Design Strategies for a Wetter World

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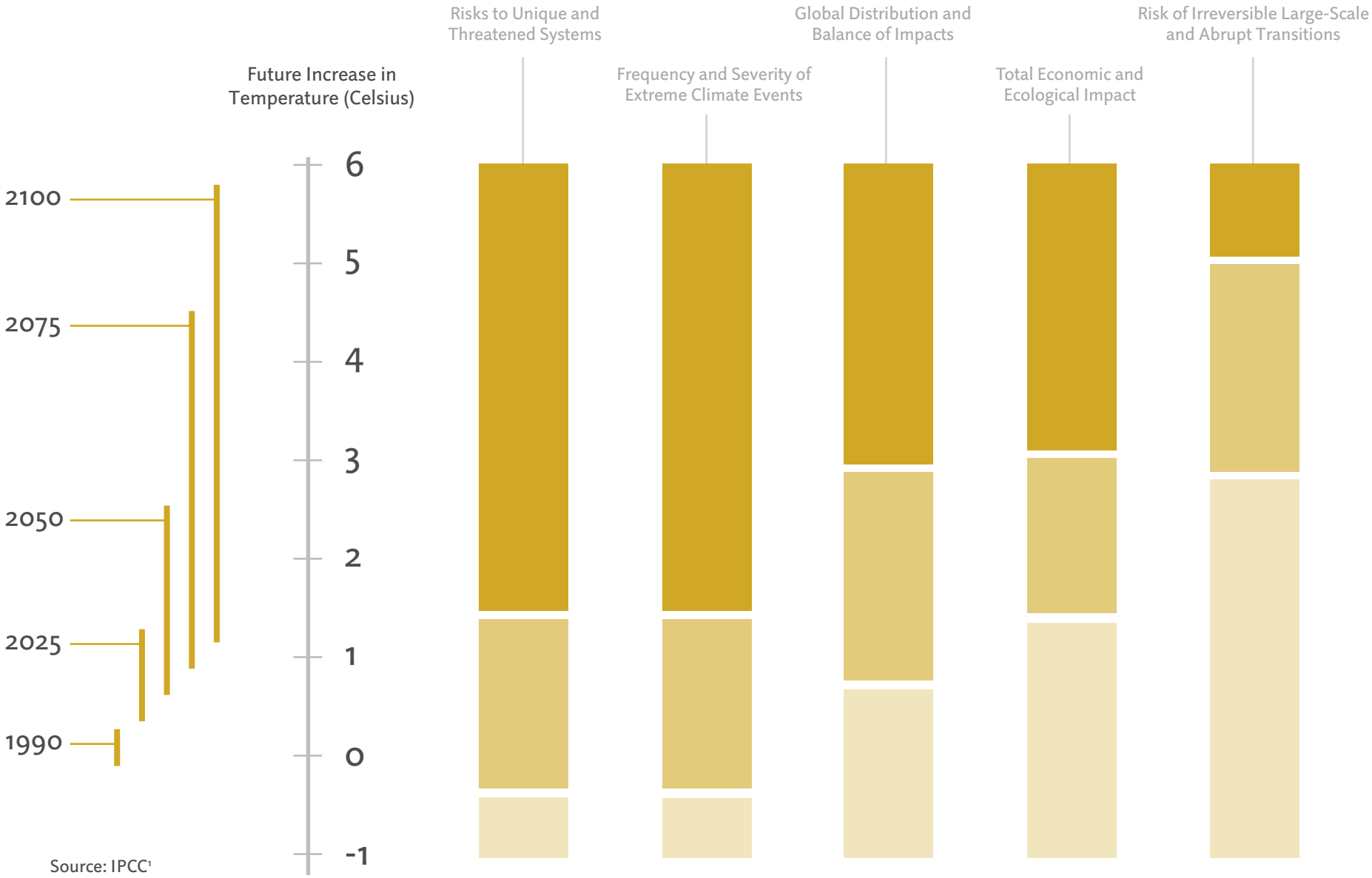
THE RISKS AND IMPACTS OF GLOBAL WARMING



BACKGROUND

THE PROBLEM

Global warming is now recognized as a fact almost without question. The science community has long held that current environmental trends will lead to major catastrophic weather events, and for the first time those ideas are growing present in mainstream culture, visible in the popularity of Al Gore's documentary film "An Inconvenient Truth". One event cited in the film includes the rise of global sea levels, which may rise more than 20 feet through "the loss of shelf ice in Greenland and Antarctica, devastating coastal areas worldwide." Just in the past 50 years, around 8000 square kilometers of ice sheets in Antarctica have been lost. In the same period, meteorological stations measured an increase in the air temperature of about 2°C.[1]

The World Health Organization states that "deaths from global warming will double in just 25 years -- to 300,000 people a year." Yet, significant changes are still slow in coming. Around the globe, there are still disparate perspectives on what is at stake. The effects of global warming are becoming more tangible, though, seen in the increasing frequency of natural disasters around the world. Even with current levels of carbon dioxide in the atmosphere, the earth will continue to get warmer; the effects on climate change are already in action and we are beginning a period of repercussions. In the coming years, a warmer Earth will produce an even wetter, hotter and drier environment, with rising sea levels. Cities and towns can "ride it out" and just react to the changing climate conditions, or they can "build their way out" by looking at ways to mitigate the negative effects and harness the positive effects of climate change. Adaptation strategies are our responsibility to preserve life and property in the coming decades - without them, as Al Gore suggests, our behavior is unethical.

In the 1930s, Winston Churchill wrote of leaders who could not grasp imminent war catastrophes: "They go on in strange paradox, decided only to be undecided, resolved to be irresolute, adamant for drift, solid for fluidity, all powerful to be impotent. The era of procrastination, of half-measures, of soothing

and baffling expedients, of delays, is coming to a close. In its place, we are entering a period of consequences." We are now in such a period, a period that will have a major influence on life in the next century. But we don't have much time. Levels of carbon dioxide in the atmosphere will reach a tipping point in 20 years[2], which gives us 10 years to come up with ways to stop it. In the meantime, the Earth will continue to get warmer and produce more frequent and intense natural disasters requiring new ways to mitigate the loss of lives and property.

THE PROJECT

Using a computer-supported planning process called Structured Planning (summarized later in the Preface) four teams undertook an extensive project to develop integrated and adaptive solutions to future climate change. The teams were created to allow each to focus on one of three severe weather conditions scientists predict will occur with greater frequency. They include a wetter environment, a hotter and drier environment, and rising sea levels. The final group's focus involved the

"The era of procrastination, of half-measures, of soothing and baffling expedients, of delays, is coming to a close. In its place, we are entering a period of consequences."

Winston Churchill, 1938

development of adaptation solutions within urban environments. Together the projects provide a comprehensive solution set for communities around the world. The particular focus of this report concerns adaptation strategies to a wetter environment which involves altered rainy seasons, severe thunderstorms, heavy rains and heavy snow. At the beginning of the project charters were issued to each team, setting the context of the project and its goals. The Charters acted as initiating briefs. Following are some sections from them.

BACKGROUND

Over the twentieth century, the Earth's average global surface temperature increased .6 degrees Celsius (1.08 degrees Fahrenheit). Estimates made in 2004 of the amount of warming we will experience in this century suggested a likely range of 2.4 to 5.4 degrees Celsius (4.3 to 9.7 degrees Fahrenheit), but a more recent paper (2005) by a team of Oxford University scientist suggest a significantly hotter range of possibilities: 2 to 11 degrees Celsius (3.6 to 19.8 degrees Fahrenheit), pushing the most likely value upward.

Darkening the picture further, the greenhouse gases already put into the atmosphere will have effects lasting centuries. The concentration of carbon dioxide and greenhouse gas equivalents in the atmosphere before land-clearing and industrialization in the 18th century was about 265 parts per million (ppm). Increase has accelerated greatly, bringing it now to nearly 400 ppm. To stabilize concentrations at 450-550 ppm will require major reductions in carbon emissions beginning immediately. And the 450-550 level is not safe; stabilizations must be succeeded by reductions in concentration, which will take more than a century at natural rates of absorption. Warming at this magnitude is likely to be greater than any since the large and abrupt Younger Dryas event 11,000 years ago. "Warming as large and rapid as that projected for the twenty-first century might be expected to create severe problems for natural ecosystems and human societies. Indeed, evidence from past climate changes of similar magnitude point to major impact, which, if humans had been present in number like today would have been disastrous." (Pit-

tock 2005, 21).

It is too late to avoid the effects of global warming. But it is not too late to assemble and project strategies and tools that allow us to adapt. To be able to deal with the great challenges of emissions reduction that will be necessary on a global scale to mitigate the worst of the greenhouse changes – while improving or even maintaining our quality of life – will require that we face the widely diverse environmental challenges that now will confront local regions and communities.

We're already starting to see some of the changes. The arctic ice sheets and glaciers are melting and receding, plants and animals are being seen at higher elevation levels, and the number of severe storms and droughts is increasing. The number of Category 4 and 5 hurricanes has almost doubled in the last 30 years.[3] Malaria has spread to higher altitudes in places like the Colombian Andes, 7,000 feet above sea level.[3] The flow of ice from glaciers in Greenland has more than doubled over the past decade.[3] At least 279 species of plants and animals are already responding to global warming, moving closer to the poles.[3]

The effects of a warmer Earth can be catastrophic. Heat waves will be more frequent and more intense.[3] Droughts and wildfires will occur more often. Frequent and heavy rainfall will produce disastrous and deadly floods. The Arctic Ocean could be ice free in summer, and more than a million species worldwide could be driven to extinction by 2050.[3]

"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. Our Earth is getting warmer and this means we will have a more intense hydrological cycle. Increase in the surface air temperature will increase evaporation and add higher levels of water vapor in the atmosphere. In addition, a warmer atmosphere can hold more water vapor which leads to more frequent heavy precipitation events - a wetter world. More

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

David A. King, Chief Scientific Advisor to the British Government, 2004

intense precipitation can cause floods, soil erosion, landslides, and damage to structures and crops. Spring will come earlier and altered rainy seasons will change how crops are grown.

Early in the millennium, Dr. Sharon Locke of the University of Southern Maine and Dr. Susanne Moser of the Union of Concerned Scientists researched, categorized, and described the events featured on a world map and completed a map update in January 2003 based on the latest scientific findings. These "fingerprints" showed a multitude of record-setting disastrous effects within the past 7 years.[4]

> *The Pampas region in Argentina/Uruguay had the worst flooding on record in from August to October 2001. Nearly 8 million acres (3.2 million hectares) of land in the Pampas region were flooded after 3 months of high rainfall (WMO, 2002a). Mean annual precipitation in the humid Pampa increased by 35% in the last half of the 20th century (IPCC, 1998).*

In southeastern Norway, the year 2000 was the wettest year since records began in 1895 (WMO, 2001). Precipitation in northern Europe has increased 10-40% in the last century (IPCC, 2001b).

Buenos Aires, Argentina had the heaviest rains in 100 years in May 2000. 13.5 inches (34.2 cm) of rain, more than 4 times the average monthly rainfall, fell in just 5 days (NOAA Office of Global Programs, 2000). Northeastern Argentina is exhibiting a long-term trend of increasing precipitation (IPCC, 2001b).

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

December 1999 in Venezuela produced the heaviest rainfall in 100 years caused massive landslides and flooding that killed approximately 30,000 people. Total December rainfall in Maiquetia, near Caracas, was almost 4 feet (1.2 m), more than 5 times the previous December record. The high death toll was attributed to population growth in vulnerable areas and forest clearing on steep hill slopes (Wieczorek et al., 2001; USGS, 2000).

Not only do these events add to loss of life, but they are also a financial burden. Since 1950, the costs of natural disasters has risen steadily. There are various factors in this including the growing population and land-use, but the increase in severity and frequency of wetter events is related to the steady rise of economic damages. In 2005, economic damages caused by natural disasters tallied 159 billion (US$). This compared to a yearly average of 65.5 billion (US$) from 1994-2004.[5] Hurricane Katrina alone accounted for 1.5% of the total deaths and 78% of the total economic damage. By contrast, the cost of catastrophic events in 1950 was 3.9 billion (US$).[6]

In 2005, floods were the most common type of natural disaster in the world, occurring a total of 168 times compared with

annual averages of 107 from 1994-2005[7], killing a total of 7 million people, and costing almost 15 billion (US$).[8]

Dr. Debarati Guha-Sapir of the Centre for Research on the Epidemiology of Disasters (CRED), highlights some data from the first semester assessment of 2006.

> "An interesting point to note about the first semester of 2006 is the significant number of recorded flood disasters, with a total of 113 floods representing all-time high of 65% of all natural disasters. The first semester average for the preceding 10 years was of 58 floods, representing an average of only 36.5% of all natural disasters. In fact, floods constitute an increasingly large proportion of all disasters recorded in the EM-DAT database over the last 50 years."

Greater moisture will favor extensions of the geographical range and season for vector organisms such as insects, rodents, and snails. This means a larger zone of potential transmission for many vector-borne diseases, among them malaria, dengue fever, yellow fever, and some forms of viral encephalitis. Poorer regions that aren't prepared for disease outbreak from extreme weather events will be highly at risk.

