



Design Strategies for a Wetter World

Systems and Systematic Design Workshop, Fall 2006

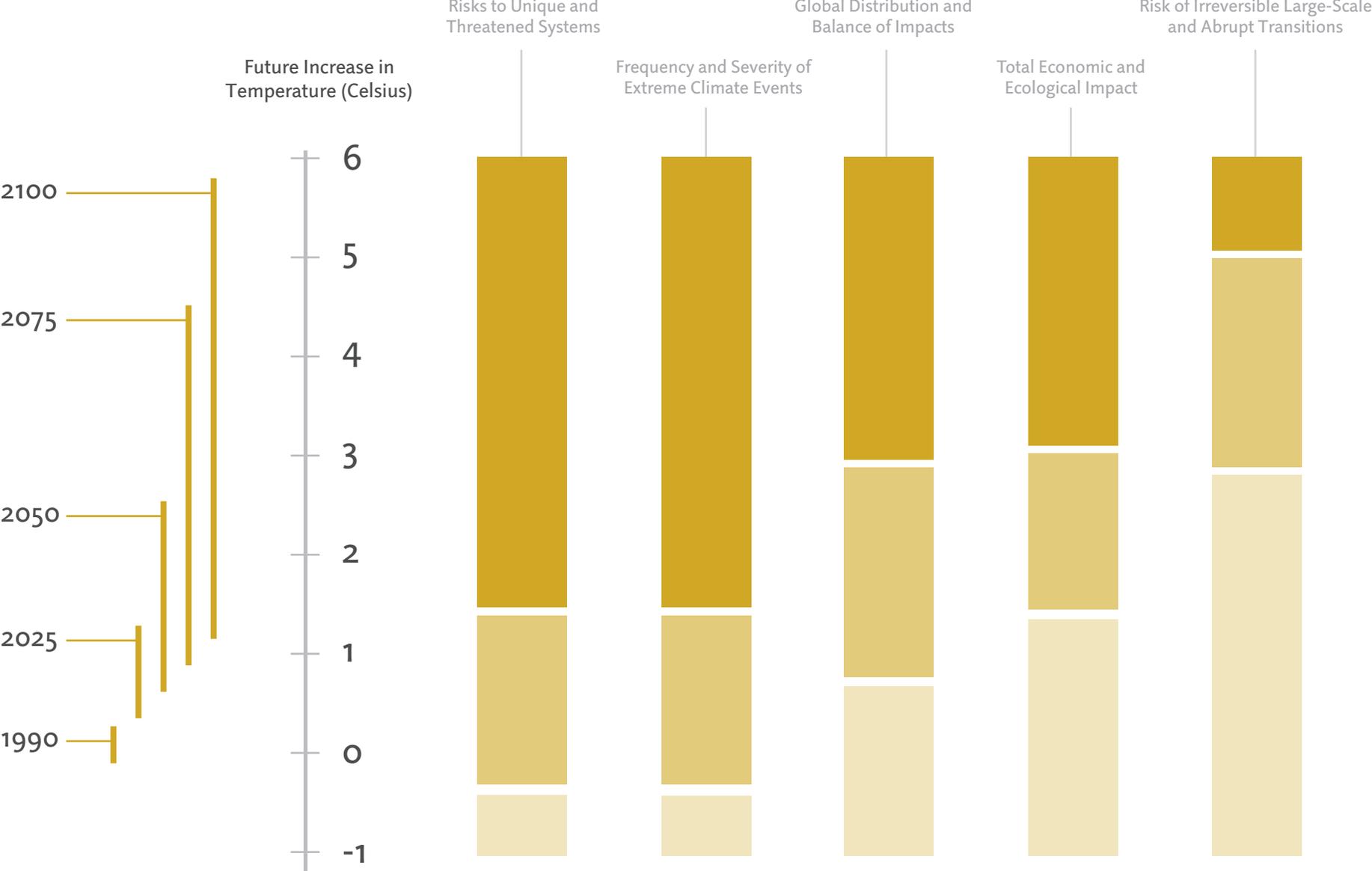
Manoj Adusumilli
Kristian Buschmann
Andrew Buhayar
Alex Cheek
Jihyun Lee
Mario Ruiz

“In my view, climate change is the most severe problem that we are facing today—more serious even than the threat of terrorism.”

With this warning to an international science meeting in February 2004, David A. King, Chief Scientific Advisor to the British Government, brought the issue of global warming into sharp focus.

The Earth is getting warmer and this means we will have a more intense hydrological cycle.

The Risks and Impacts of Global Warming



Source: IPCC

More Water Vapor

+

Warmer Atmosphere

=

A Wetter World



The Pampas region in Argentina and Uruguay had the worst flooding on record from August-October 2001.

Mean annual precipitation in the Pampas region increased by 35% in the last half of the 20th century.



In southeastern Norway, the year 2000 was the wettest year since records began in 1985.

Precipitation in northern Europe has increased 10-40% in the last century.

A photograph of a white building with a doorway and a window, overlaid with a semi-transparent white text box. The building has a simple, somewhat weathered appearance. The doorway is on the left, and a window with a wooden frame is on the right. The text box is centered in the lower half of the image.

In the summer of 2005, parts of India received record rainfall - 37 inches fell in Mumbai in 24 hours, killing more than 1,000 people.

In 2005, world economic damages caused by natural disasters tallied 159 billion (US\$).

By contrast, the cost of catastrophic events in 1950 was 3.9 billion (US\$).



EFFECTS ON CROPS

Water runoff from heavy rainfall and flooding can carry with it contaminants. However, farming will be done in higher altitudes.



SPECIES

A warmer Earth will produce more habitable land in the higher altitudes.



DISEASE

Poorer regions that aren't prepared for disease outbreak from extreme weather events will be highly at risk.



ANIMALS & PLANT EXTINCTION

Possibly more than a million species could be extinct by the year 2050.⁶

“The era of procrastination, of half-measures, of soothing and baffling expedients, of delays, is coming to a close. Instead we are entering a period of consequences.”

Sir Winston Churchill

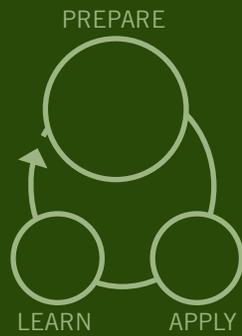


Mitigate disaster through adaptive solutions and harness the positive effects of wetter weather like new and distributed energy sources, water collection, and milder winters.

Structured planning for wetter weather...



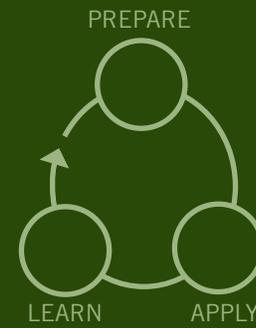
Structured planning for wetter weather...



(before)

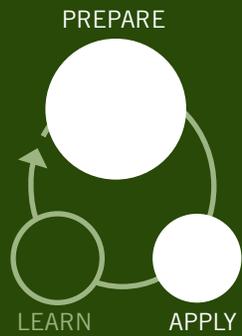


(during)



(after)

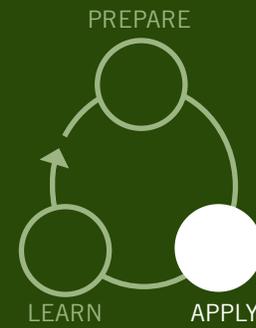
Structured planning for wetter weather...



(before)



(during)



(after)

Solution Map



Earth Nailing Robot
TerraFilters
BacterialCement
WaterWall
Networked Ponds
Future Farm



Disaster Icon
Language



Power Display
Lightning Harvester



Earth Mod-



ClimateChange



Water-



Common Cur-



CitizenScience
Flood Craft



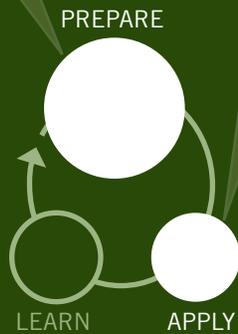
MedicShelter
Personal Locator



Roll-out



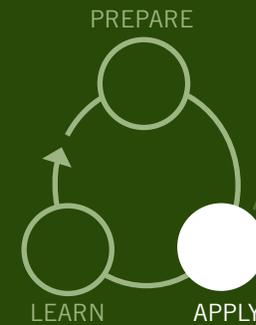
Water Safe



(before)



(during)



(after)

Securing Utilities Communicating Danger & Response



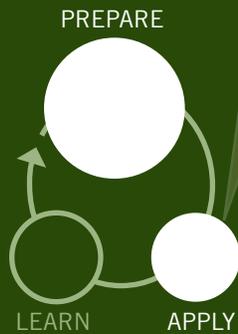
Power Display
Lightning Harvester



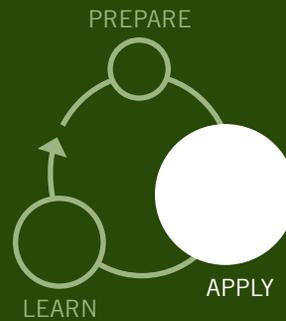
Earth Mod-



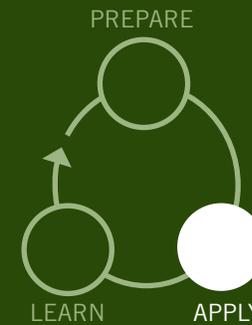
ClimateChange



(before)



(during)



(after)

Environmental Preparation: Land Use

EarthModeler

The Earth Modeler combines advanced weather modeling tools with 3D land visualizations to create and communicate structural and non-structural solutions for adapting to a wetter world. It would interact seamlessly with all of the system's other information technologies to create a visual clearinghouse of information for use by rescue planners, city officials and everyday citizens. It would act, in many ways, like a sophisticated 3D Google earth layered with GIS information from databases and updatable in real time.

