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A Vision of a Future Sustainable-Water-Use Society

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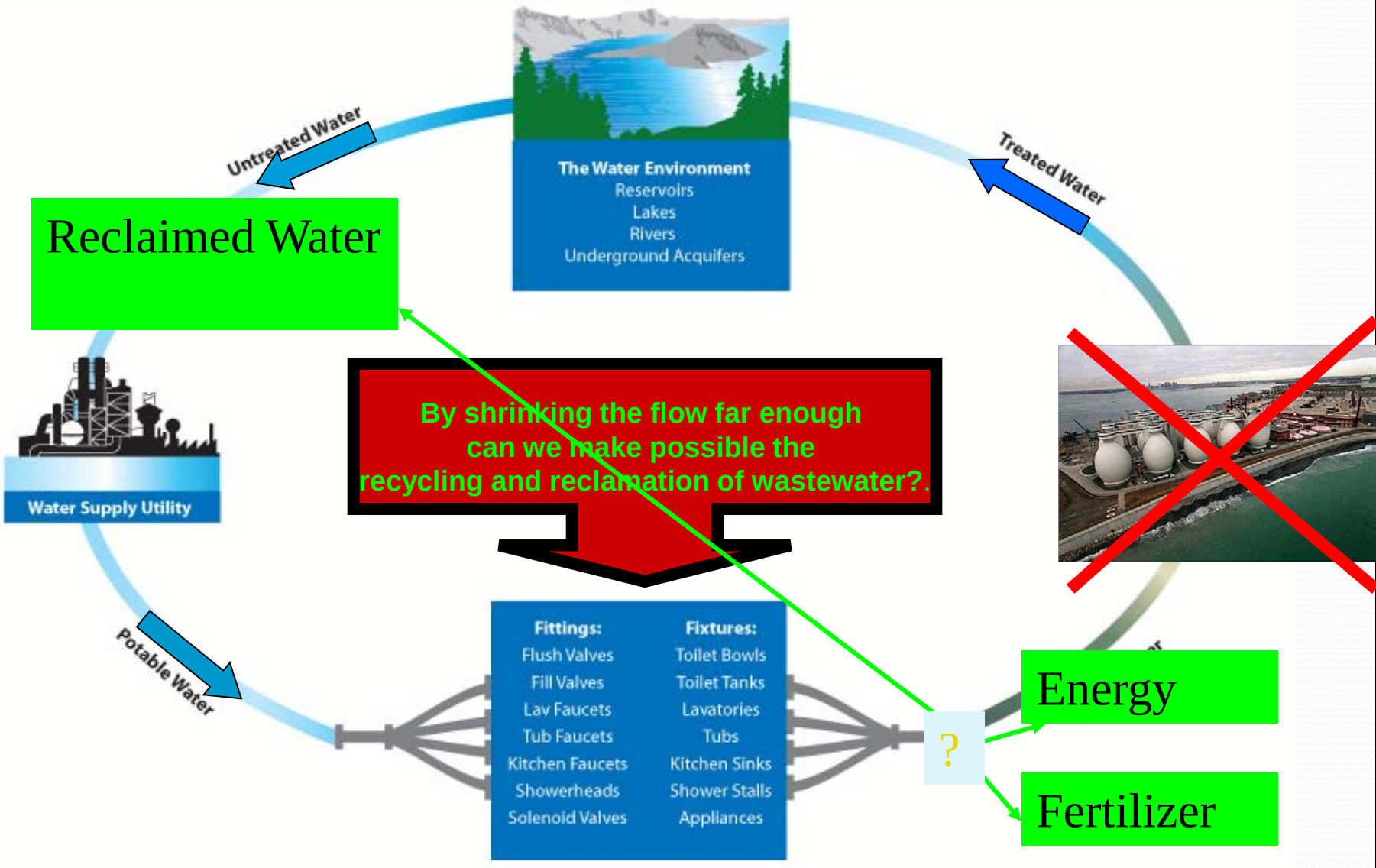
Wastewater

- Ingredients:
  - Water
  - Nutrients
  - Energy
- All of the above are valuable.

Can we improve on this Water Cycle?