In addition to vector-borne diseases, a wetter world will likely produce an increase in mosquito abundance, biting rates, and activity level, and will accelerate the incubation of the parasites and viruses within them.[9] A warmer and wetter earth will likely expand the zone of where mosquitos can inhabit land, thus increasing the likelihood of greater disease transmission. Model predictions indicate that a 3° C global temperature rise by 2100 could increase the number of annual malaria cases by 50-80 million (not considering factors such as local control measures or health services).[10] In regions adjacent to current risk areas, there could be a shift to seasonal epidemics with malaria.

A warmer earth will also produce more habitable land in the higher altitudes. Mosquito-borne diseases are now reported at higher elevations than in the past at sites in Asia, Central Af-

rica, and Latin America.[11] Diseases carried by rodents or other small mammals, in addition to mosquitos, may be impacted as well. A recent study found a 60% rise in human plague cases in New Mexico following wetter than average winter-spring time periods (October-May).[12] Increased precipitation enhances food supply and provides a favorable environment for fleas to reproduce, increasing infection from animal-flea-human contact.

Climate change can also cause disease in animals and plants around us and we will likely see extinction of certain species. Possibly more than a million species could be extinct by the year 2050.[13] Water runoff from heavy rainfall and flooding can carry with it contaminants that harm plants. Forests and crops are more susceptible to the spread of pathogens, especially following extended droughts and floods.[14] Disproportionate warming at night and during the winter may allow destructive insects and pathogens to invade forests at higher latitudes and elevations from which they are now excluded.[15]

Despite the destructive forces of wetter weather, there are also some positive aspects of wetter weather. There is the ability to look at new energy sources from the natural wind and water effects of heavy precipitation events. There are ways to convert wind, water, and electric energy into distributed energy sources for towns and cities to share. The world is full of natural resources that haven't been fully tapped into. Adaptive solutions to climate change force one to look at wetter weather with a slightly different perspective and search for advantages, rather than simply mitigating its catastrophic effects.

In summary, the effects of a wetter Earth will have many dimensions, affecting not only lives and property damage, but also bringing about disease and impacting the plants and animals around us. Adaptation strategies to these imminent effects can abate the damage caused by heavy rain, altered rainy seasons, heavy snow, and thunderstorms, while possibly creating new sources of energy and distributed resources for the world.

APPENDIX

1. British Antartice Survey, http://www.antarctica.ac.uk/Key_Topics/IceSheet_SeaLevel/ice_shelf_loss.html
2. The Guardian, "Climate change will reach point of no return in 20 years, says expert"; http://environment.guardian.co.uk/climatechange/story/0,,1865081,00.html
3. An Inconvenient Truth, The Science; http://www.climatecrisis.org/
4. Global Warming, Early Warning Signs; http://www.climatehotmap.org/newpoints.html
5. http://www.em-dat.net/documents/CREDCRUNCH4-feb2006.pdf
6. http://earthobservatory.nasa.gov/Study/RisingCost/
7. http://www.em-dat.net/documents/2005-disasters-in-numbers.pdf
8. http://www.em-dat.net/documents/CREDCRUNCH4-feb2006.pdf
9. http://www.ucsusa.org/global_warming/science/early-warning-signs-of-global-warming-spreading-disease.html
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12. http://www.ucsusa.org/global_warming/science/early-warning-signs-of-global-warming-spreading-disease.html
13. http://www.climatecrisis.net/thescience/
14. http://www.ucsusa.org/global_warming/science/early-warning-signs-of-global-warming-spreading-disease.html
15. http://www.ucsusa.org/global_warming/science/early-warning-signs-of-global-warming-spreading-disease.html

RELEVANT TRENDS

POPULATION GROWTH

Population growth continues to soar around the world. Particularly in developing countries, but also in countries with significant immigration (such as the United States), rates of population increase re putting heavy demands on available resources. Although estimates for a final asymptote have decreased, world population is still expected to top 9 billion by 2050. It is now 6.64 billion.

POPULATION MOVEMENTS

A combination of forces is creating a movement of people from rural to urban environments. In the developing countries, it is the perception that better jobs are in the cities. In the developed countries, it is the renaissance of the city as a cultural center coupled with the progression of societies from agriculture to manufacturing to service to information economies. In 2005 for the first time, the world's population was more urban than rural.

ENERGY RESOURCE DEPLETION

World petroleum resources are reaching the point where additions to reserves no longer equal reductions from production. Estimates for final peak production vary from 2005 to just a few years from now. The world economy, deeply committed to petroleum as a fuel resource, must meet its energy needs by other means in the near future.

DIMINISHING WATER RESOURCES

Water supplies are already becoming precious resources in many parts of the world. Today, one-third of the world lives in water-stressed countries; by 2050, two-thirds will be in similar circumstances-including significant parts of the U.S. As regions are strained by greater demand, new efficiencies in water distribution, use, purification and reuse will be mandatory.

INCREASING EXPECTATIONS

The growing availability and capabilities of communications such as cellular telephones, satellite, and cable TV, and the Internet are providing people with daily knowledge of living con-

ditions, problems, products, threats and services everywhere. As the media create new and faster avenues of communication, they also raise levels of awareness and create expectations that both fueled demand and encourage willingness to change.

INTERNET PENETRATION

Computer use and Internet access grow exponentially every year. Information of encyclopedic detail can be obtained more and more easily, and complex, sophisticated processes can be used remotely. Access to high-quality communications and sophisticated computer tools are increasingly available to individuals and groups anywhere. In the United Sates, Internet penetration reached 67% in 2005, and some Asian and European countries surpass that.

EMERGING TECHNOLOGIES

The pace of technological change continues to accelerate, bringing new science to industrial, institutional and governmental uses at an ever quickening pace. Most notable among many promising fields, major technological innovations can be expected in the new disciplines of molecular nanotechnology, robotics and the biosciences.

NEW RELATIONSHIPS

Greater public mobility and access to information is changing the nature of association for many individuals and organizations. Organizations that once operated in isolation are now players in a common environment. Sometimes the emerging relationships are competitive, sometimes cooperative, and new forms of relationship can be expected to be created as conditions evolve.

PROJECT STATEMENT and GOALS

Using Structured Planning methodology, conduct an advanced planning project to develop a portfolio of strategies, processes and system concepts that can be custom-tailored to threats of a wetter environment as they may massively affect a locality or region. The proposal should:

SUPPORT ADAPTIVE SOLUTIONS

Treat all concepts as adaptive tools, adaptive to site conditions at implementation, adaptive over time to changing capabilities and conditions.

BE THOROUGH AND EXHAUSTIVE

Consider the full spectrum of environmental planning from anticipation to preparedness to implementation to restoration.

INCORPORATE BEST PRACTICES

Collect and incorporate best practices as they are known to organizations, agencies and planning experts throughout the emerging global warming community.

ANTICIPATE COLLABORATION

Anticipate and plan for networked operational cooperation among affected and spared communities locally, regionally and internationally.

MAXIMIZE ECONOMIC, SOCIAL, and/or ENVIRONMENTAL BENEFITS

Seek out and favor concepts that maximize economic, social and/or environmental benefits beyond their primary function to alleviate the effects of global warming.

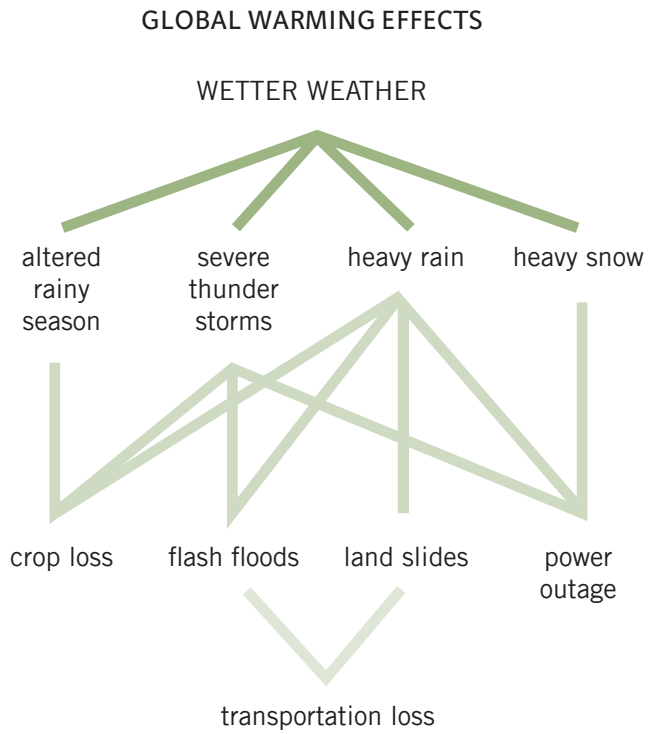


Fig A. Ordered effects of global warming by changing rain and snow patterns.

PROJECT GOALS

Explore a full range of possibilities paying especial attention to the products of emerging technologies successfully advancing through research and development.

Include ideas for processes, tools, systems and products--including procedures, services, activities, organizational concepts and any relevant relationships among them.

Explore revolutionary as well as evolutionary ideas.

Plan for communication processes by means of which other localities, regions and states can learn of and implement successful procedures.

Consider potential costs and funding thoughtfully; proposals should not incorporate unnecessary frills, but should not ignore perilous outcomes with low risk simply to avoid costs. Treat costs as you would treat those for catastrophe insurance; err on the cautious side and hedge your bet with ancillary economic benefits.

Conceive the properties and features of the concepts as means to build trust and cooperation between communities. Some will be lucky; others will not; means for the support of others will need to be core tools for all.

OVERALL, THE SOLUTION SHOULD:

Assume that the proposal can be acted upon as it is conceived. Do not under propose on the assumption that a concept might be politically opposed.

Demonstrate what might be achieved. The value of the proposal is in its ideas, not in its certain attainability. Ideas that might not be fully attainable or feasible today may be achieved tomorrow - if they are known.

ABOUT STRUCTURED PLANNING

THE PROCESS

The semester-long Systems and Systematic Design course is a project-based course in which teams of graduate students, deliberately of mixed international origins and different academic backgrounds, apply the computer-supported Structured Planning process to complex design and planning problems. The goal for each project is to develop information thoroughly, propose innovative solutions that take maximum advantage of the information, and integrate these ideas into system concepts that can both be evaluated in their own right and (in a real situation) be the comprehensive project specifications for a follow-on detail design phase of development.

COURSE ISSUES

COMPLEXITY. What is the nature of "systems" concepts, where products, processes, services and settings are organized to act together to achieve multiple goals? What can be done to assure that a concept is as complete as possible, covering many functions and attaining a high degree of "wholeness" and organic reliability?

DESIGN AND PLANNING METHODS. What is Structured Planning and how can its tool-kit of methods be used to collect, structure and handle information in projects of greater complexity than can be comfortably dealt with intuitively? How can such methods be used by a team to extend the effectiveness of all?

TEAMWORK. How do individuals with different cultural origins and different academic backgrounds work together successfully on teams? What roles are there to be played and what difficulties must be overcome?

STRUCTURED PLANNING

A number of projects have been undertaken with it and used to further its development. Among nearly 100 of these, an early published project for Chicago's transit authority (CTA) was Getting Around: Making the City Accessible to Its Residents (1972). In 1983, the House of the Future project won the Grand Prize in the Japan Design Foundation's First International Design Com-

petition. In 1985, the design of a habitation module for Space Station was undertaken for NASA. In 1987, the Aquatecture project won the Grand Prize again in the Japan Design Foundation's Third International Design Competition. In 1991, Project Phoenix on global warming was honored as Environmental Category Grand Winner in Popular Science magazine's "100 Greatest Achievements in Science and Technology" for the year. In 1993, two award winning projects, NanoPlastics and Aerotecture, were widely publicized in Europe and Japan; in 1995, the National Parks project developed plans for the future of the U. S. National Park Service. In 2001, Access to Justice, a project sponsored by the National Center for State Courts, was implemented for use in state courts across the United States, and in 2005, four projects on Home, Play, Work and Health were finalists in four of the five competition categories for Denmark's INDEX Awards, the world's richest design prizes. As the process has evolved, it has become an increasingly useful planning tool for products, systems, services, processes and organizations. It is now being used commercially.

A diagram of the process, shown below, outlines the activities that make up Structured Planning and the working documents and final products that are produced along the way. The following general description follows the diagram. Where products of the process are discussed here in the abstract, it is possible to see specific examples produced for this project in the appendices that accompany this report.

PHASE I **PROJECT DEFINITION**

The Structured Planning process begins with Project Initiation and the production of a Charter. This is a "brief" that serves as an initial communication vehicle between client and planners. It contains background, context, basic goals, a project statement that cuts to the heart of the planning task, resources to be used, and an initial set of issues to be investigated. Defining Statements are mini "white papers" produced in the Framework Development portion of Project Definition. They focus the project within the direction of the Charter, concentrating on the issues and arguing specific directions that the project should follow with regard to them. Together with the Charter, they de-

fine the project.