Source:
<http://earth.google.com/index.html>



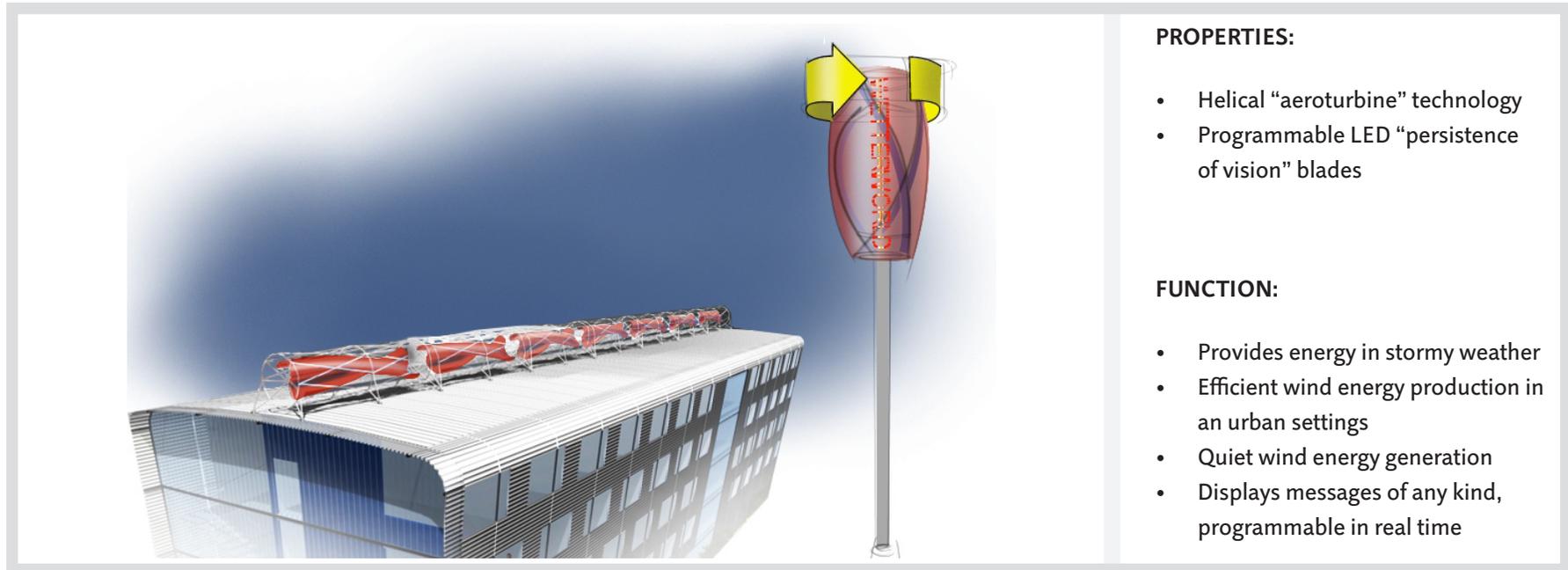
PROPERTIES:

- Interactive 3D land visualization that overlays GIS and demographic information
- Weather modeling tools
- Dynamic modeling tool for building, animation and virtual prototyping

FUNCTION:

- Simulates the effects of wetter conditions to strategies
- Allows for virtual prototype testing using fluid dynamic modeling
- Creates animations used for mass communication

Securing Utilities



PowerDisplay

The PowerDisplay is an array of helical “aeroturbines” that generate electricity from wind and use LED’s coordinated using a “Persistence of Vision” technology to display messages of all types. In the event of a powerful storm, the PowerDisplay’s helical turbines can handle the gusty,

multi-directional winds much better than unidirectional standard turbines. The addition of the LED display allows for an increase on return on investment through advertising sales. It could easily be adapted for municipal applications for informational or decorative purposes.

Source:
<http://www.aeritecture.com/>

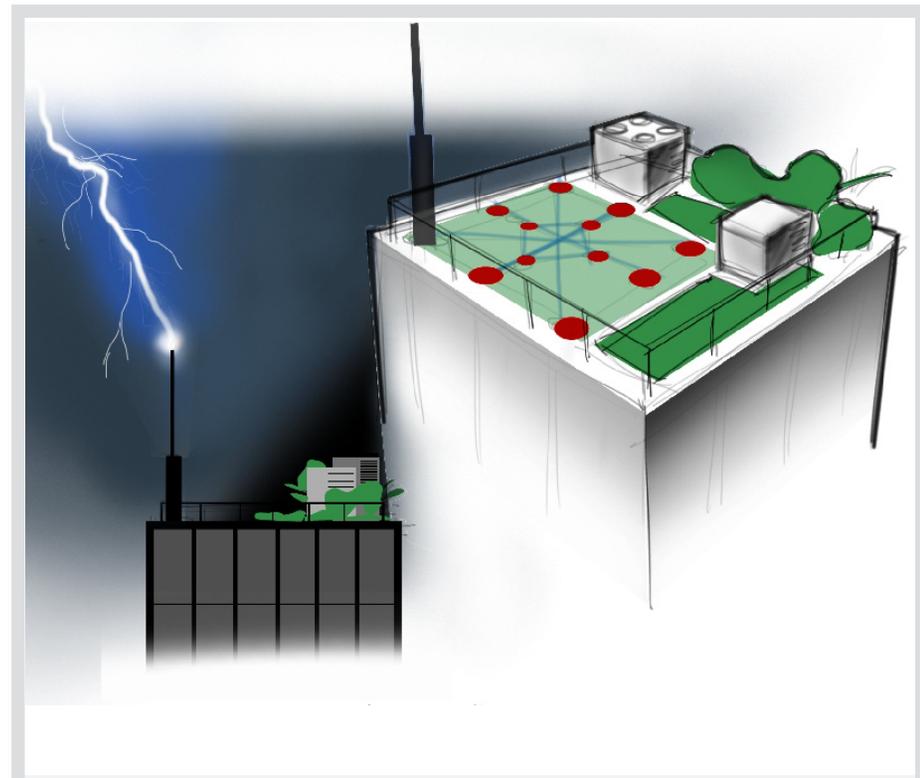
Securing Utilities

LightningHarvester

The LightningHarvester is a roof top solution for harvesting the enormous power released during a thunderstorm. Because the average lightning bolt contains so much energy that it cannot be directly captured by any available means, it must be buffered by earth. If this technique is coupled with a green roof system, the tallest buildings in a city could be outfitted and capture the power of the 20-75 strikes that they receive per year. The electricity would be stored in new utility-scale batteries and converted to AC as it was dispersed.

Source:
http://www.alternateenergyholdings.com/alternate_energy.html

http://www.eia.doe.gov/http://peswiki.com/index.php/Directory:Lightning_Power



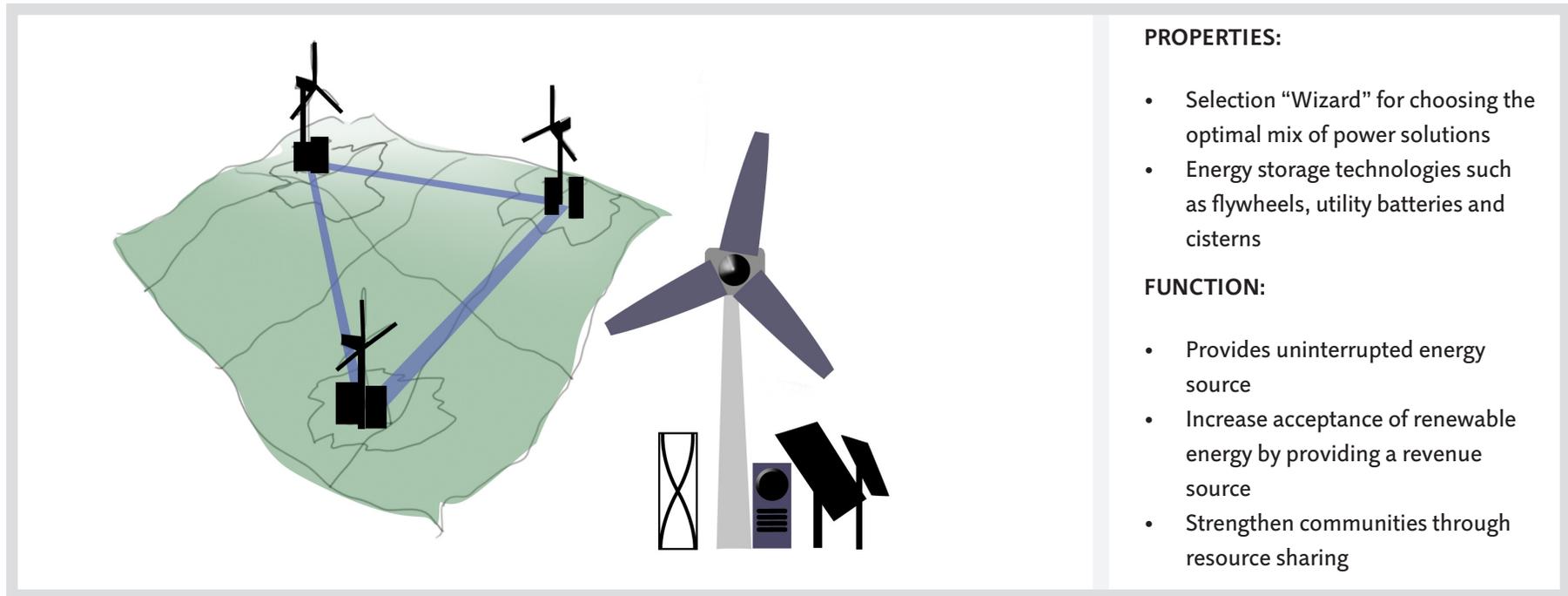
PROPERTIES:

