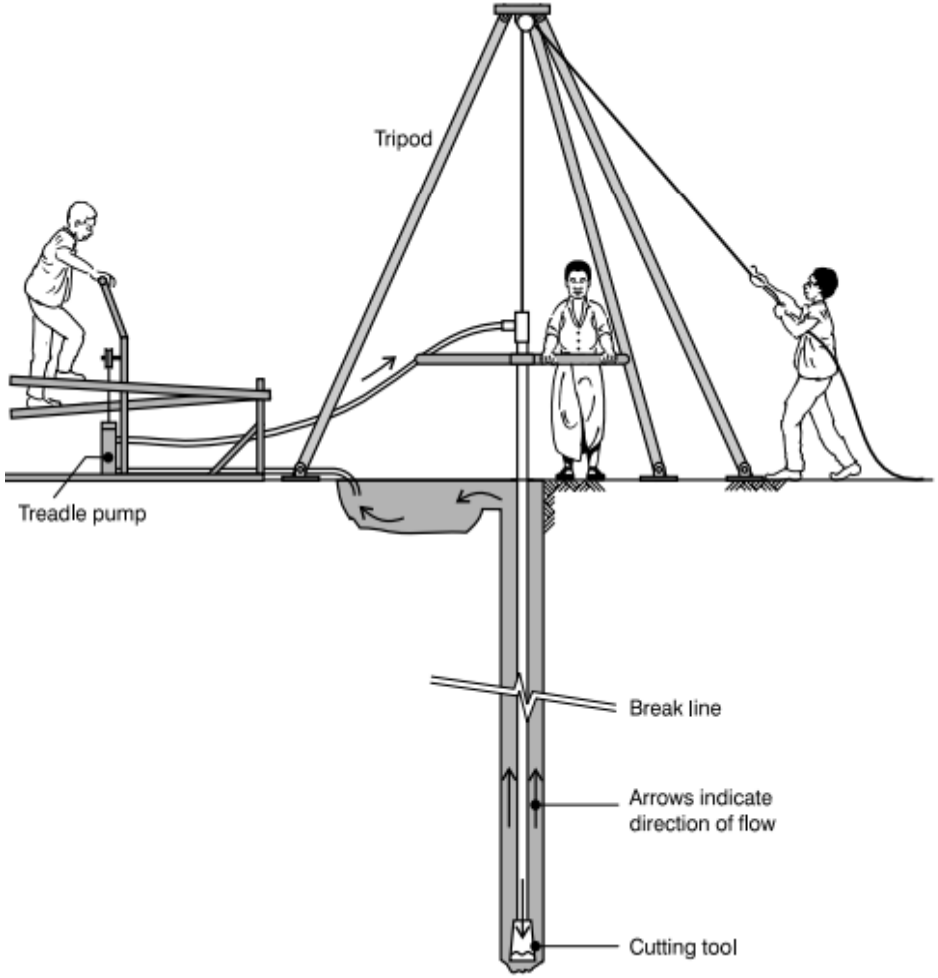
WWW.ONEMILLIONWELLS.ORG

…..a entirely new type of well drilling <$500 per drill

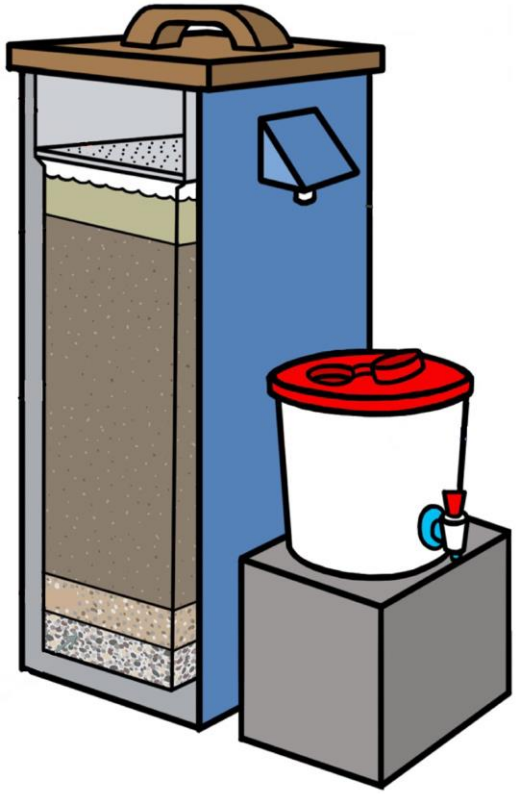
- air lift reverse flow drilling
- $400 per well
- easy training