PHASE II ACTION ANALYSIS

Any system can be viewed as a complex entity working with its users in different ways appropriate to its modes of operation. To plan effectively, a planning team must recognize these Modes, identify Activities that occur within them, and isolate the Functions that the users and system are intended to perform within each Activity. The result of the Activity Analyses conducted is a Function Structure.

Half of the purpose of Action Analysis is the enumeration of Functions. The other half is the development of information about these Functions that reveals insight about what happens as they are performed. During Action Analysis, insights are sought about why things go wrong in performing some Functions, and how other Functions manage to be performed well. These insights are uncovered in the Design Factor Description procedure and developed in documents that become part of a qualitative knowledge base. Activity Analyses record information at the Activity level; Design Factors document insights and ideas associated with Functions.

To capture as fully as possible the ideas suggested on Design Factors, Solution Element documents are written in the Solution Element Description portion of Action Analysis. These are one-page documents designed to capture enough detail about ideas to give them substance when they are needed later. They have three important sections: “Description” -- a short explanation, “Properties” -- what the idea is, and Features -- what the idea does. The Solution Element form is the tool used for committing ideas to paper.

The product of Action Analysis is three sets of critical information: a set of Functions (the Function Structure), a set of insights (Design Factors) and a set of preliminary ideas (Solution Elements).

PHASE III INFORMATION STRUCTURING

Paradoxically, as useful as the Function Structure is for estab-

lishing coverage, it is not the best form of organization for developing concepts. Reorganizing information for use in concept development is the job of two computer programs, RELATN and VTCON.

The controlling factor for whether two Functions are associated from the planning standpoint is not whether they are categorically "related" in some manner, but whether a significant number of their potential solutions are of concern to both. Which Solution Elements are of concern to each Function is established in an Interaction Analysis procedure. The RELATN program then uses this information in a Graph Construction process to establish links between Functions.

Another program, VTCON, completes the information structuring process. The graph establishes paths through the Functions by linking them when they are related, but, unlike a road map, a graph is not naturally arranged nicely for visual comprehension. In the Hierarchy Construction activity, VTCON finds clusters of highly interlinked Functions and organizes them into a semi-lattice hierarchy, a very general form of hierarchy most appropriate for planning. The hierarchy is called an Information Structure.

PHASE IV SYNTHESIS

In its form from the VTCON program, the Information Structure is simply a hierarchical organization. Nodal points do not have names. The task of Means/Ends Analysis is to create labels for all nodal points in the hierarchy. Moving bottom-up from the known Functions in the bottom level clusters, the question is asked, "To what end are these Functions means?" The answering purpose, in turn is grouped with its sibling nodes and viewed as means to a higher level end. The process continues to a completely labeled Information Structure.

The process is then reversed as a top-down, structured brainstorming procedure: Ends/Means Synthesis. In this process, the planning team asks of high level nodes, "what means do we need to meet this end?" As means are established, they are treated in turn as new ends for which means must be found, until the means become concrete enough to be described as final elements of the system (System Elements). Solution Ele-

ments originally conceived for the Functions involved are constantly reviewed as possible end products. New ideas, however, are encouraged, and original ideas are modified or combined in the light of the means that evolve.

During Solution Evaluation, features of the System Elements are evaluated for their contribution to fulfillment of Functions in their part of the Information Structure. If there are unfulfilled Functions, this is the signal to return to the Ends/Means process for additional development.

System Element Interaction compares System Element with System Element in a search for additional synergies that can contribute to systemic qualities. More than simply recognizing relationships, the planning team proactively seeks out ways for System Elements to work together -- to the extent of modifying one, the other, or both. Changes are incorporated in the properties and features of the individual System Elements.

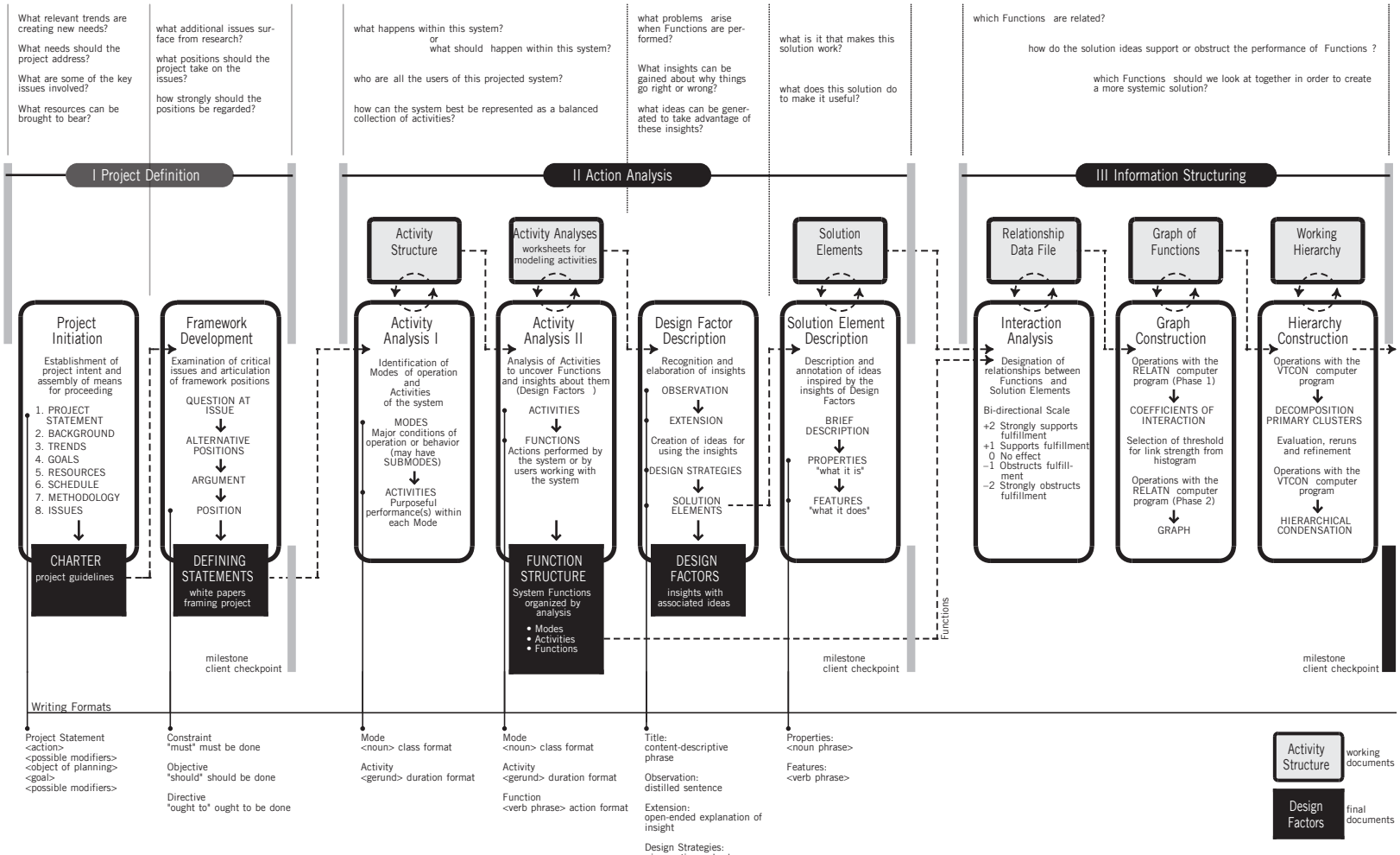
The last task, System Element Description, completes the write-up of System Elements as specifications, including a succinct description, all relevant properties and features, and extensive Discussion and Scenario sections that contain detailed expositions of the ideas in both conceptual and operational terms.

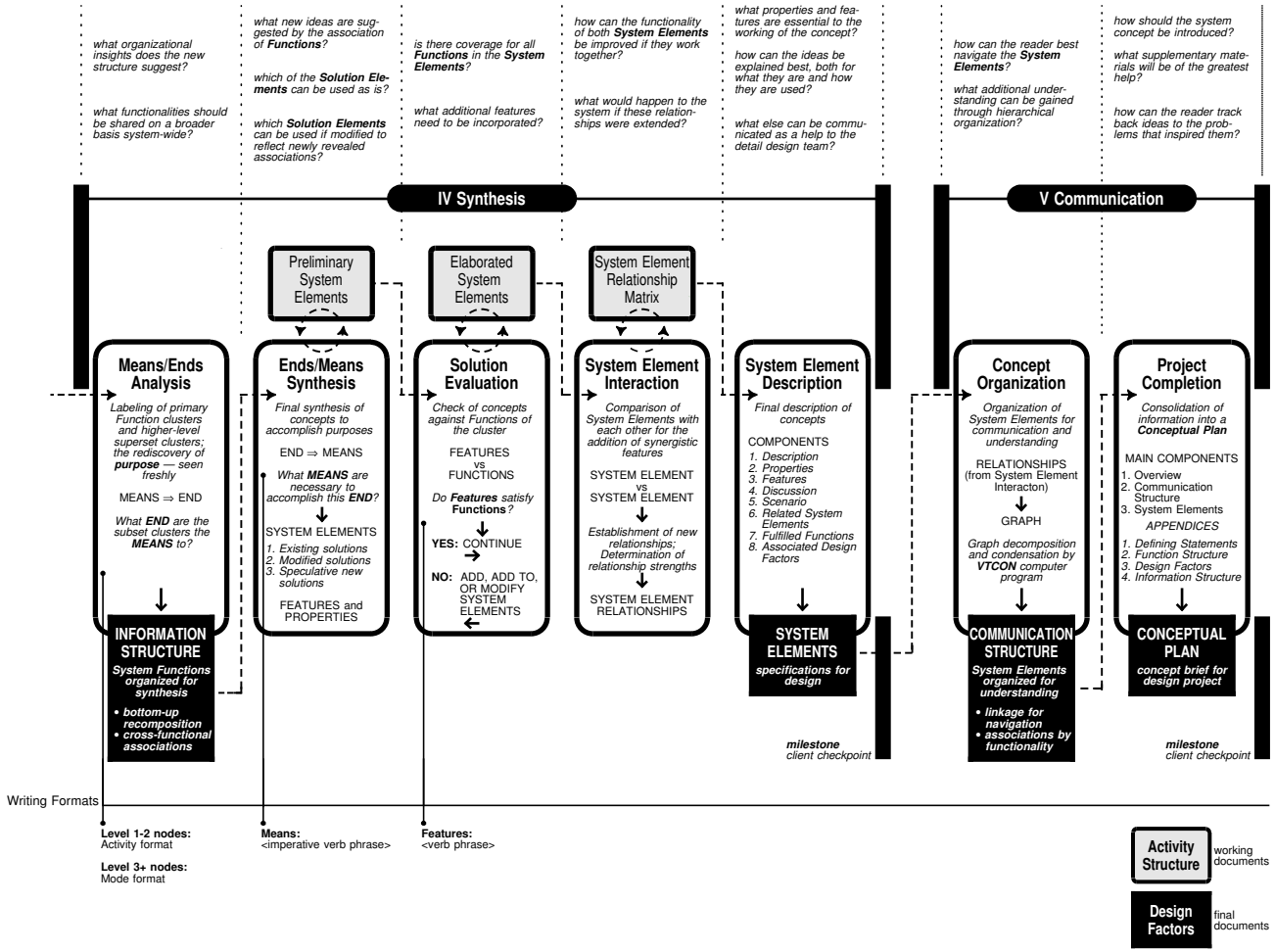
PHASE V **COMMUNICATION**

Because the result of the Structured Planning process is a complex system, usually with a number of System Elements, a Communication Structure is frequently included as an aid to understanding. This is created during Concept Organization by the VTCON program from an assessment of how important the System Elements are to each other's operation. Using this structure, the reader can understand the system and navigate its concepts with greater efficiency.

The product of the Structured Planning process, assembled in the Project Completion section, is a Conceptual Plan, made up of an Overview that provides background and introduces the system, the System Elements that describe the ideas and their relationships, and Appendices that contain all

relevant support information, including the Defining Statements, Design Factors, Function Structure and Information Structure.