- Lightning rod installed in a green roof
- Grounded green roof
- Web of conductors to direct the current into the battery
- Utility scale battery
- Alternator to convert DC to AC

FUNCTION:

- Attract lightning to the lightning rod and protect surrounding structures
- Channel electricity into a green roof buffer
- Collect portion of the energy into a storage apparatus

Securing Utilities



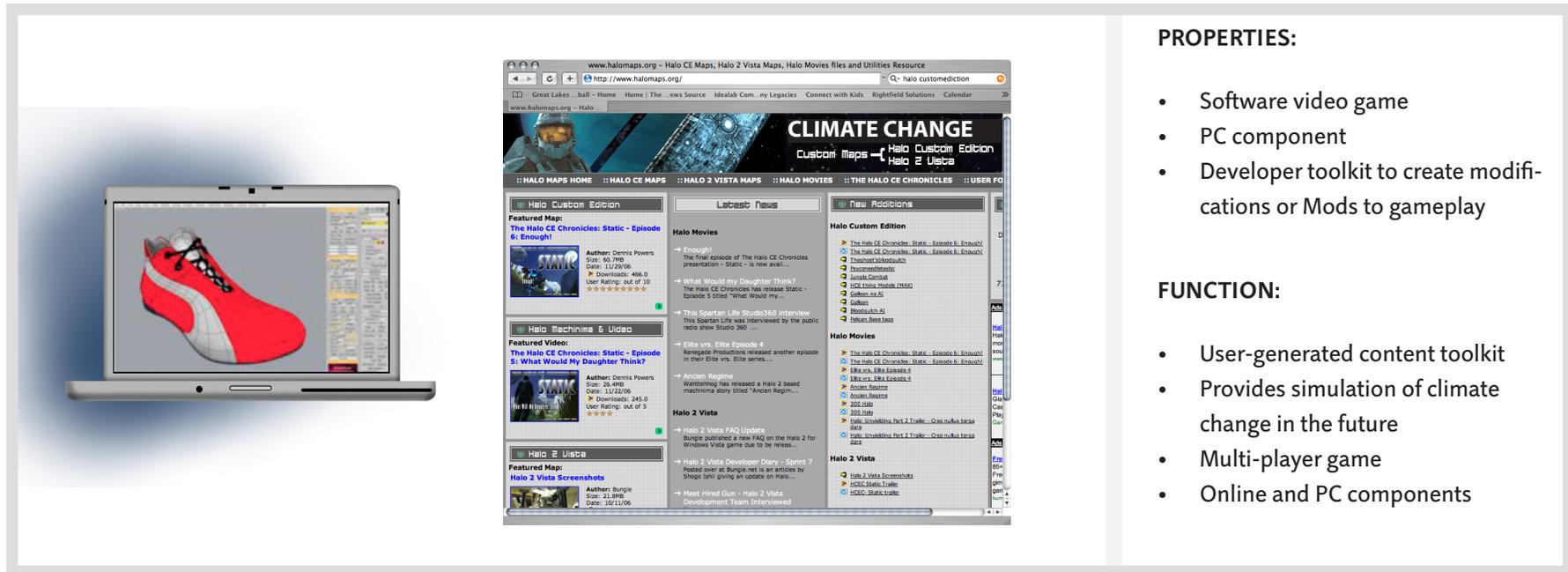
CommonCurrents

Common Currents is a self-healing power grid made up of a network of community based power generation sites that utilize renewable energy generation technologies to create a distributed energy grid that can respond rapidly to regional outages. By incorporating a wide variety of renewable technologies, the

system allows the flexibility that communities need to harness the energy afforded by the natural resources of a region.

Source:
<http://www.windshare.ca/>

Communicating Danger & Response



PROPERTIES:

- Software video game
- PC component
- Developer toolkit to create modifications or Mods to gameplay

FUNCTION:

- User-generated content toolkit
- Provides simulation of climate change in the future
- Multi-player game
- Online and PC components

ClimateChange - The Game

Climate Change is a real-time strategy and first-person shooter video game produced in partnership with the makers of Halo 1 and 2, Bungie. Climate Change (vanilla) version will work together with the PC version that has a toolkit to produce Mods (or user-generated content).

Source:

http://en.wikipedia.org/wiki/Mod_%28computer_gaming%29

[http://en.wikipedia.org/wiki/Halo_\(video_game_series\)](http://en.wikipedia.org/wiki/Halo_(video_game_series))

<http://www.educause.edu/ir/li-brary/pdf/ffpiu018.pdf>

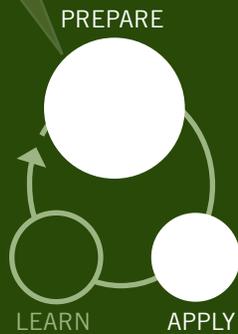
Environmental Preparation Communicating Danger & Response



Earth Nailing Robot
TerraFilters
BacterialCement
WaterWall
Networked Ponds
Future Farm



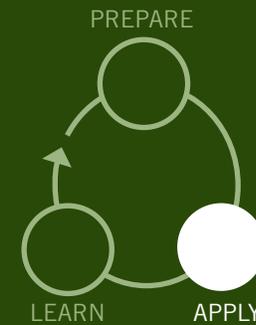
Disaster Icon
Language



(before)

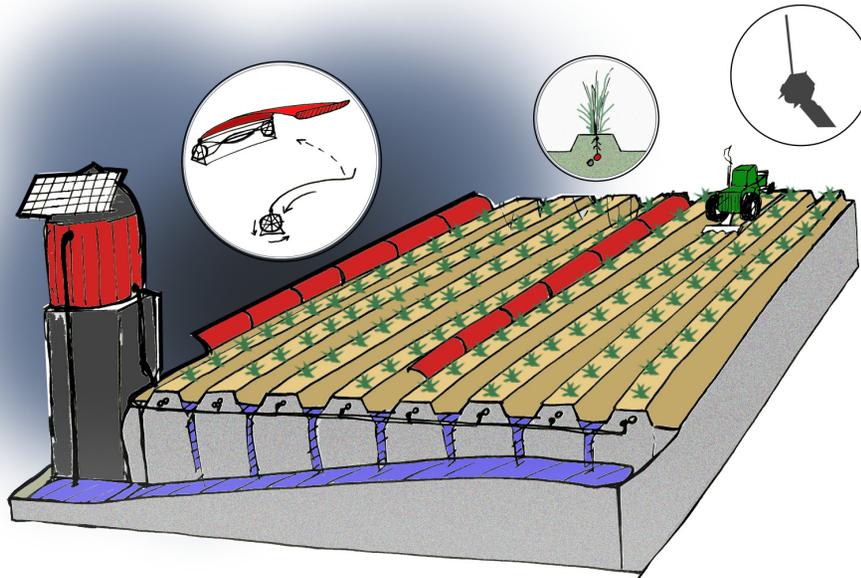


(during)



(after)

Environmental Preparation: Agriculture



PROPERTIES:

- Subsurface irrigation/collection systems utilizing capillary action
- Raised beds with repellent surface
- Flood proof, precision planted crops
- Airfoil windbreak turbines

FUNCTION:

- Delivers precise amounts of water
- Collects rainfall and run-off
- Reduces erosion of soil and resists potential damages caused by floods
- Harnesses wind for power generation and prevents wind erosion

Future Farm

In a wetter world it will be increasingly difficult to manage agricultural output due to unpredictable weather conditions. This system element (system) aims to reduce damages caused by irregular weather conditions and preserve productivity. A combination of these

elements can be used to safeguard agricultural land and prevent destruction of crops.