Main Constituents of Municipal Wastewater

- Suspended or dissolved solids
- Organic matter
- Oxygen-consuming aggregate constituents
  - Biochemical oxygen demand (BOD)
  - Chemical oxygen demand (COD)
- Nutrients - N (organic N, NH_4^+) and P
  - Can cause eutrophication
- Pathogens - health threats

The amount of water on earth remains a constant and has been recycled through the water cycle for millenia….

But our population is growing rapidly!

The increase in use of fresh water resources is outstripping our ability to channel it to where we use it.

Unfortunately this word “**use**” has always meant “creating wastewater”.

“Waste” is something we usually “dispose” of. **And which has no intrinsic VALUE**

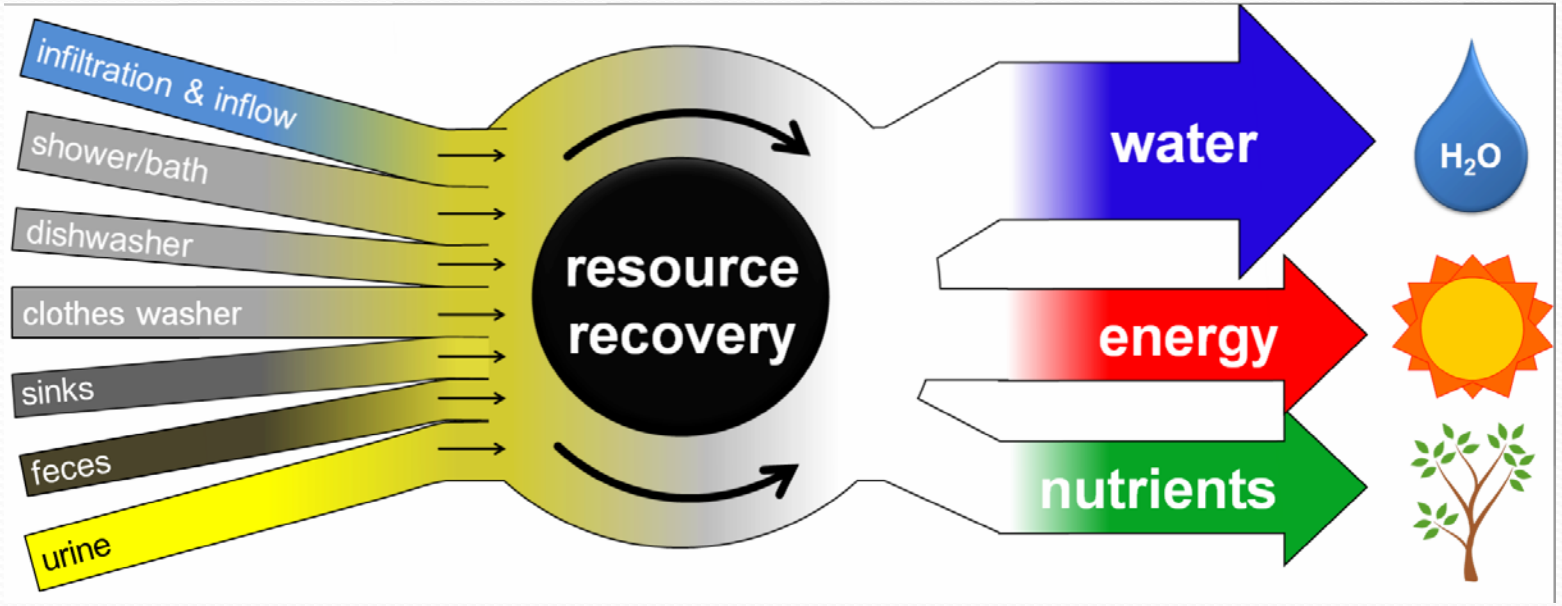
“Dispose of”
means to remove from sight and mind!

Dilution has been the solution to pollution for too long!

But, at last, we are starting to talk about **recovery and beneficial use** of the components of wastewater.