What relevant trends are creating new needs?
What needs should the project address?
What are some of the key issues involved?
What resources can be brought to bear?
what additional issues surface from research?
what positions should the project take on the issues?
how strongly should the positions be regarded?
what happens within this system? or what should happen within this system?
who are all the users of this projected system?
how can the system best be represented as a balanced collection of activities?
what problems arise when Functions are performed?
What insights can be gained about why things go right or wrong?
what ideas can be generated to take advantage of these insights?
what is it that makes this solution work?
what does this solution do to make it useful?
which Functions are related?
how do the solution ideas support or obstruct the performance of Functions ?
which Functions should we look at together in order to create a more systemic solution?
I Project Definition
II Action Analysis
III Information Structuring
Project Initiation
Establishment of project intent and assembly of means for proceeding
1. PROJECT STATEMENT
2. BACKGROUND
3. TRENDS
4. GOALS
5. RESOURCES
6. SCHEDULE
7. METHODOLOGY
8. ISSUES
CHARTER
project guidelines
Framework Development
Examination of critical issues and articulation of framework positions
QUESTION AT ISSUE
ALTERNATIVE POSITIONS
ARGUMENT
POSITION
DEFINING STATEMENTS
white papers framing project
milestone
client checkpoint
Activity Structure
Activity Analysis I
Identification of Modes of operation and Activities of the system
MODES
Major conditions of operation or behavior (may have SUBMODES)
ACTIVITIES
Purposeful performance(s) within each Mode
Activity Analyses
worksheets for modeling activities
Activity Analysis II
Analysis of Activities to uncover Functions and insights about them (Design Factors)
ACTIVITIES
FUNCTIONS
Actions performed by the system or by users working with the system
FUNCTION STRUCTURE
System Functions organized by analysis
• Modes
• Activities
• Functions
Design Factor Description
Recognition and elaboration of insights
OBSERVATION
EXTENSION
Creation of ideas for using the insights
DESIGN STRATEGIES
SOLUTION ELEMENTS
DESIGN FACTORS
insights with associated ideas
Solution Elements
Solution Element Description
Description and annotation of ideas inspired by the insights of Design Factors
BRIEF DESCRIPTION
PROPERTIES
"what it is"
FEATURES
"what it does"
Functions
milestone
client checkpoint
Relationship Data File
Interaction Analysis
Designation of relationships between Functions and Solution Elements
Bi-directional Scale
+2 Strongly supports fulfillment
+1 Supports fulfillment
0 No effect
–1 Obstructs fulfillment
–2 Strongly obstructs fulfillment
Graph of Functions
Graph Construction
Operations with the RELATN computer program (Phase 1)
COEFFICIENTS OF INTERACTION
Selection of threshold for link strength from histogram
Operations with the RELATN computer program (Phase 2)
GRAPH
Working Hierarchy
Hierarchy Construction
Operations with the VTCON computer program
DECOMPOSITION PRIMARY CLUSTERS
Evaluation, reruns and refinement
Operations with the VTCON computer program
HIERARCHICAL CONDENSATION
milestone
client checkpoint
Writing Formats
Project Statement
<action>
<possible modifiers>
<object of planning>
<goal>
<possible modifiers>
Constraint
"must" must be done
Objective
"should" should be done
Directive
"ought to" ought to be done
Mode
<noun> class format
Activity
<gerund> duration format
Mode
<noun> class format
Activity
<gerund> duration format
Function
<verb phrase> action format
Title:
content-descriptive phrase
Observation:
distilled sentence
Extension:
open-ended explanation of insight
Design Strategies:
<imperative verb phrase>
Solution Elements:
<evocative adjective>
<noun>
Properties:
<noun phrase>
Features:
<verb phrase>
Activity Structure
working documents
Design Factors
final documents


what organizational insights does the new structure suggest?
what functionalities should be shared on a broader basis system-wide?
what new ideas are suggested by the association of Functions?
which of the Solution Elements can be used as is?
which Solution Elements can be used if modified to reflect newly revealed associations?
is there coverage for all Functions in the System Elements?
what additional features need to be incorporated?
how can the functionality of both System Elements be improved if they work together?
what would happen to the system if these relationships were extended?
what properties and features are essential to the working of the concept?
how can the ideas be explained best, both for what they are and how they are used?
what else can be communicated as a help to the detail design team?
how can the reader best navigate the System Elements?
what additional understanding can be gained through hierarchical organization?
how should the system concept be introduced?
what supplementary materials will be of the greatest help?
how can the reader track back ideas to the problems that inspired them?
IV Synthesis
V Communication
Preliminary System Elements
Elaborated System Elements
System Element Relationship Matrix
Means/Ends Analysis
Labeling of primary Function clusters and higher-level superset clusters; the rediscovery of purpose — seen freshly
MEANS ⇒ END
What END are the subset clusters the MEANS to?
INFORMATION STRUCTURE
System Functions organized for synthesis
• bottom-up recomposition
• cross-functional associations
Ends/Means Synthesis
Final synthesis of concepts to accomplish purposes
END ⇒ MEANS
What MEANS are necessary to accomplish this END?
SYSTEM ELEMENTS
1. Existing solutions
2. Modified solutions
3. Speculative new solutions
FEATURES and PROPERTIES
Solution Evaluation
Check of concepts against Functions of the cluster
FEATURES vs FUNCTIONS
Do Features satisfy Functions?
YES: CONTINUE
NO: ADD, ADD TO, OR MODIFY SYSTEM ELEMENTS
System Element Interaction
Comparison of System Elements with each other for the addition of synergistic features
SYSTEM ELEMENT vs SYSTEM ELEMENT
Establishment of new relationships; Determination of relationship strengths
SYSTEM ELEMENT RELATIONSHIPS
System Element Description
Final description of concepts
COMPONENTS
1. Description
2. Properties
3. Features
4. Discussion
5. Scenario
6. Related System Elements
7. Fulfilled Functions
8. Associated Design Factors
SYSTEM ELEMENTS
specifications for design
milestone
client checkpoint
Concept Organization
Organization of System Elements for communication and understanding
RELATIONSHIPS (from System Element Interacton)
GRAPH
Graph decomposition and condensation by VTCON computer program
COMMUNICATION STRUCTURE
System Elements organized for understanding
• linkage for navigation
• associations by functionality
Project Completion
Consolidation of information into a Conceptual Plan
MAIN COMPONENTS
1. Overview
2. Communication Structure
3. System Elements
APPENDICES
1. Defining Statements
2. Function Structure
3. Design Factors
4. Information Structure
CONCEPTUAL PLAN
concept brief for design project
milestone
client checkpoint
Writing Formats
Level 1-2 nodes:
Activity format
Level 3+ nodes:
Mode format
Means:
<imperative verb phrase>
Features:
<verb phrase>
Activity Structure
working documents
Design Factors
final documents

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Design Strategies Map

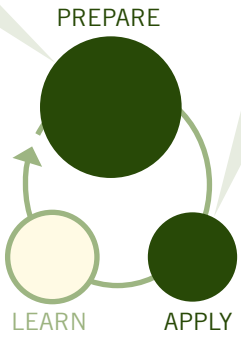
Our approach to the project was to consider the enitre lifecycle of a wetter event, from early preparation period to its occurence (before), when the wetter event becomes a natural disaster (during), and recovery and rehabilitation after a natural disaster (after).

Solutions in this area apply to a preparation period before a wetter event occurence. They generally have a longer lead time and, with careful planning, can help mitigate the disastrous effects of wetter weather.

Solutions in this area are most effective during a wetter weather event. Some are used to take advantage of the natural weather effects like wind, water, and lightning to create new energy sources.

Solutions in this area are applied in response to a disaster. This is considered the backup plan to the backup plan. When the preventative tools to mitigate disaster effects are not enough, we move to a different set of tools.

Solutions in this area are applied during a disaster recovery/rehabilitation period. There are many dimensions to tools in this area and we focused our solutions in areas to prevent mold and fighting disease.



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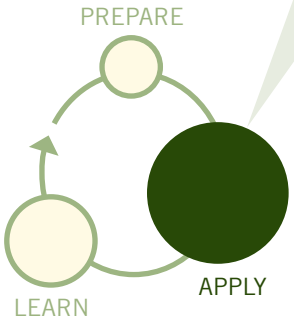

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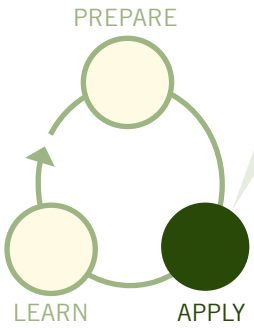

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Design Strategies Map

Environment:
Land Use

Environment:
Water Management

Environmen:
Erosion

Environment:
Agriculture

Environment:
Transportation

Communicate Danger
& Response

Securing Utilities

Environment:
Land Use

Medical Care

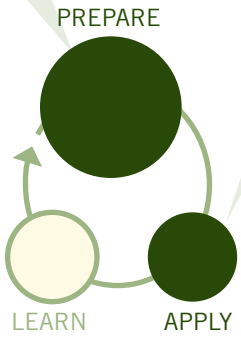
Gathering Equipment
& Materials

Prioritizing Aid

Communicate Danger
& Response

Securing Utilities

Managing Secondary
Disaster



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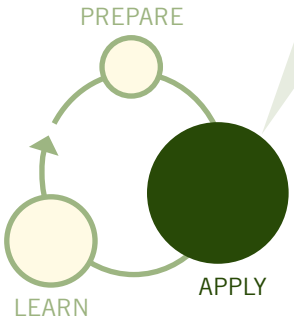

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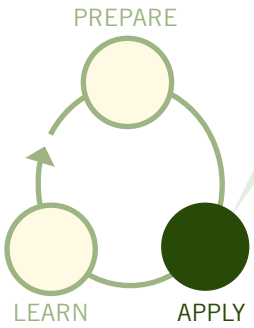

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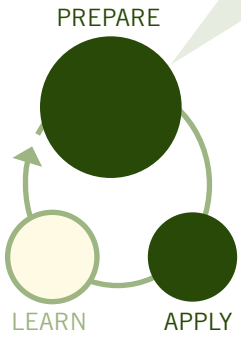
Environment:
Land Use

System Elements
Earth Modeler

Land Use solutions are used to help planning and development. Land Use helps assess geographies to identify vulnerable areas and prevent crop loss with erosion and severe flooding. In addition, policy can help create incentives for communities to use this type of planning method in their development efforts.



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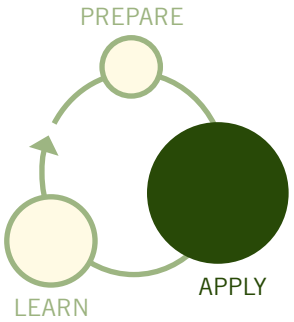

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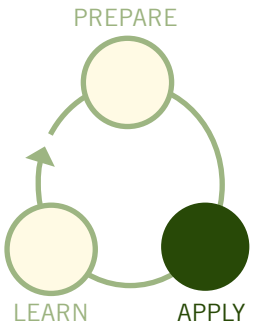

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Environment: Land Use

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.

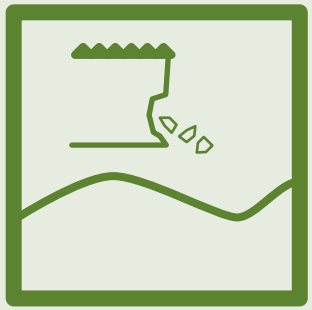
Source:
http://earth.google.com/index.html

PROPERTIES:

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

FUNCTION:

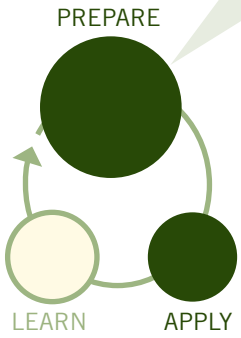
- Simulates the effects of wetter conditions to strategies
- Allows for virtual prototype testing using fluid dynamic modeling
- Creates animations used for mass communication



Environment: Erosion

Erosion solutions are used to help prevent structural or crop damage with flooding. In many cases, floods can destroy crops and cause landslides, which destroy structures and communities in their way. These solutions require preparation and implementation time long before wetter weather events occur.

System Elements
WaterTraps
Earth Nailing Robots
BacterialCement



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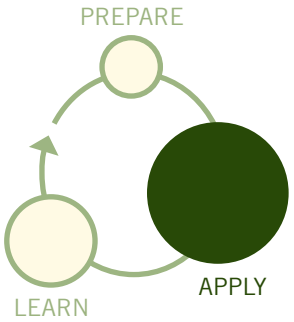

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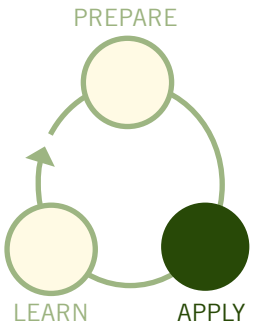

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Environment: Erosion

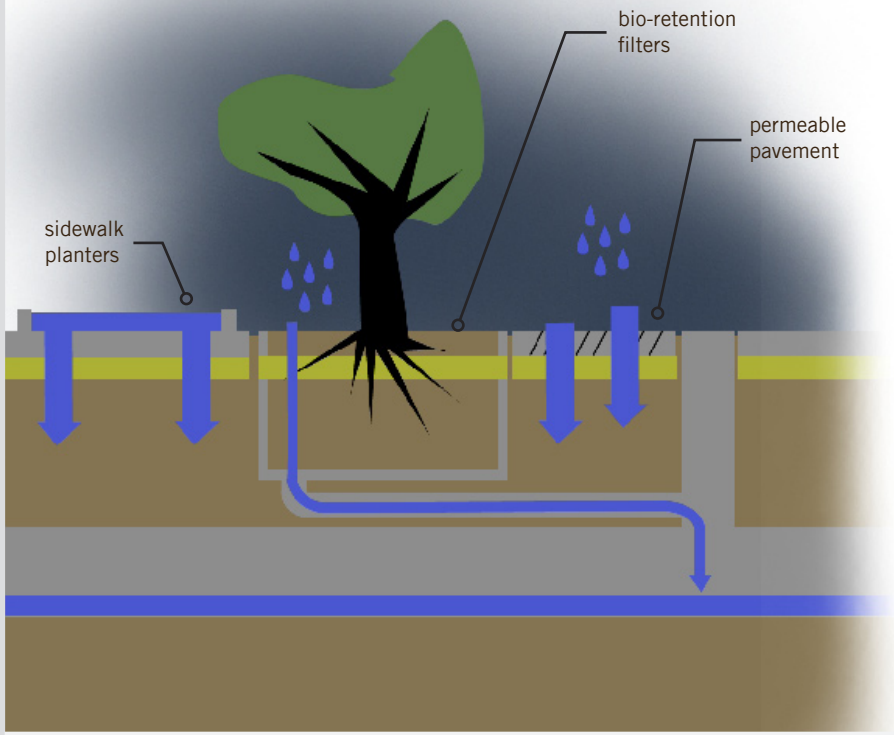
Water Traps

Within urban areas excess rain often creates problems of runoff and water contamination. The problem occurs most often because cities have few areas where water can be absorbed. Water Traps are a sidewalk based system that can be integrated into the urban streetscape without significant changes to the existing drainage system.