Source:

<http://www.samd.com.au/rbm.html>

<http://www.asiaweek.com/asiaweek/97/0905/cs1.html>

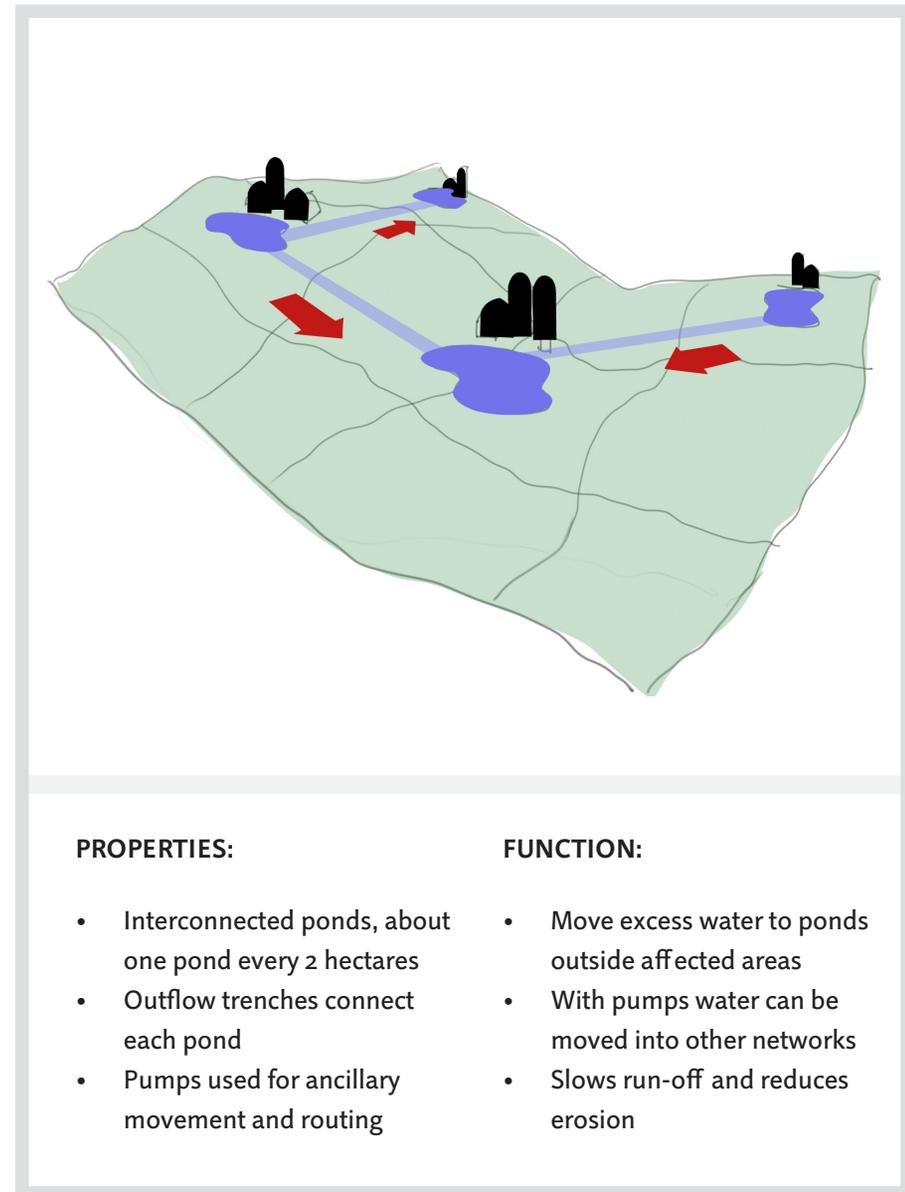
http://www.cseindia.org/dte-supplement/water20031115/drip-ping_proms

Environmental Preparation: Water Management

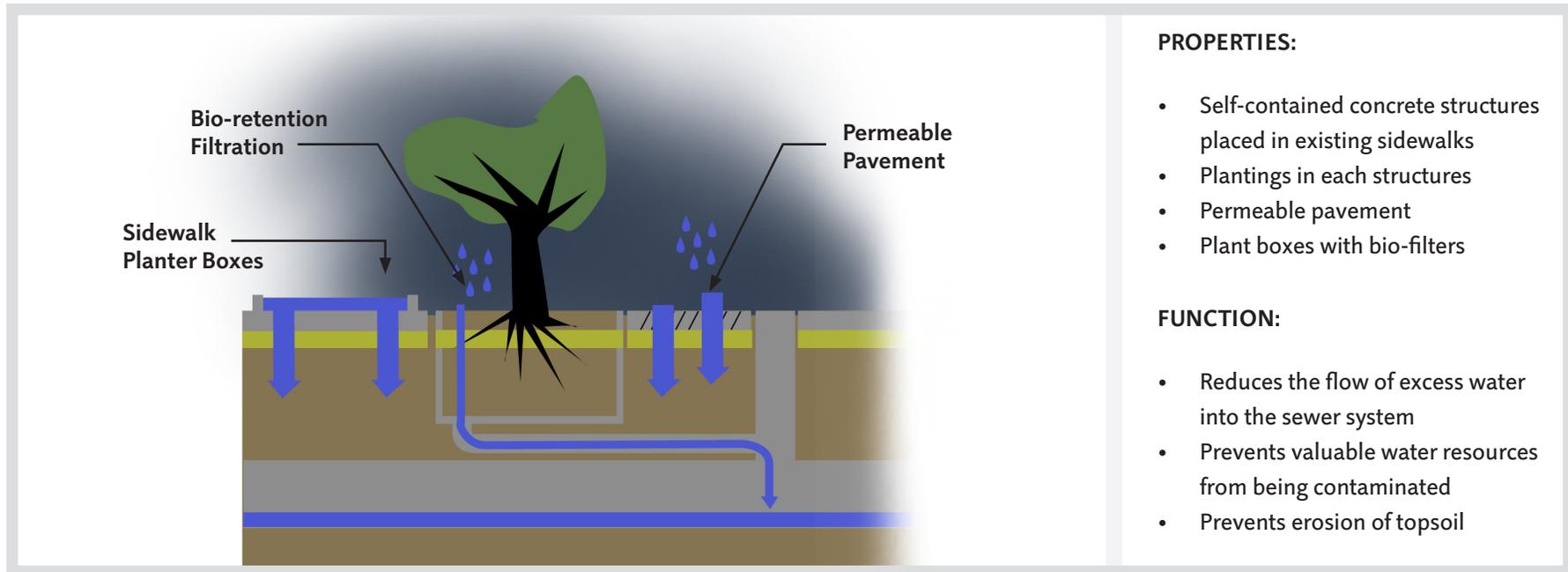
Networked Ponds

Instead of having large costly central reservoirs a network of interconnected ponds can be used to collect and release water to the areas where it is most needed. Suited mostly for rural areas with less existing infrastructure the idea could be incorporated into city planning or used at the city's perimeter. The ponds are carefully linked and created by analyzing contour lines which define capacity and flow balancing needs with erosion and demand. As weather patterns shifts, the network of ponds could more meet the needed capacity than a central reservoir.

Source:
<http://www.indiatogether.org/2003/aug/env-baifwater.htm>



Environmental Preparation: Erosion



TerraFilters

The TerraFilter captures excess water before it reaches the sewer system - reducing erosion and contamination of water sources. The terra-filter system reduces the burden on urban sewer systems during extensive rains by holding and slowly processing runoff. Deployed in a variety of formats, the system uses

concrete barriers and permeable pavement combined with carefully selected plantings. The system integrates easily with existing sewer systems and can be built to enhance the streetscape.