Wastewater as a renewable resource

http://www.sustainlane.com/reviews/getting-the-most-from-human-waste/ICF8A2T14UAQ9HTV27Q8VLQXRTOI



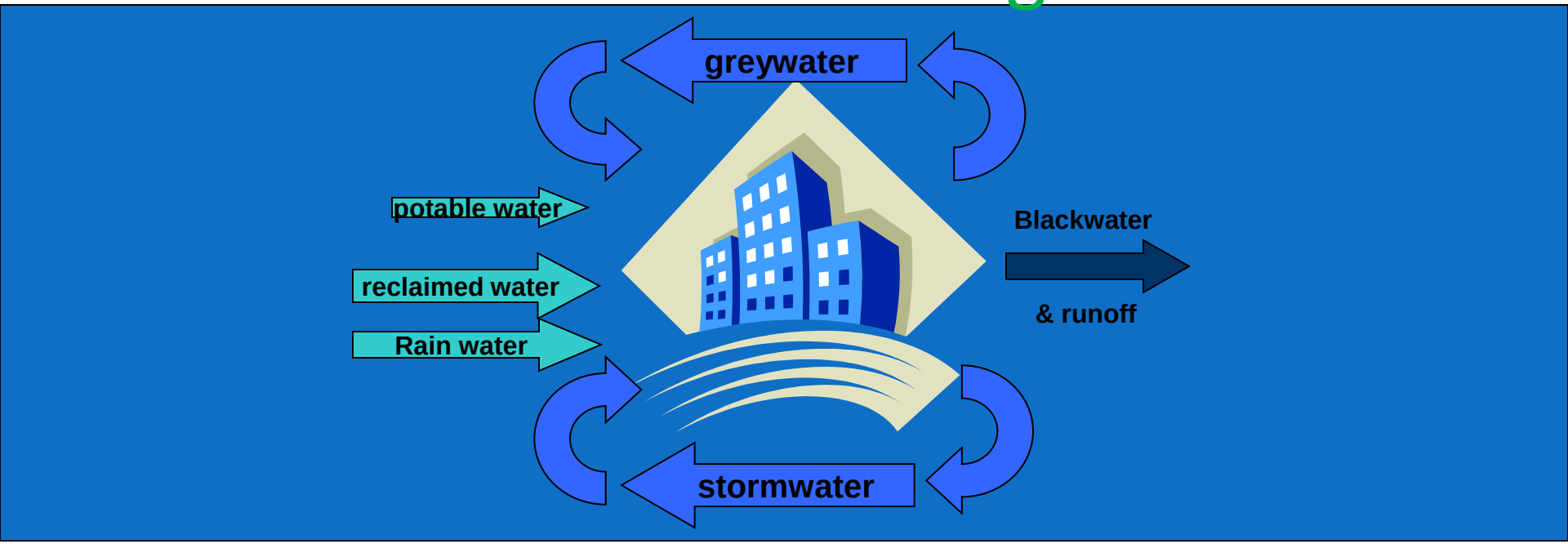
Graphics: Jeremy Guest, University of Michigan

Water Flow: Conventional Building

- **INFLOWS:**
  - Potable water
  - Groundwater
  - Stormwater

- **OUTFLOWS:**
  - Greywater
  - Blackwater
  - Stormwater runoff

Water Flow: Green Building



- Decreased demand for potable water, reducing costs and preserving resources
- Decreased net wastewater discharge from building
- Use of reclaimed water
- Recycle stormwater (rain water), greywater and potentially blackwater for uses within the building

Some examples of Wastewater Recovery and Beneficial Reuse

Composting

Recovering Nutrients in Solid Waste

Nitrogen Recovery and Reuse:

How to Use Urine as Fertilizer by Angie Moore, EHow

Mix urine in the ratio of one part urine to ten parts water. This dilutes the urine's nitrogen content enough to use on tender plants. Use the diluted urine on plants immediately and do not store either full strength or diluted.

Energy from Wastewater

- E3 Technologies, LLC, a new firm based in Athens, Ohio, will develop an Ohio University invention called the "GreenBox" designed to clean commercial and agricultural wastewater and produce hydrogen energy—a technology that's been described as "pee power."

According to Jonsson et al.:
”While human urine contributes 80% of the nitrogen and 55% of the phosphorus in household wastewater, it is only 1% of the volume of that wastewater.
The plant nutrients found in urine are almost entirely in the mineral form readily available to plants.”

Pee Spray!