Bio-retention filters route excess flows into self-contained concrete units located on both or either side of existing drainage inlets. These units hold and filter excess flows using plantings to remove contaminants and slow run-off, gradually reintroducing the clean water into the sewer. Should water be in excess of the of the filter's capacity it begins to flow directly into the sewer system.

At the same time permeable pavement underneath designated street parking areas allows water to be absorbed into the earth prior to the sewer system. Lastly, concrete planters built up on the sidewalk collect excess water coming off of buildings and allow it to drain directly into the earth.

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



PROPERTIES:

- Self-contained concrete structures placed in existing sidewalks
- Plantings in each structures
- Permeable pavement
- Plant boxes soil drainage

FUNCTION:

- Reduces the flow of excess water into the sewer system
- Prevents valuable water resources from being contaminated
- Prevents erosion of topsoil

Environment: Erosion

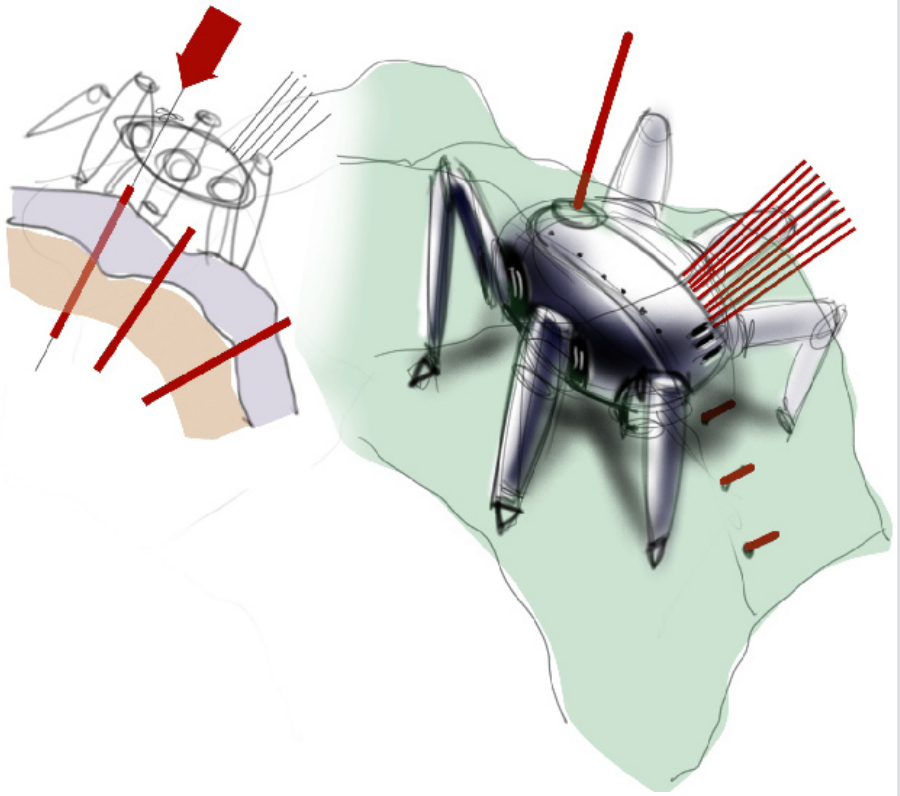
Earth Nailing Robot

Wet weather will likely increase soil erosion, increasing the risk of landslides. Landslides are a major secondary disaster, potentially taking lives and damaging property. Landslides are often the result of a decrease in slope stability related to softening and sheering of upper layers of soil. Slope stability can be affected by saturation of snow-melt and heavy rains. Vibration from thunderstorms can even initiate a slide.

Using 20ft steel or fiberglass nails, shot into the earth by carefully moving robots, layers of earth can be held together to prevent the topmost layers from sheering off. Robots can make ongoing adjustments to slopes adding additional nails as needed to secure the land and prevent dangerous situations.

Each robot can navigate in response to to sensor data streaming from each submerged sensor as well as from remote observation equipment that studies the entire area. Humans interact with the robots remotely to avoid potential landslide areas.

Source:
http://www.rose-hulman.edu/~sutterer/EFRI/Fiberglass_launched_nails.pdf
http://www.livescience.com/ima¬geoftheday/siod_050114.html



PROPERTIES:

- Self-navigating robots equipped with seismic sensors
- 20ft by 1.5in diameter nails made of fiberglass and steel, tipped with remote sensors
- Remote scanning equipment

FUNCTION:

- Robots navigate slopes to stabilize conditions, using sensors and remote scanning
- Nails are injected into the earth to prevent layers from sheering
- Nail sensors provide data

Environment: Erosion

BacterialCement

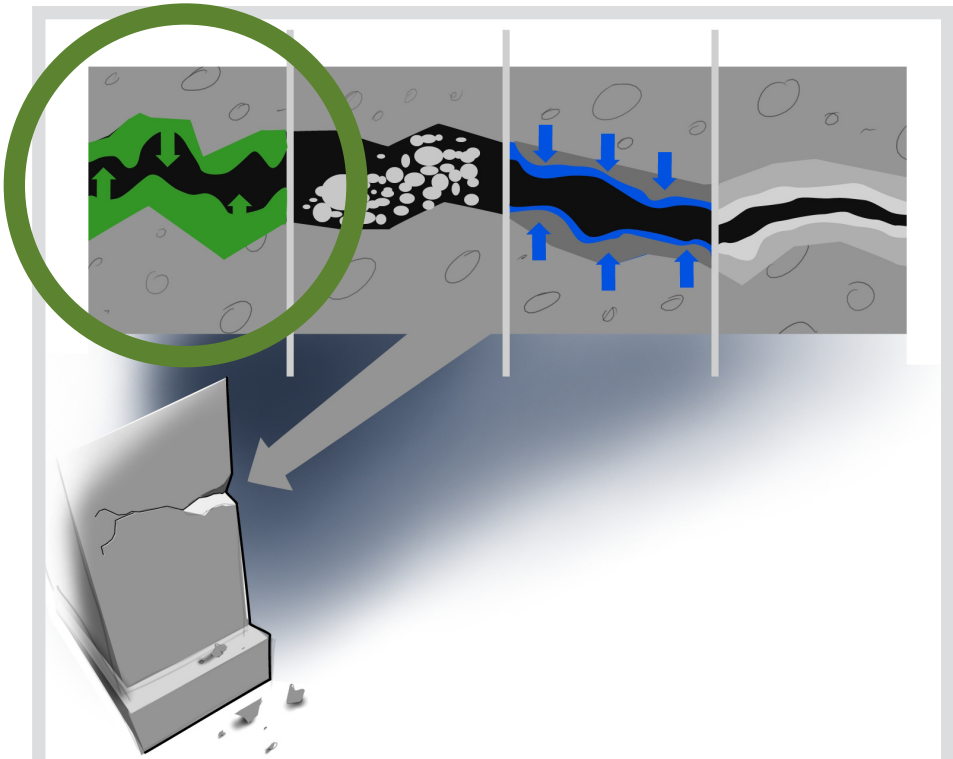
Self-healing cement through microbiologically-enhanced crack remediation. Bacteria immobilized in a polyurethane sheet precipitate calcite, which causes early cracks in cement to heal.

Concrete is by far the most used material in building throughout the world. Concrete is good in compression, but not so stable in tension so steel is used to reinforce concrete so that it can be used as a structural component. Many times concrete cracks and water can seep through the cracks. The water seeping through the cracks oxidizes the steel reinforcements and the strength of the structure begins to deteriorate. Soon afterwards, the concrete structure begins to crumble around the cracks and maintenance is required to keep the structure in place.

Currently, extra steel is used to mitigate the effects of cracking in cement, but that is costly. The bacteria Bacilus Pasteurii is known for its ability to produce a layer of calcite above another layer and is currently being researched by a team at The Delft University in Netherlands and in the South Dakota School of Mines & Technology.

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

http://reu.sdsmt.edu/projects/projects_2003.htmlbrary/pdf/ff-piu018.pdf



PROPERTIES:

- Self-healing cement matrix
- Embedded bacteria (Bacilus pasteurii) precipitate calcite

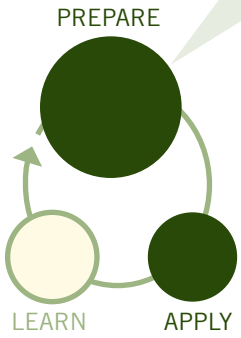
FUNCTION:

- Bacteria precipitate calcite which seals cracks in cement
- Stronger structure with less maintenance
- More efficient use of steel

System Elements
Bridge Collapse

Environment: Transportation

Efforts to maintain thoroughfares and distribution networks are important during wetter weather events. Bridges, in particular, are vulnerable when swift river waters scour the foundation and make bridges collapse. Bridge jams can also cause flooding upstream by blocking water flow and downstream when the jam ultimately breaks up.



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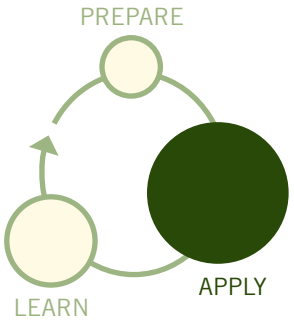

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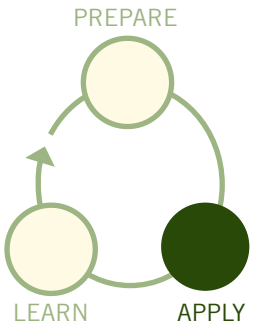

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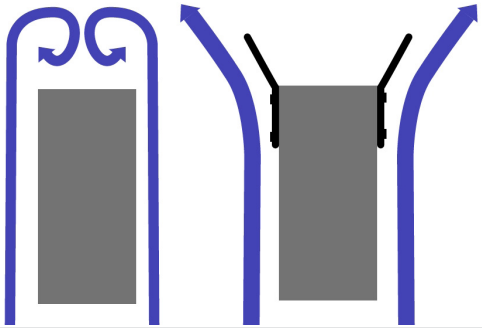
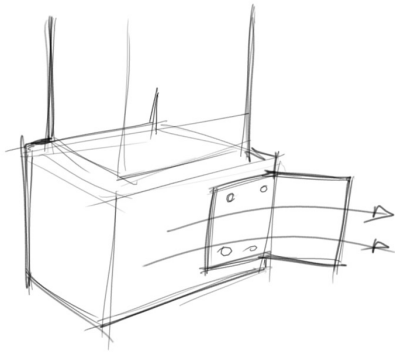
Environment: Transportation





PROPERTIES:

- A device that attaches to current bridge supports
- Reinforced plastic water foil

FUNCTION:

- Prevents "scour" under bridge foundations
- Redirects water flow around bridge foundations
- Allows bridges to remain stable, especially during flood conditions

BridgeCollapse

In a wetter world flooding will become more commonplace and transportation across bridges will likely become more hazardous due to unsafe bridge structures. Flood waters increase damage to bridges by undercutting bridge supports.

"Scour is the hole left behind when sediment (sand and rocks) is washed away from the bottom of a river. Although scour may occur at any time, scour action is especially strong during floods. Swiftly flowing water has more energy than calm water to lift and carry sediment down river... If sediment, or rock on which bridge supports rest is scoured by a river, the bridge could become unsafe for travel."

The BridgeCollapse attaches to existing bridge supports and pushes water down stream of the supports eliminating eddies that help create scour. The BridgeCollapse can be fastened to all types of bridge supports and would be less expensive than repair efforts.