Source:
<http://www.americastusa.com/filterra.html>

Environmental Preparation: Erosion

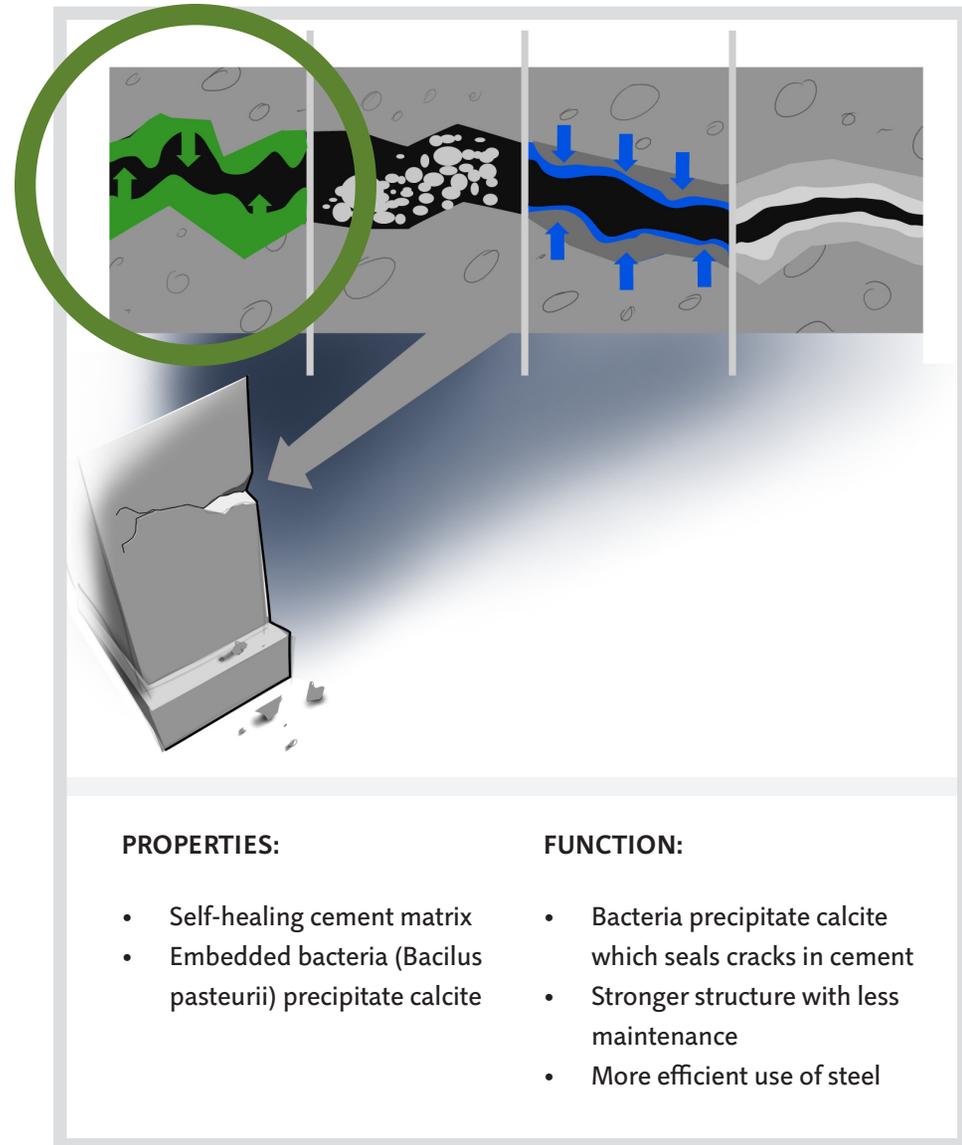
BacterialCement

Self-healing cement through microbiologically-enhanced crack remediation. Bacteria immobilized in a polyurethane sheet precipitate calcite, which causes early cracks in cement to heal.

Source:

<http://www.tudelft.nl/live/pagina.jsp?id=8691221d-ebab-4841-97cb-1cfacad3a4bc&lang=en>

http://reu.sdsmt.edu/projects/projects_2003.html-brary/pdf/ffpiu018.pdf



Environmental Preparation: Erosion

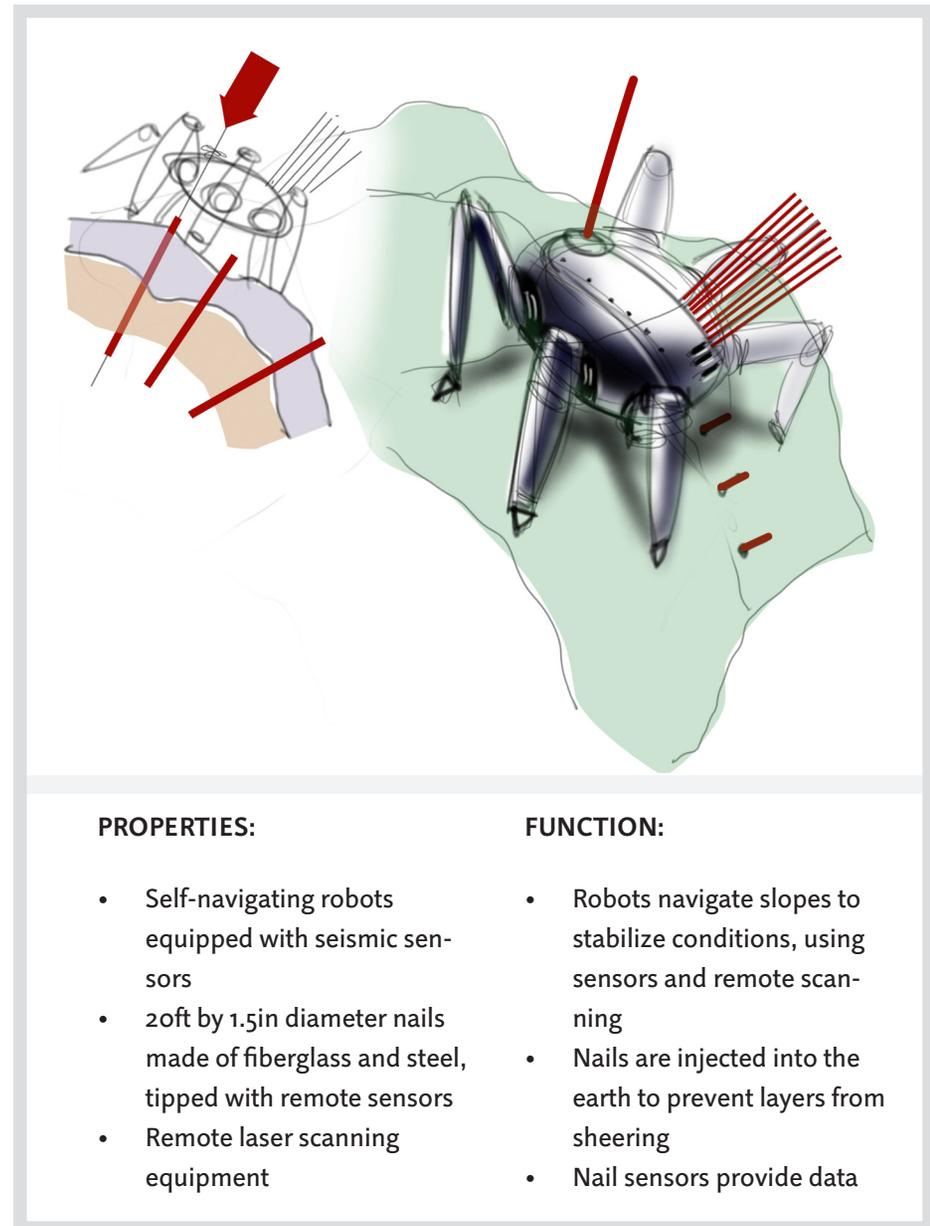
Earth Nailing Robot

Wet weather will likely increase soil erosion, increasing the risk of landslides. Slope stability can be weakened by saturation of snowmelt or heavy rains. Vibration from thunderstorms can even initiate slides. Using 20ft steel or fiberglass nails, shot into the earth by carefully moving robots, layers earth can be held together to prevent the topmost layers from sheering off. Robots will make ongoing adjustments to nail locations and navigate the dangerous slopes without putting lives at risk.

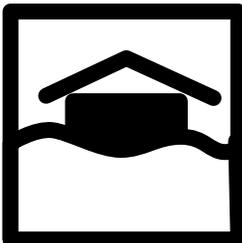
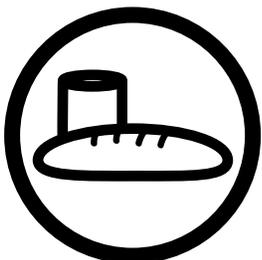
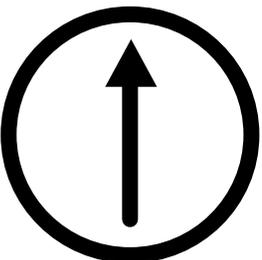
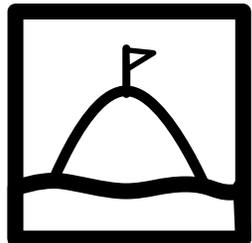
Source:

http://www.rose-hulman.edu/~sutterer/EFRI/Fiber-glass_launched_nails.pdf

http://www.livescience.com/ima-geoftheday/siod_050114.html



Communicate Danger and Response

					PROPERTIES: <ul style="list-style-type: none">• Library of symbols and icons• A visual “grammar” that systematizes construction of visual “phrases”• Computer program to visually concatenate the classifiers FUNCTION: <ul style="list-style-type: none">• Dispersion of instructions without concern for language differences• Decreases production time in creating icon based communications• Creates visuals that are easily ported to other platforms
	Danger! Flood coming	Gather rations	climb	high ground	

Disaster Icon Language

The Disaster Icon Language is a visual system that will serve as an international standard for communication. Icons representing every possible activity, tool, role would be associated with words from the world’s major languages. From there, all disaster instructions could be translated into a format that would be easily understandable, regardless of language

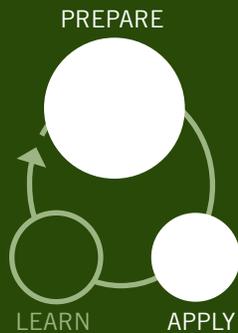
differences. Because of the simple visual language, resolution of media could be low and transmitted at low bandwidth and in print. It would also be so easily interpreted by people that converting the message from the visual, back into the local language would be a simple task for anyone who might have to serve as a communicator.