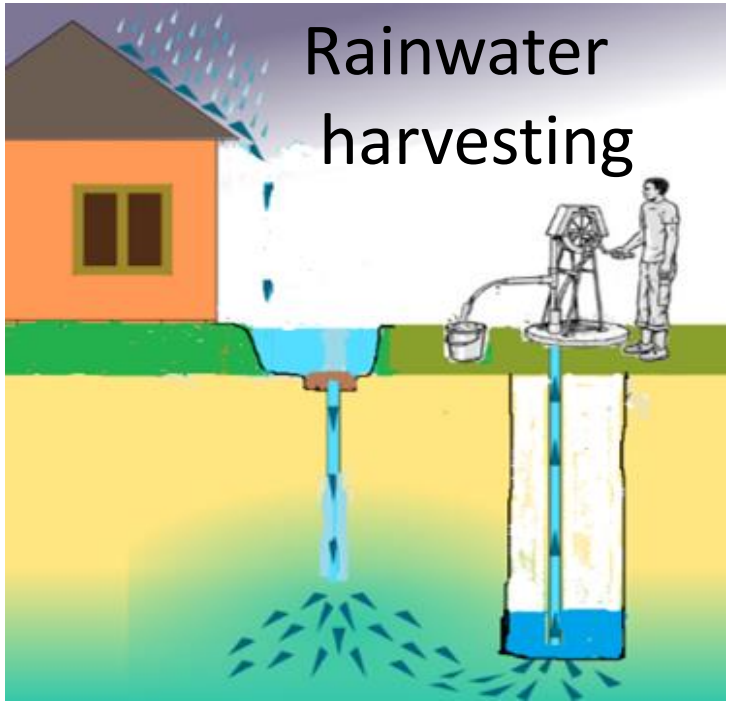
Four methods need to be used *synergistically* at the family farm scale

Small household wells



Point of use water filters



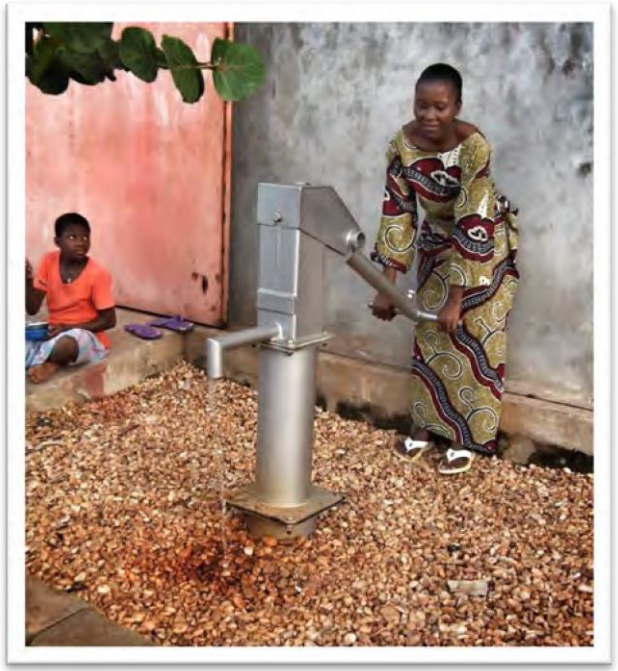


Tens of millions of household wells
are needed to access the groundwater that exists nearly everywhere

What are the obstacles?
…….knowledge and money for supported self supply

……understanding what are best methods to drill wells in the many circumstances……need comparative field trials

Wells installed by manual drilling or small engine machines equipped with hand pumps……



cannot drain aquifers

Thanks for your attention

“Insanity is doing the same thing over and over while expecting different results”

Attributed to Albert Einstein