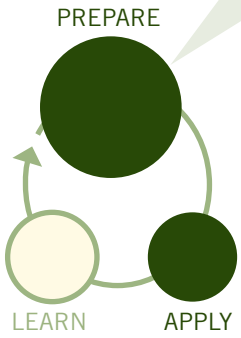
Because floods also increase the likelihood of foreign material in waterways, the Bridge Collapse could be extended (and made into a wedge) upstream of the bridge support to lessen bridge support damage. The chance that foreign river material(s) strikes or becomes stuck against the bridge support would be reduced.

Source: http://ma.water.usgs.gov/publications/ofr/scour.htm
http://ttap.colostate.edu/Library/MISC/USDA%209877%201207%20SDTDC.pdf

Environment:
Water Management

Water is a great natural resource that comes with wetter weather. Where in some cities it will grow hotter and drier, some areas will experience heavier precipitation events. Preventing flood damage from excess water runoff and collecting water for distribution are important themes in managing water flow.

System Elements
WaterWalls
Artifical Glaciers
Networked Ponds



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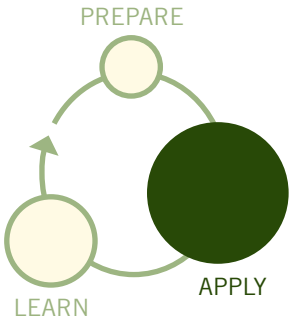

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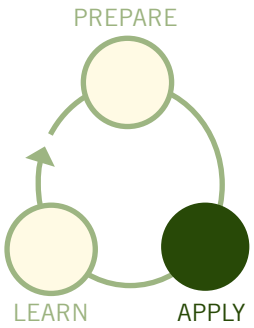

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Environment: Water Management

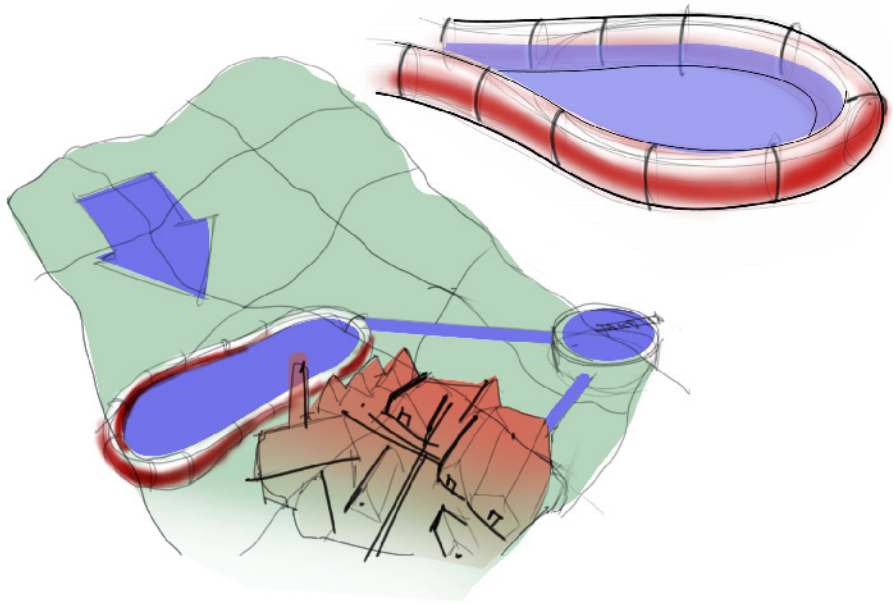
WaterWall

In a wetter world flash floods will be more common. Reducing infrastructure damage related to flooding will become increasingly more important. The WaterWall can be used to route and hold excess water until it can be managed by existing water treatment facilities.

In the event of excess water flow WaterWalls will be deployed along contour lines to first guide and then hold water in designated safe locations. At first, excess water is diverted into the WaterWalls, creating solid barriers. Those barriers are positioned strategically to route continuing flows into containment and prevent additional infrastructure damage.

Once the excess flows have stabilized, water can be pumped out of the temporary containment areas and back into the treatment facilities. To prevent the spread of water-borne disease the tubes are coated in anti-microbial solution.

Source: http://www.aquabarrier.com/index.html
http://www.oil-control-systems.nl/nl/roulunds/rm-water-barrier.php



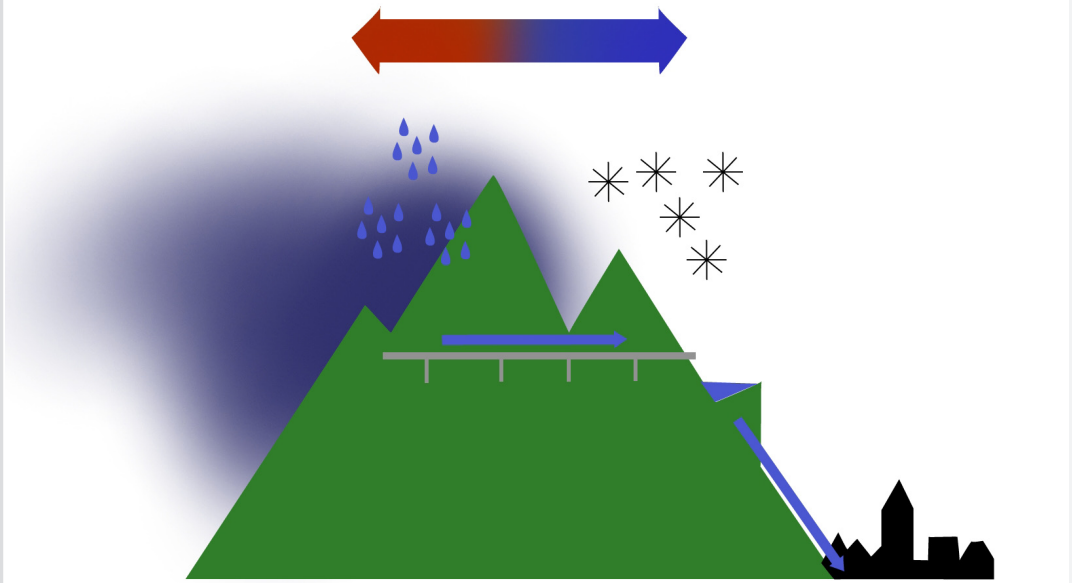
PROPERTIES:

- 8ft diameter, 50ft length vinyl tubes, puncture proof
- Sealable or quick connect ends that allow linking multiple lengths
- Anti-Microbial coating

FUNCTION:

- Can be linked to hold great amounts of water both internally and in creating ponds
- The tubes are unrolled, easily dispersed and filled
- Tubes set along contour lines for routing and collection

Environment: Water Management



PROPERTIES:

- Metal pipelines that circumnavigate a hillside
- Higher elevations, colder temperatures and shade

FUNCTION:

- Collection and release of water built up through collected, then frozen rain, occurring on opposite sides of a hill
- Manages and makes available existing water resources

Artificial Glaciers

In an effort to store water without the creation of specialized holding tanks, this technique uses a network of pipes to capture and channel precious snow-melt that would otherwise be wasted. This collection can later be accessed, preventing flooding and maintaining consistent water supply.

First, water from an existing stream is diverted through iron pipes to a shady area of the valley. From there, the water was made to flow out onto a sloping hill at regular intervals along the mountain slope. Small stone embankments impede the flow of water, creating shallow pools. During the winter, as temperatures drop steadily, the water in these small pools freezes. Once this cycle has been repeated over many weeks, a thick sheet of ice forms, resembling a long, thin glacier

There are several advantages of an artificial glacier over a natural one. To start with, it's closer to the area of need and at a comparatively lower altitude. Natural glaciers, on the other hand, are located way up in the mountains and they melt slowly in summer, releasing water to the villages quite late. Early water release from an artificial glacier comes as a bonus for farmers. It enables them to get water a whole month before the snow starts melting on the mountain tops.

The largest artificial glacier built so far is about 1,000 feet long, 150 feet wide, and four feet deep, it supplies irrigation water to a village of around 700 people. The cost was about a tenth of what a reservoir with similar storage capacity would have been.

Source: http://www.infochangeindia.org/WaterResourceIstory.jsp?section_idv=17&storyofchangev=WaterResourceIstory.jsp

Environment: Water Management

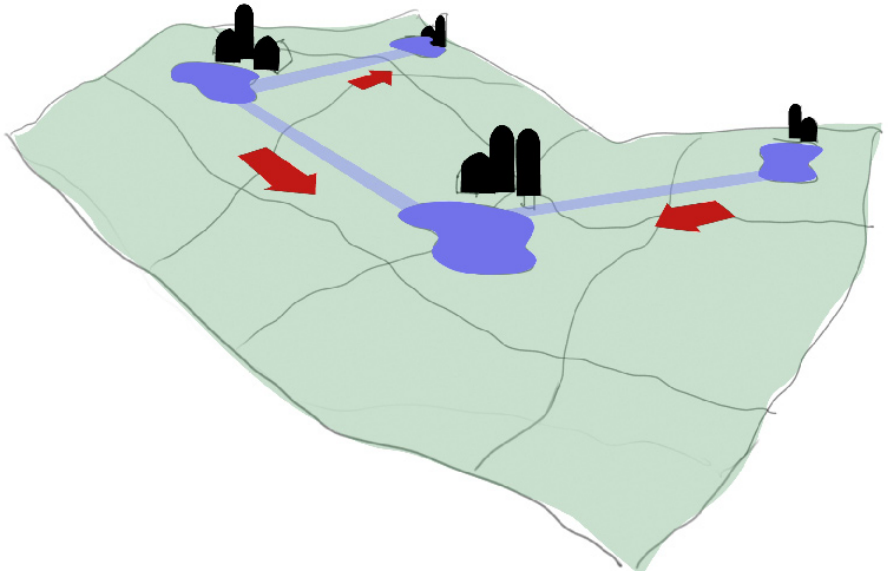
Networked Ponds

Wetter weather in unorganized agricultural regions can strip valuable topsoil from the earth, limiting future production. Instead of creating a large and costly central reservoir system a network of interconnected ponds can be created to lessen damages caused by swiftly and uncontrolled moving water, and actually contain and utilize water resources in a more systematic manner.

The ponds are carefully linked and created by analyzing contour lines which define capacity and balance needs. The ponds help control erosion by limiting the speed of runoff water, simply by routing excess flows into ponds earlier. As weather patterns shift, the network of ponds could easily adjust to match needed capacity.

This is a community based approach to water management relying on the cooperation of the community to maintain and share collections. The ponds are currently in use in agricultural regions of India.

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



PROPERTIES:

- Interconnected ponds, about one pond every 2 hectares
- Outflow trenches connect each pond
- Pumps used for ancillary movement and routing

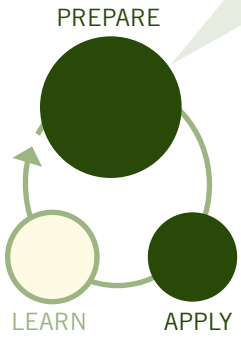
FUNCTION:

- Move excess water to ponds outside affected areas
- With pumps water can be moved into other networks
- Slows run-off and reduces erosion

Environment: Agriculture

Farms will need to adapt to changing weather in their regions. Changes in the climate will affect where and which crops are grown. In addition, carefully managing the crop growth so it is not affected by excessive water runoff is critical for sustainability. Adaptive solutions in how farms are designed are vital to reduce crop damage and continue growth.

System Elements
Future Farm
Vertical Farming
Raised Beds
Dynamic Crops
Air Foil WIndbreaks



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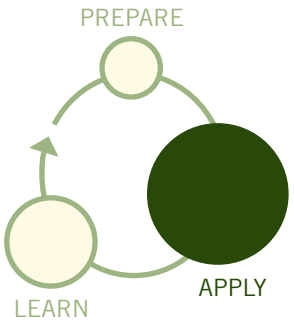

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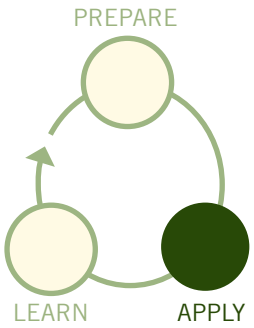

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Environment: Agriculture

Vertical Farming

It will be increasingly difficult to manage agricultural output due to unpredictable weather conditions. While steps can be taken on existing farmland to temper and harness harsh weather, Vertical Farming will produce needed food stocks in carefully controlled indoor climates, that are not susceptible to a wetter world. Great for urban centers where space is at a premium, these farms can be established to supplement existing agricultural output and provide food stocks directly to densely populated areas.

The vertical farm would eliminate agricultural runoff, reduce the use of fossil fuels used in crop production, make use of abandoned or unused properties, offer the possibility of sustainability for urban centers, convert black and gray water to drinking water, and add energy back to the grid via methane generation that it recycles from restaurant waste. The vertical farm would also reduces the risk of infection from crop related agents and help return existing farmland to nature, helping to restore ecosystem functions and services.