Source: <http://www.pictogrammar.net/>

Environmental Protection
Medical Care
Securing Utilities
Prioritizing Aid



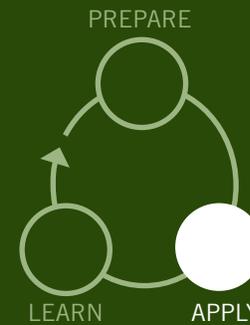
- Water-
- MedicShelter Personal Locator
- Common Cur-
- Roll-out
- CitizenScience Flood Craft



(before)

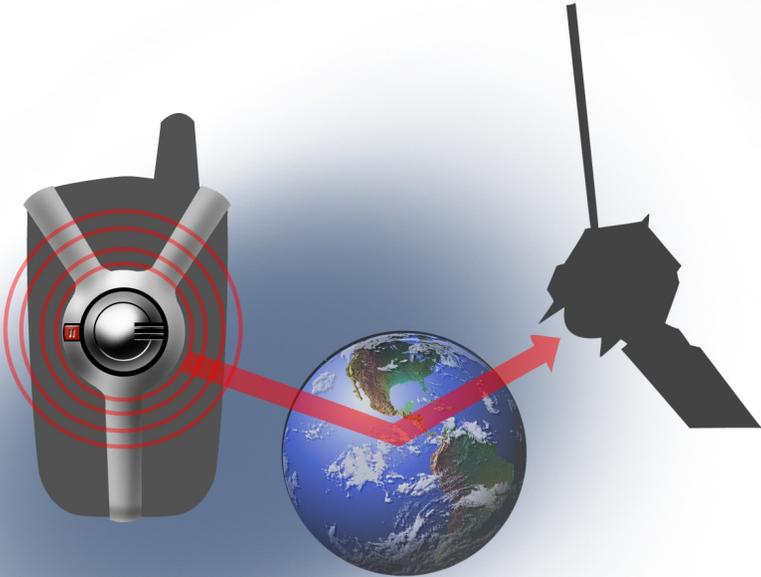


(during)



(after)

+ Medical Care



PROPERTIES:

- Adjustable strapping that protects the phone during normal usage
- Strapping holds a long lasting power source and GPS locator

FUNCTION:

- Alerts cell phone users of disaster situations
- Initiates GPS locator activation
- Serves as a GPS target even when the phone battery has expired

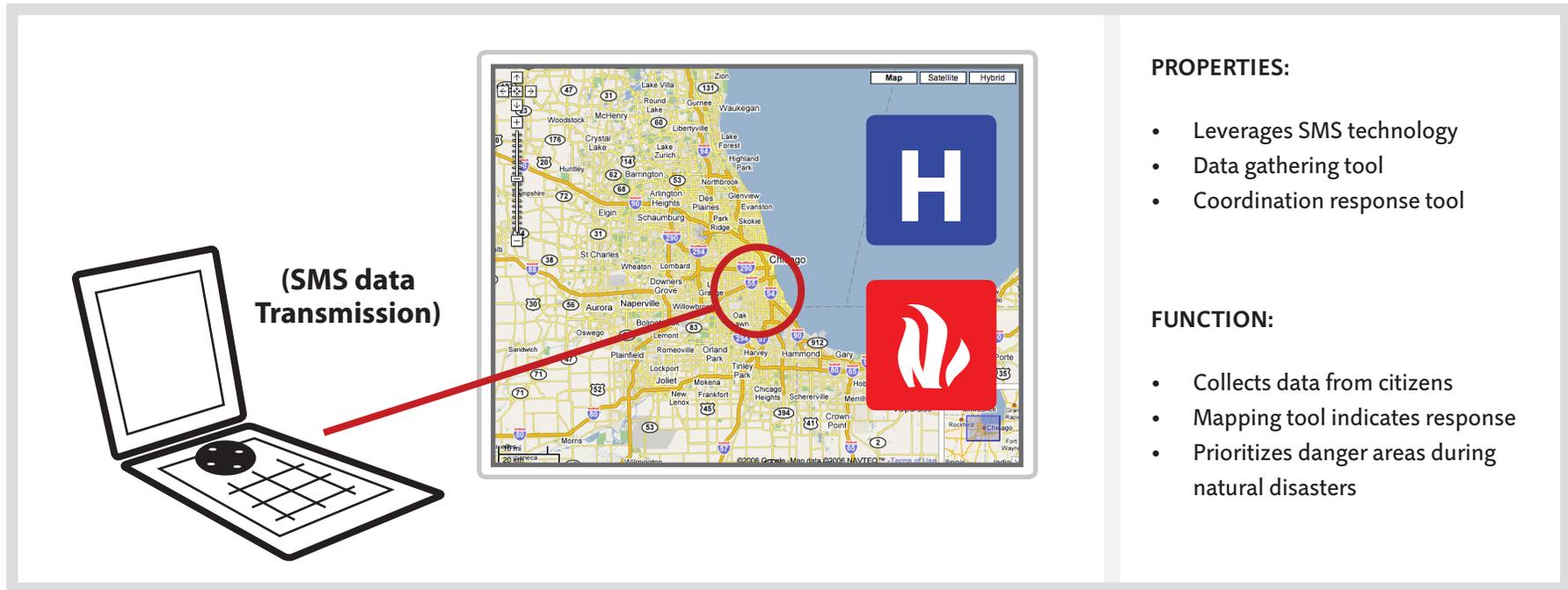
Personal Locator

Not all phones are equipped with GPS capabilities, but as the number of cell phones worldwide increases, it has become one of the best ways to communicate emergency information. This device allows any phone to be used as a GPS locator in the event of a disaster. A SMS message sent across the entire

region triggers the phone to emit a unique audible alarm, alerting the user to activate their GPS locator. Locators that are switched on are then searchable targets.

Source:
<http://www.wired.com/wired/archive/10.10/view.html?pg=2>

++ Prioritizing Aid



PROPERTIES:

- Leverages SMS technology
- Data gathering tool
- Coordination response tool

FUNCTION:

- Collects data from citizens
- Mapping tool indicates response
- Prioritizes danger areas during natural disasters

CitizenScience

System that gathers data from citizens; and then uses it to populate and route emergency response to more prone areas.

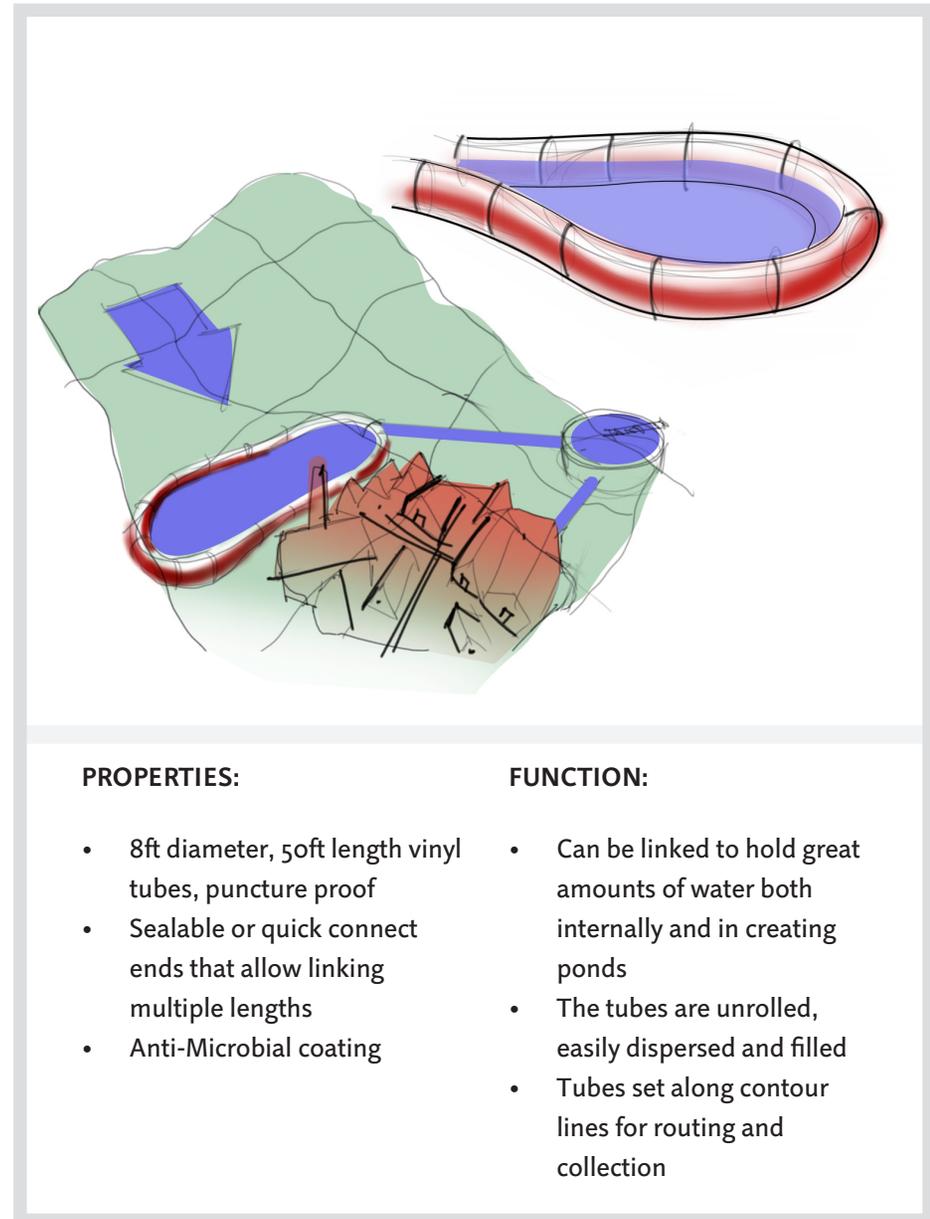
Source:

[http://ocha.unog.ch/virtualosocc/\(jyjbefdczbrws55mbv0lw55\)/VOLogin.aspx](http://ocha.unog.ch/virtualosocc/(jyjbefdczbrws55mbv0lw55)/VOLogin.aspx)

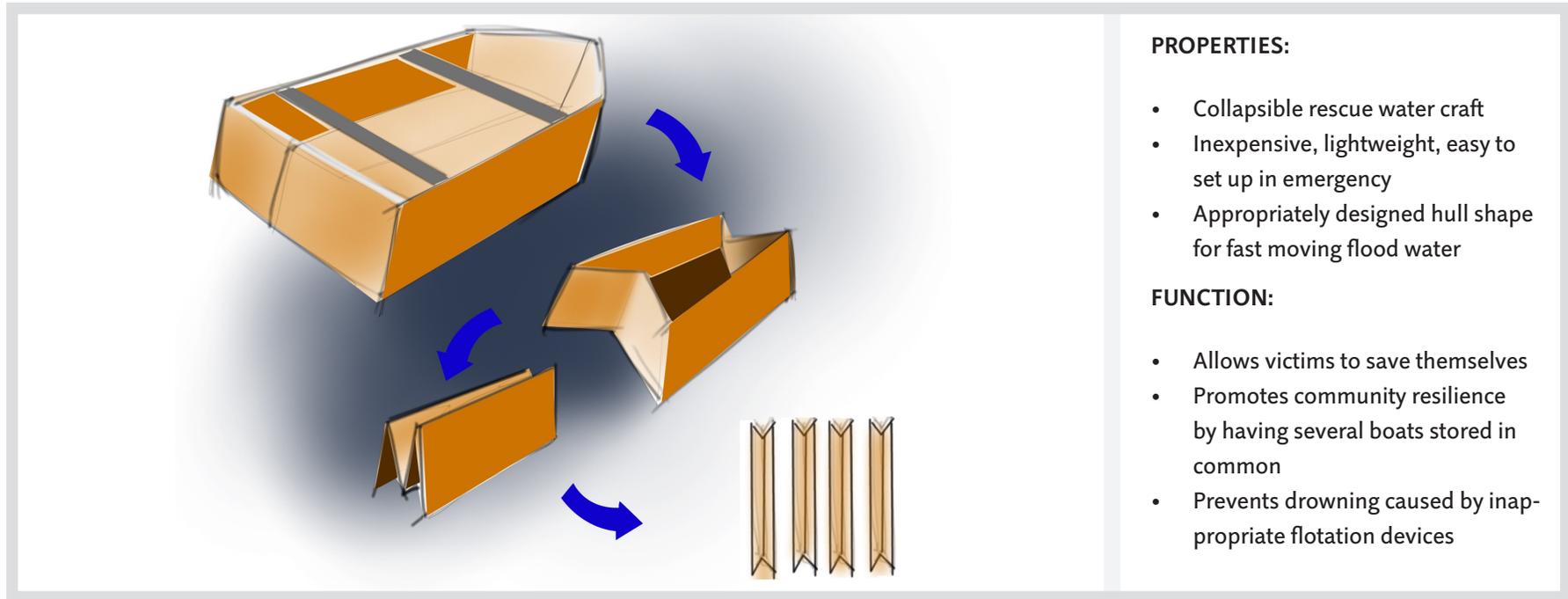
Environmental Preparation: Water Management

WaterWalls

In the event of excess water flows that could potentially cause infrastructure damage, sets of water filled soft-sided tubes can be used route overflow to designated drainage areas away from valuable property. These tubes are first filled with the excess flows and create large containment walls for routing and capturing the excess water until it can be rerouted back into the regions water treatment facilities. The tubes are coated in an anti-microbial solution to reduce the spread of waterborne diseases.



✚✚ Prioritizing Aid



PROPERTIES:

- Collapsible rescue water craft
- Inexpensive, lightweight, easy to set up in emergency
- Appropriately designed hull shape for fast moving flood water

FUNCTION:

- Allows victims to save themselves
- Promotes community resilience by having several boats stored in common
- Prevents drowning caused by inappropriate flotation devices

Flood Craft

During flood disasters flotation devices are not always readily available for evacuation of victims. At the same time personal flotation devices, while keeping one afloat, do not protect against debris and water borne disease. Having community Flood Craft readily available will not only prevent drowning, but also protect

victims from secondary disaster conditions. The Flood Craft also has the ability to transport critical supplies and aid in rescue.

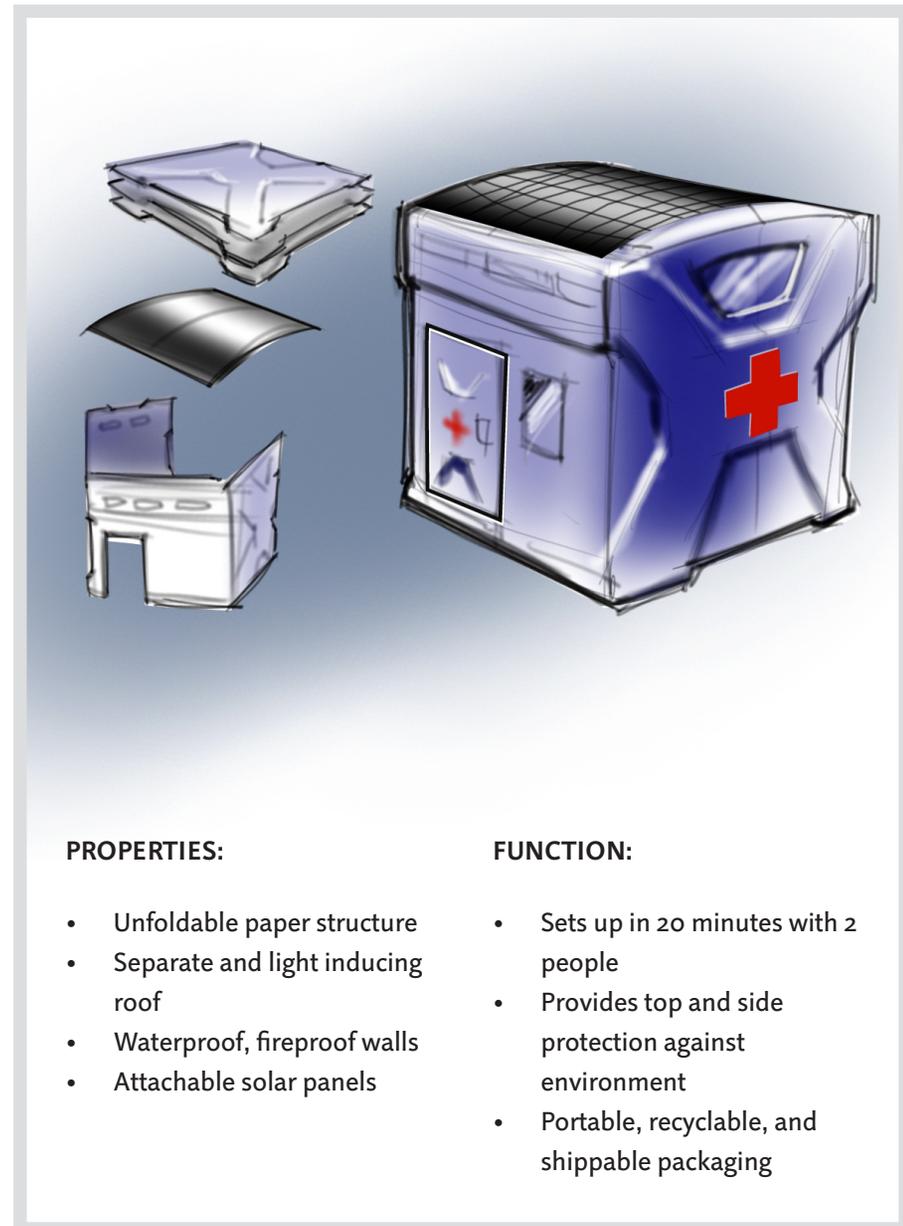
Source:
<http://www.crisisresponsejournal.com/vtiss5.pdf>

+ MedicalCare

MedicShelter

During an environmental disaster like a flood, regions need to equip themselves for medical relief efforts. The MedicShelter combined with WaterClean, a water purification system, and HandSanitizer, a water oxygenization and sanitizing system, equip a field hospital for various levels of medical treatment. Portable HealthCare also includes a BioData Medical information system that accesses stored medical information from victims.