WE Credit 3: Sustainable Wastewater Management (Draft proposed for LEED 2012)

- **Intent**
- To reduce the environmental impact associated with wastewater by increasing wastewater treatment on site and encouraging **resource recovery.**
- **Requirements**
- **OPTION 1**
- Eliminate the need for water based sewage conveyance through the use of alternative technologies (e.g., composting toilets).
- **OR**
- **OPTION 2**
- **Recycle 25% of wastewater**. Recycled wastewater must meet the applicable NSF 350 standard or local code, whichever is more stringent, for its intended use (e.g. onsite irrigation, toilet flushing, cooling tower needs).
- **OR**
- **OPTION 3**
- **Resource recovery and beneficial use of 25% of the baseline nitrogen or organic carbon loading from the occupants.**

Components of wastewater are valuable resources that, **if recovered and reused** , could open up a new paradigm in how we think of water use and just may offer to brighten our future.

Recovery of nutrients

- Struvite ($MgNH_4PO_4$) and other precipitates
- Biosolids
- Bio-P phosphorus recovery
- Algae (for biofuel)
- Recovery of nutrients at WWTP vs. decentralized onsite nutrient recovery (e.g., source separation toilets in Europe)

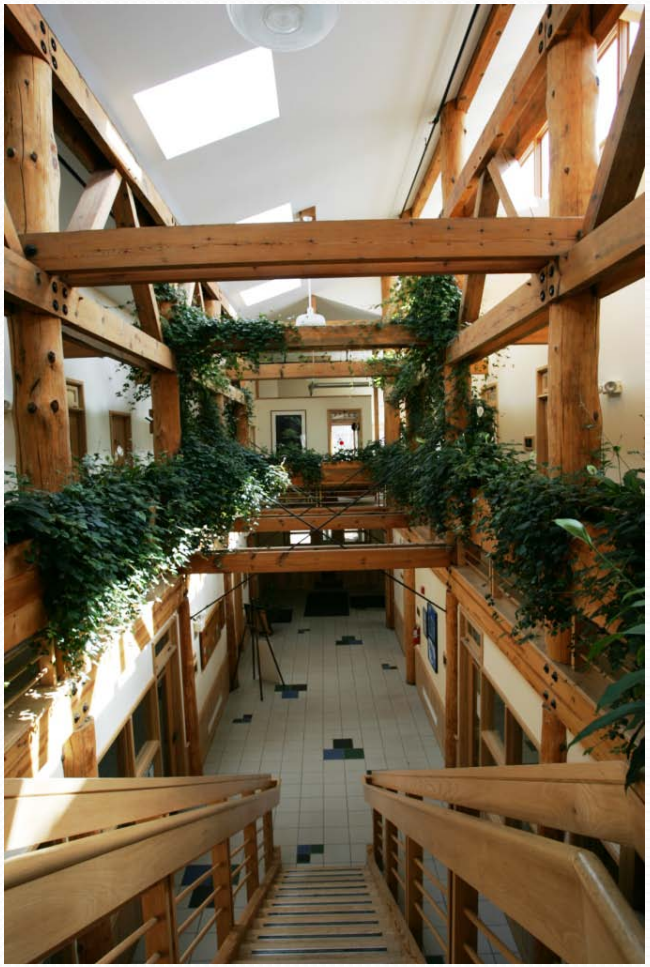
Guest et al 2009 ES&T

http://www.eawag.ch/organisation/abteilungen/eng/schwerpunkte/abwasser/abwasserbehandlung_haushalt/Reactor_in_Toilet_248.jpg

Society for the Protection of New Hampshire Forests

Concord, NH

- Greywater from the kitchen and bathroom sinks, shower, and dishwasher is sent to a filtering system and recycled throughout indoor planter beds.



Urine Separating Toilets?

- Divert most of the nitrogen in human waste to processing and use as fertilizer at the source.
- Reduce the energy needed for separation from wastewater downstream
- Reduce the volume of wastewater
- **Does this look like it would pass the market acceptance test?**