Source: http://www.verticalfarm.com/designs.htm

"The Living Tower" by Pierre Sartoux
www.verticalfarm.com

PROPERTIES:

- Advanced indoor structures that house bed farming
- Sustainable systems that rely on alternative energies to run production equipment

FUNCTION:

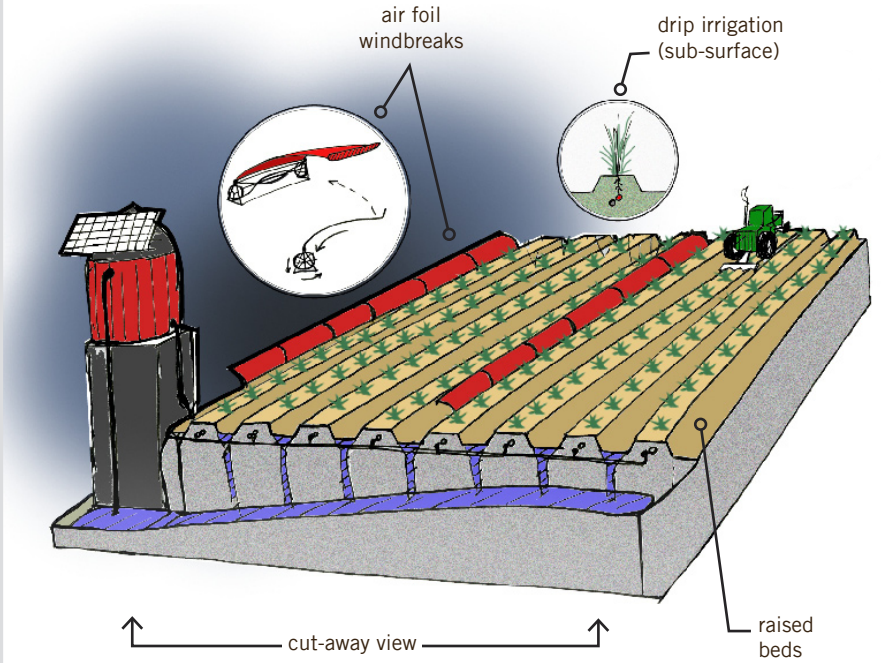
- Year-round production, no weather related crop failure
- Eliminates agricultural runoff
- Reduces use of fossil fuels related to operating farm machines and transport of crops

Environment: Agriculture

Future Farm

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

Solutions are both speculative and existing, combining technologies that will make it possible to preserve and even improved crop yields in highly variable weather conditions.



PROPERTIES:

- Raised crop beds
- Sub-surface drip irrigation systems
- Genetically modified crops

FUNCTION:

- Maintains soil's nutrients for long-term productivity
- Channels runoff and reduces soil erosion
- Increases yields

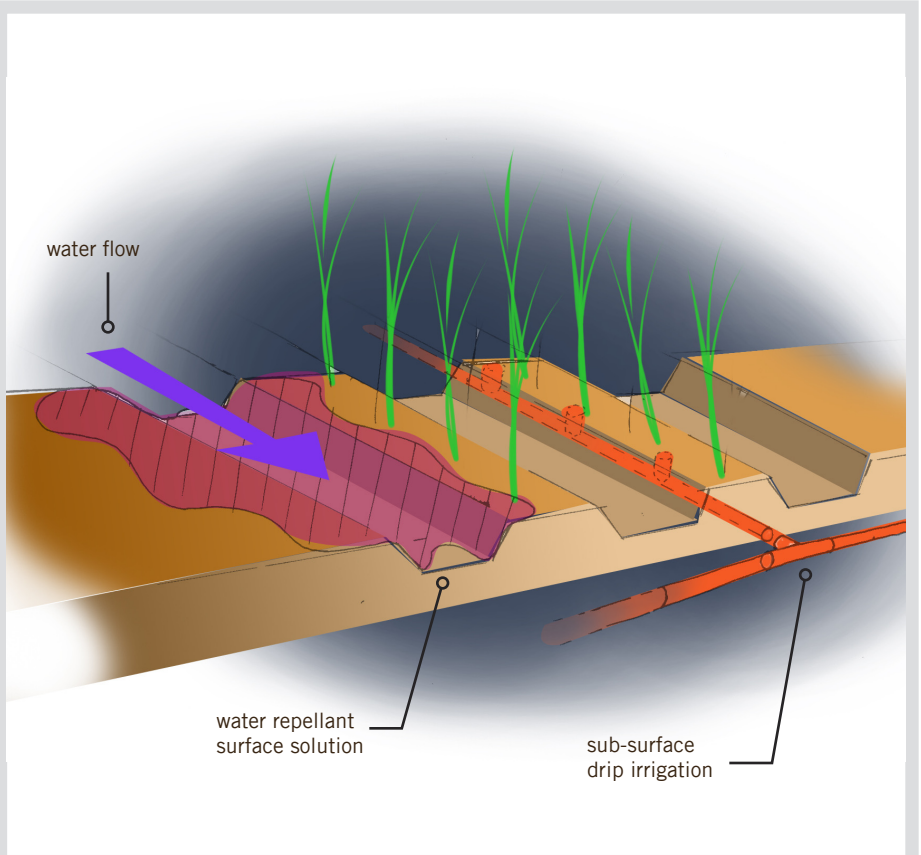
Environment: Agriculture

Future Farm: Raised Beds

Raised bed farming allows for greater precision in managing crop production. By positioning crops higher and in more carefully organized soil formations, the right balance of nutrients and protection can be achieved.

At the same time it allows for easier channeling of excess water off fields into localized containment. Adding a rain repellent surface solution reduces the crops chance of being over watered. By protecting the surface of the fields, sub-surface drip irrigation systems can deliver the precise amount of needed water to each plant allowing water resources to be maximized. Farm equipment is currently available to practice raised bed techniques.

Source: http://www.samd.com.au/



PROPERTIES:

- Raised crop beds
- Water repellent sprayed surface solution.
- Sub-surface drip irrigation systems

FUNCTION:

- Maintains soil's nutrients for long-term productivity
- Channels runoff and reduces soil erosion
- Increases yields
- Reduces water demand

Environment: Agriculture

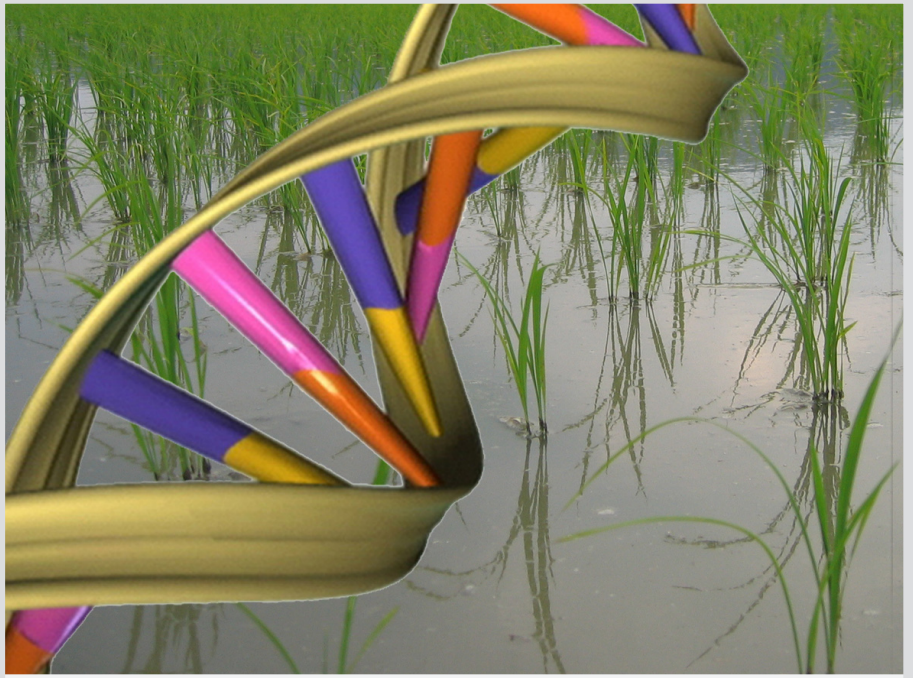
Future Farm: Dynamic Crops

Engineering crops to withstand new harsher conditions is a significant step in preventing crop loss. Using genetically modified crops that continue to grow during heavy rains and even flooding, is one way to preserve output. Strains of rice have already been shown to perform well even when submerged for periods of time. Developing more resilient varieties will help maintain needed food supplies.

At the same time introducing new forms of pest and fungal control can be used in place of harsh chemicals to not only protect and salvage water damaged yields, but prevent contamination of ground water and surrounding lands.

Source: http://www.asiaweek.com/asiaweek/97/0905/cs1.html
http://query.nytimes.com/gst/fullpage.html?sec=health&res=9C0CEFDE113DF933A25754C0A966958260

http://www.cas.psu.edu/docs/biosecurity/EMERGENCY/FloodCrop.html



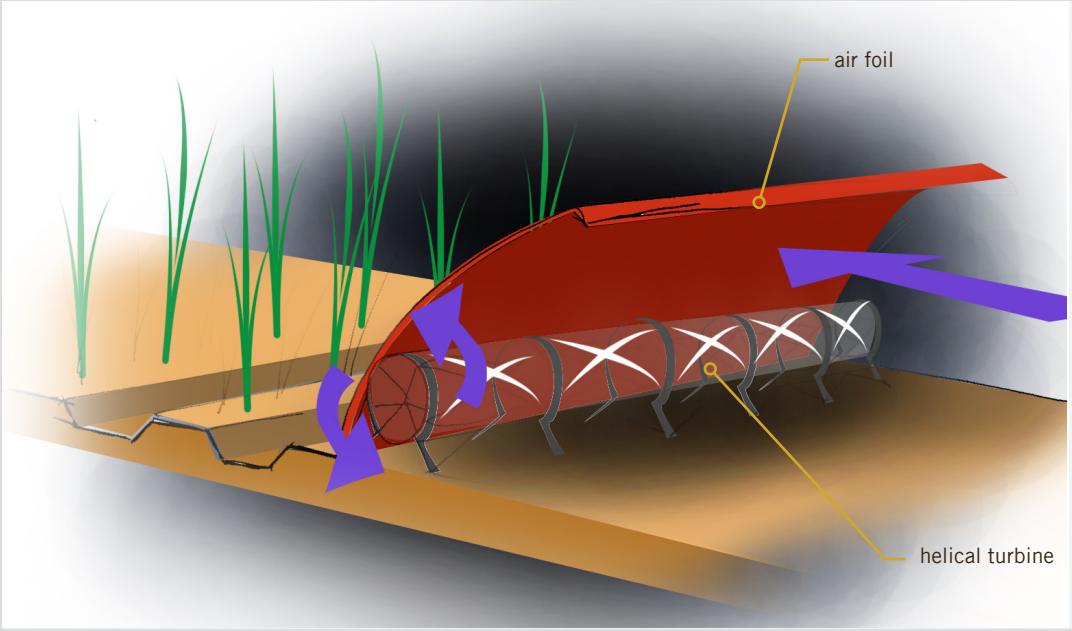
PROPERTIES:

- Genetically modified crops
- Mass-produced pest-killing insects and parasites

FUNCTION:

- Crops resist and even thrive in variable wet weather
- Microorganisms kill or suppress other microbes, weeds, fungi and insects preserving yields

Environment: Agriculture



PROPERTIES:

- Airfoils with incorporated helical turbines
- Energy storage facilities

FUNCTION:

- Prevent winds from damaging crops
- Prevents wind erosion of soil
- Uses winds to provide energy for farm systems

Future Farm: Airfoil Windbreaks

Farmers have used natural windbreaks to protect crops from winds for years. In a wetter world, winds will come with greater intensity and with greater variability. To protect crops and harvest the new wind resources, incorporating helical wind turbines into airfoils provides a possible solution.

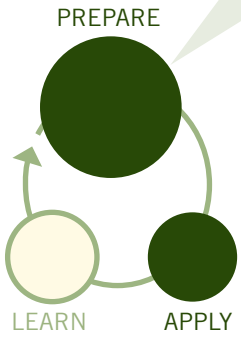
Deployed on the edges and even within the crop beds the wind-breaks catch damaging winds, routing them into the turbines, and disperse the winds safely. The breaks also help in controlling wind erosion which might otherwise carry away valuable topsoil.

Source: http://ohioline.osu.edu/for-fact/002-3.html

Communicate
Danger & Response

Education and awareness of wetter weather events will be even more important in the future. Ways to communicate internationally as well as to children, youth, adults will all require different methods. Inspired by the military's use of simulation software, we hope this can become a more mainstream solution in the future that is both interactive and educational in demonstrating the effects of climate change before they actually happen.