Source:
<http://www.gvshelters.com/>

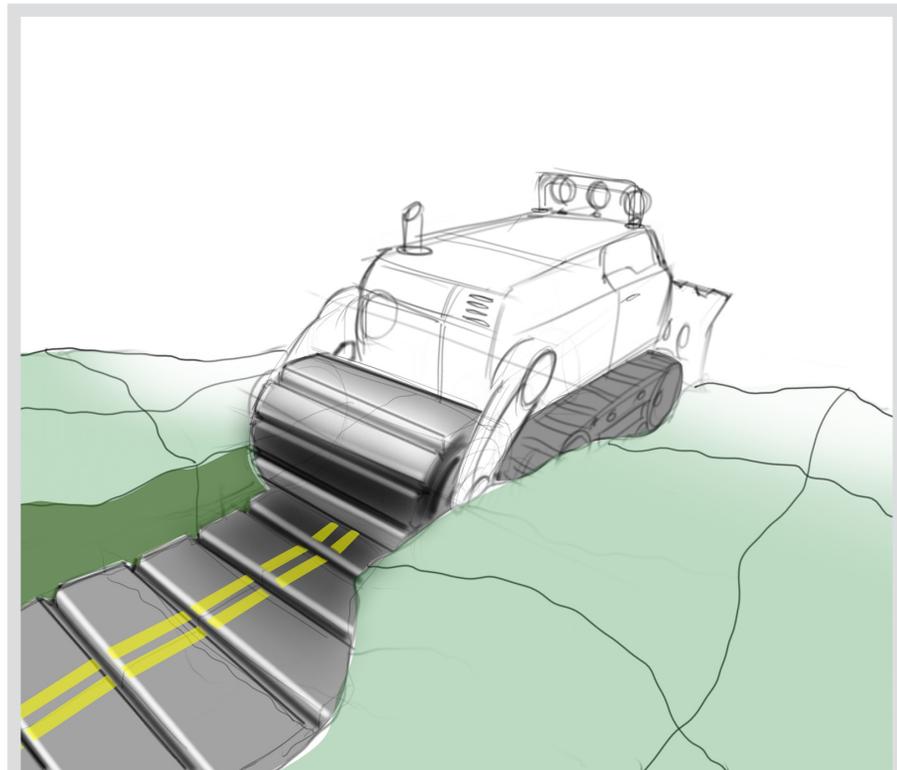


Environmental Preparation: Land Use

Roll-out Roads

During wet weather conditions roads are often damaged or impassable due to erosion, fallen trees, or other debris. Using Roll-out roads allows important goods and rescue operations to continue, placing usable transportation surfaces across uneven and rough terrain.

Source:
<http://www.eventdeck.com>



PROPERTIES:

- Lightweight composite roll out roadway system for rough terrain
- Portable, fast set up system that is deployed using an all terrain vehicle
- Re-rolls and can be used again

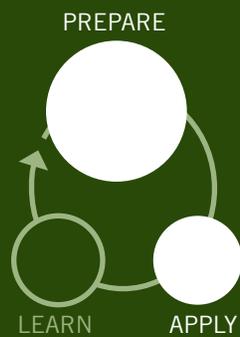
FUNCTION:

- Provides temporary roadway for vehicles and equipment
- Provides access to disaster struck areas/allows for faster disaster aid
- Temporarily replaces damaged highways and roads

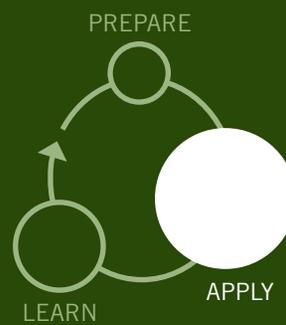


Water Safe

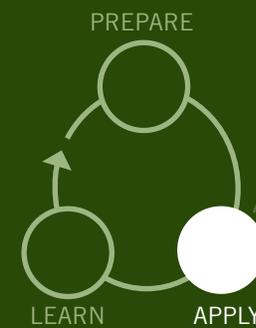
Managing Secondary Disasters



(before)



(during)



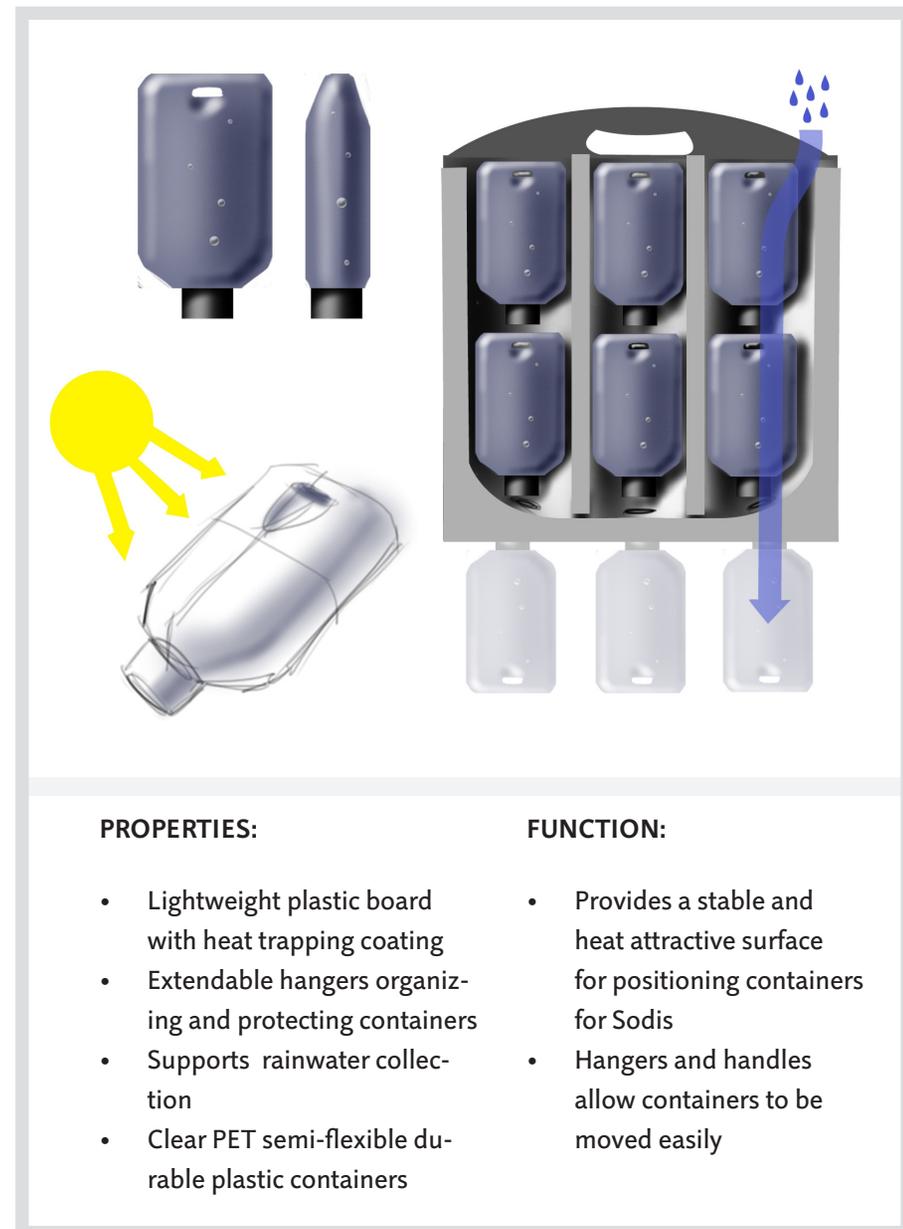
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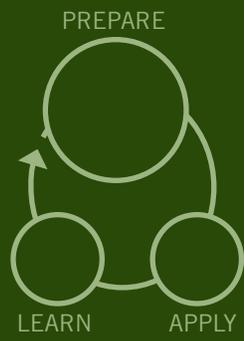
Managing Secondary Disasters

WaterSafe Board

“Every year, there are already 1.6 million diarrheal deaths related to unsafe water, most of them children under the age of five” (www.swissinfo.org, 2005) Providing safe drinking water may be the most important step in securing a region post disaster. The WaterSafe board allows for easy distribution and organization of Solar Disinfection (Sodis) materials and instructions. While many advanced technologies have been introduced, this technology can be maintained easily by local populations long after disaster aid has pulled out.

Source:
<http://www.sodis.ch/>

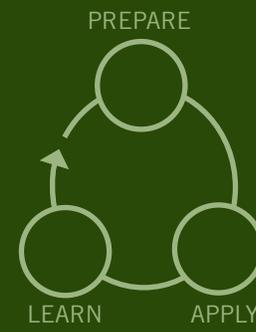




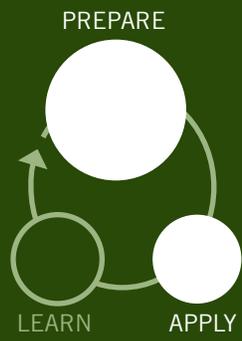
(before)



(during)



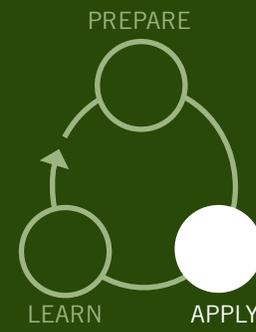
(after)



(before)



(during)



(after)

Solution Map



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Common Currents



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Flood Craft



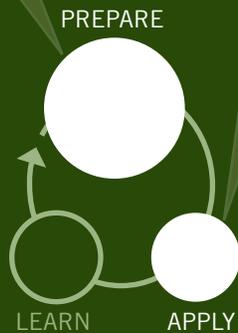
MedicShelter
Personal Locator



Roll-out Roads



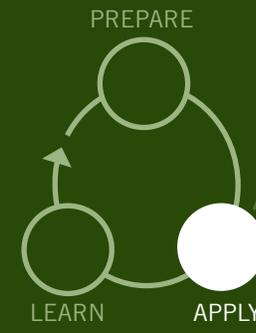
Water Safe Board



(before)



(during)



(after)

Q&A