Note the need for education

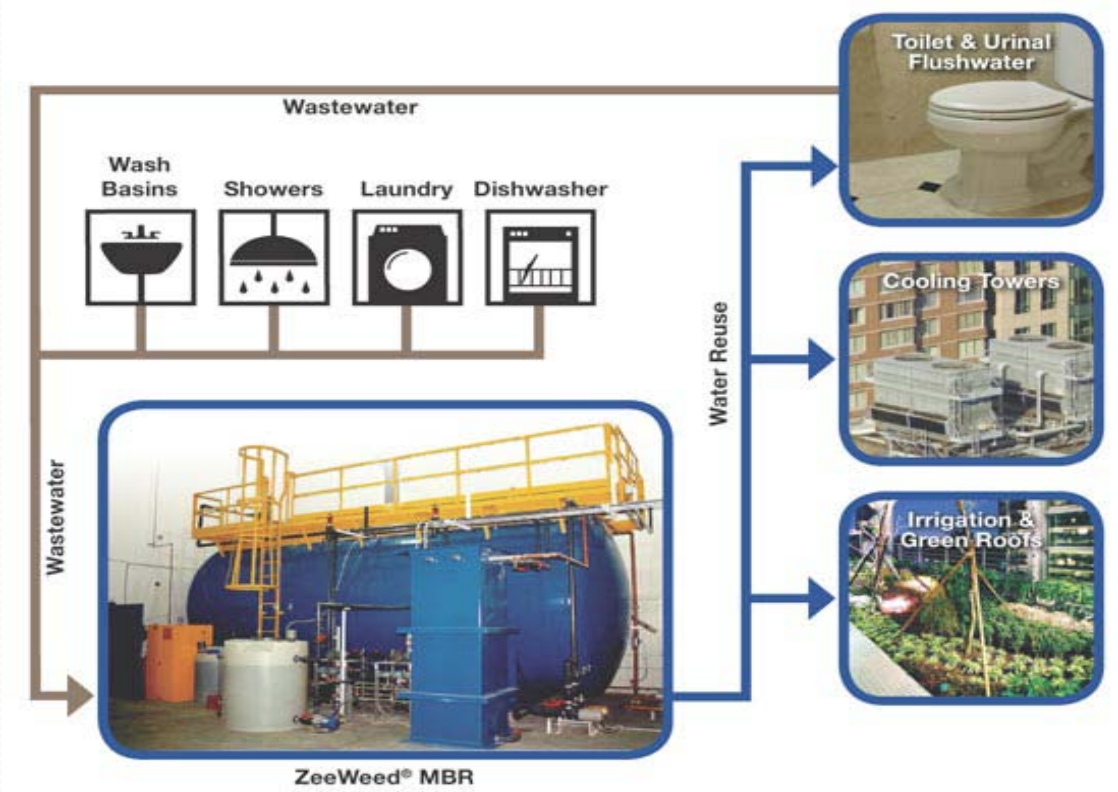
Photos courtesy of Ecovita
www.ecovita.net

Downstream Options

- Advanced filtration systems are available to purify the water that has carried these nutrients through our drain pipes and return it to our supply.

Membrane Bioreactor (MBR)

- Biological and membrane processes combine in order to filter pathogens and other contaminants from wastewater
  - Occupy less space than other conventional treatment
  - System provides recycled water for toilet flushing, irrigation, and cooling



http://www.zenon.com/applications/green_building.shtml

“The completed Orange County project (2007) will produce 70 million gallons of water per day, which will provide enough water for 144,000 families annually. The water can be purified for less than the cost of imported water using one-half the energy required to import water from Northern California.”

California Green Solutions

Other technologies are available to capture the energy in the solid waste component of our wastewater in a form that can be used to heat or light our buildings or to simply power the processes recovering nutrients or purifying the recovered water.

So why aren’t these technologies in widespread use?

The answer lies in economics.

Subsidies we have indulged in for over a century distort the value we place on water supply and wastewater treatment.

- Who pays for public works projects?

Tax Payer? or Rate Payer?

We need to start the unraveling of these subsidies and pay the real cost of water supply and wastewater recovery.

These technologies would become much more cost effective.
Their greater use would lead to economies of scale which would reduce their cost even further.

But what is the industry doing?

- What are the barriers to resource conservation and recovery?
  - Top priority at WWTP is effluent compliance!
    - Focus on getting rid of the **bad** in WW, rather than potential for capturing the **good**
  - Lack of infrastructure for resource recovery and reuse
    - It costs money to save money
  - Room for innovation? Hard to overcome momentum associated with habit (if it ain't broke…)
  - Can wastewater treatment plants of the future become "**Renewable Resource Recovery Facilities (R3Fs)**?"

…perhaps in a not-too-distant future?

Graphics: Ana Lucia Prieto

A future in which there is no longer any wastewater would mean:

- Available water supply would remain constant
- A new source of energy
- A new source of fertilizer
- Water neutrality.

A growing population should only lead to more frequent uses of the same supply.

Thank you

Let’s look further ahead!