System Elements
Disaster Icon Language
Climate Change Game



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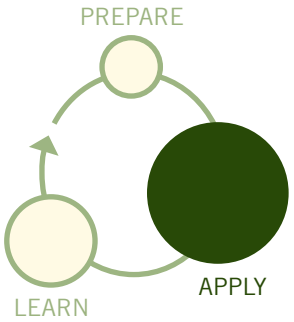

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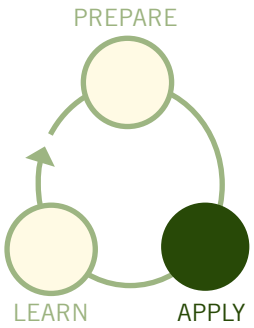

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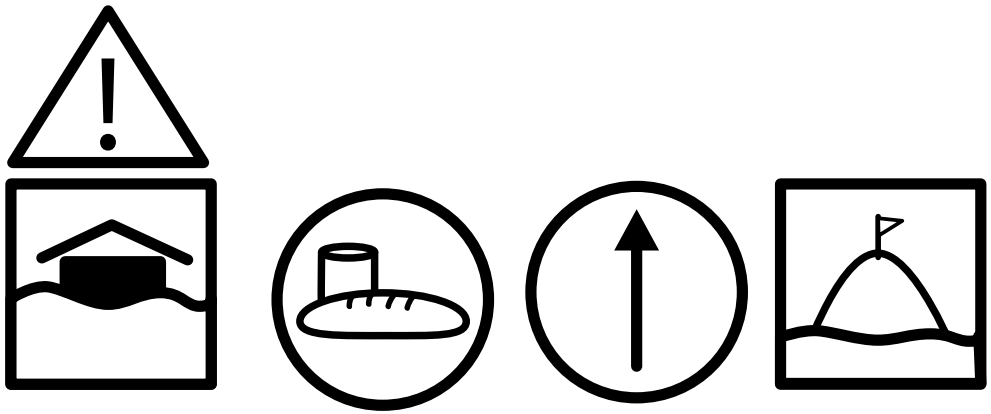
Communicate Danger & Response



Danger!
Flood coming

Gather rations

climb

high ground

PROPERTIES:

- Library of symbols and icons
- Parse natural language text
- A visual "grammar"
- Computer program to visually concatenate the icons

FUNCTION:

- Instructions without concern for language differences
- Easily ported to other platforms
- Visual chunks easily interpretted by people in disaster situation

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.

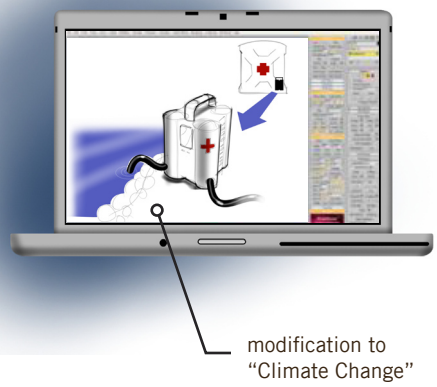
Because of the simple visual language, resolution of media could be low and transmitted at low bandwidth and in print. It would also be so easily interpretted by people, that converting the message from the visual, back into the local language would be a simple task for anyone who might have to serve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

Imagine: The day after a powerful flood in Mississippi, an international team of rescue workers converges on the scene to find that the residents are all on their roofs with stockpiles of food enough to last them weeks. Few people are absent. Those who are missing are being located already by the townspeople.

"How did you all know what to do?" ask the volunteers. "We all got text messages that looked like this." (see above)

The rescue coordinators had used the Disaster Icon Language to signal the danger to all of the local residents. They had all interpreted the icons and headed for high ground when they recieved the message via sms. *Source: www.pictogrammar.com*

Communicate Danger & Response



downloading “mods” for Climate Change

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

Currently, there is little consumer friendly simulation software that can help people learn about the effects of climate change. Though models exist, they usually don’t link the effects with the direct consequences in a community, city, or town.

Leveraging the creativity of the gaming community to imagine tools and simulate disaster effects can be a more interactive educational tool. The Armed Forces has been using simulation software since the 1970s with the introduction of the game “Mech War”. The Armed Forces continues to invest in military training that is interactive and example-based, shifting from abstract reasoning to something more concrete.

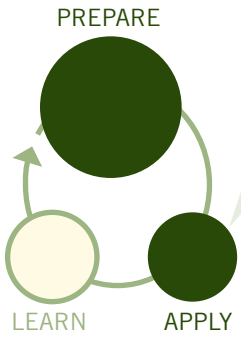
In addition to the strategic importance of simulation-based learning used in the military, software games like Halo are used as a platform by producing versions for PC players. These versions can be modified with provisional toolkits, such as the Halo Custom Edition tool kit to generate and input user content into the game.

Source:
http://en.wikipedia.org/wiki/Mod_%28computer_gaming%29
http://en.wikipedia.org/wiki/Halo_(video_game_series)
http://www.educause.edu/ir/li¬brary/pdf/ffpiu018.pdf

Securing Utilities

System Elements
Power Display
Lighting Harvester

Though wetter weather certainly brings a premonition of catastrophe, there are positive effects of wetter weather that we can learn to harness. Lightning, wind, and air are all natural effects of extreme weather, all of which can be used as potential resources for energy. In addition, these resources can be set up so they are distributed and shared among towns and cities. It's remarkable how much energy is available that we have not yet tapped.



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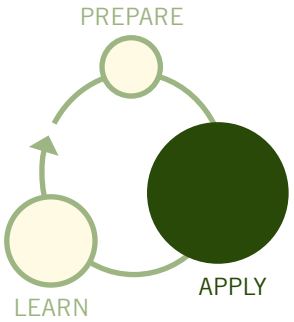

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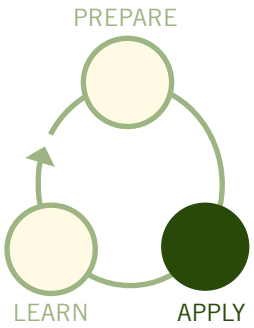

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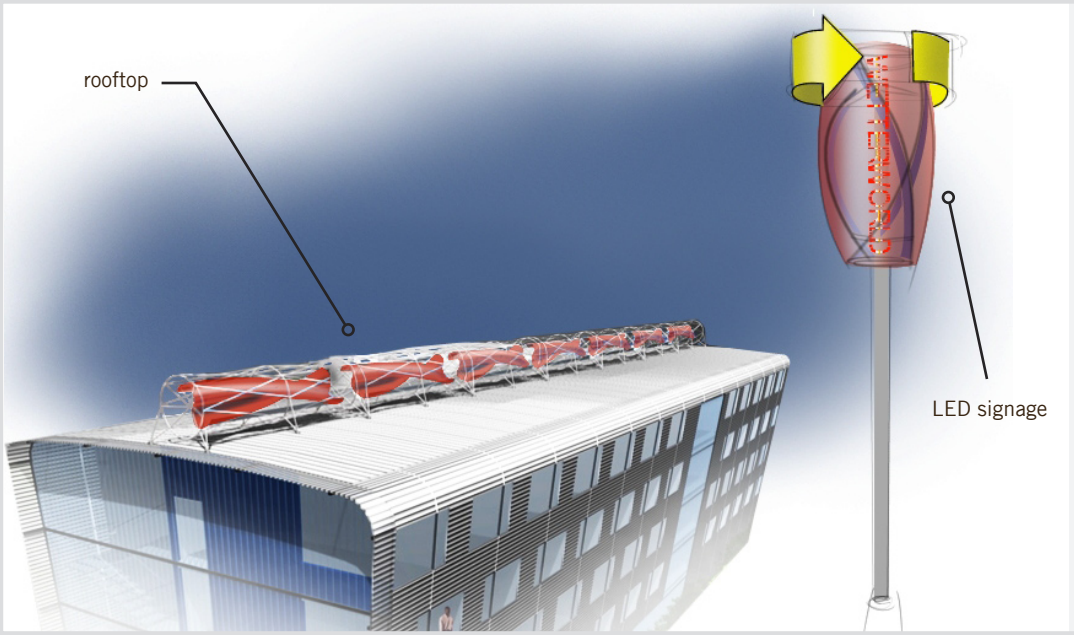
Securing Utilities



PROPERTIES:

- Helical “aeroturbine” technology
- Programmable LED “persistence of vision” blades

FUNCTION:

- Provides energy in stormy weather
- Efficient wind energy production in an urban settings
- Quiet wind energy generation
- Displays programmable in real time

Power Display

The PowerDisplay is an array of helical “aeroturbines” that generate electricity from wind and use LED’s coordinated using a “Persistance 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.

Already in use in a few notable sites such as Chicago’s Near North SRO building designed by Helmut Jahn, “aeroturbines” are a flexible, quiet, city-friendly means of harnessing the wind energy.

By converting the aeroturbines into a dynamic display, it would be possible to display important information in times of emergency and less critical things on a daily basis. Possible application include advertisements, informational displays and art installations. At the very least, they represent the possibility of off the grid advertisement and architectural lighting in windy regions.

Source: http://www.aerotecture.com/

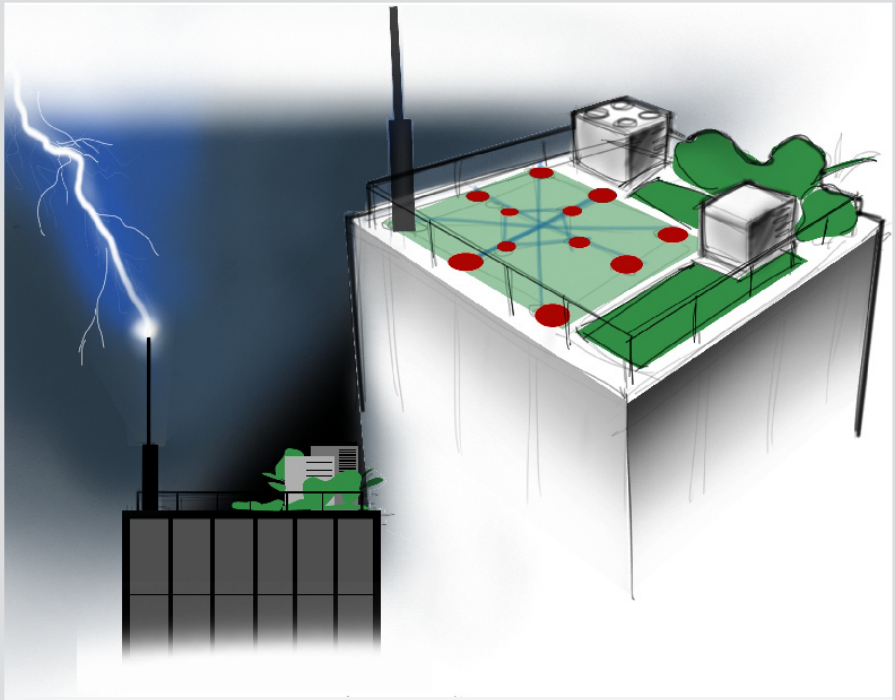
Securing Utilities

Lightning Harvester

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 recieve per year. The electricity would be stored in new utility-scale bateries and converted to AC as it was dispersed.

The average lightning bolt contains approximately one million kilowatts (1,000,000 kW) of electrical energy, and lightning strike towers work by 'harvesting' this atmospheric electrical energy and converting a portion of it into usable electricity. The average office building uses 66,000 KW of energy per year. The tallest office buildings recieve 50-90 lightning strikes per year. Even if the LightningHarvester were only able to capture 1/100 of the energy from each lightning strike to a building, and the building only recieved 40 strikes per year, it could still provide 8 times of the power that the building needs per year. If it only captured 1/1000 of the lightning, LightningHarvester could power it for almost 10 months of the year on lightning alone. On top of the pure energy benefits, the LightningHarvester could be the value add that could put green-roof technology into the mainstream.

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



PROPERTIES:

- Lightning rod installed in a green roof
- Web of conductors to collect the current
- Utility scale batery to store very large amounts of energy
- Alternator to convert DC-AC

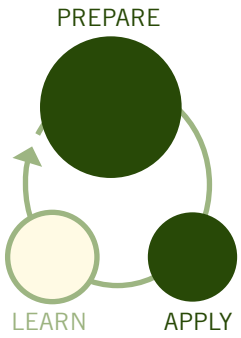
FUNCTION:

- Channel electricity into a green roof buffer
- Collect portion of the energy into a storage aparatus
- Integrate with power grid
- Enhance value of green roofs

Medical Care

System Elements
Personal Locator
Super Ambulance
Hospital Cube System
Ozone Sanitizer
WaterClean
Digitaized Medical History

When disaster happens, it will be critical to mobilize first responses like medical care. A mobile health unit that is inexpensive and portable is the theme of this next section. What if we could ship out hospitals via FedEx within a day? Enabling immediate medical response will prevent the loss of lives during the first critical hours of a disaster. As a supplement to current medical care strategies, this can amplify the help available in catastrophic situations.



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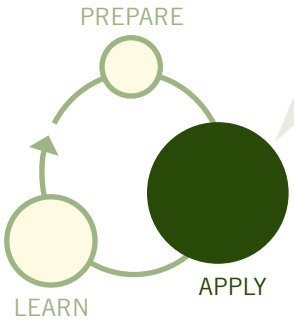

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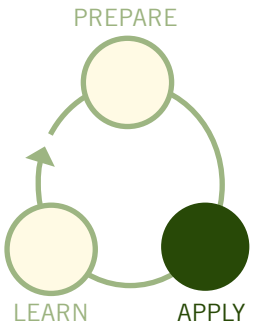

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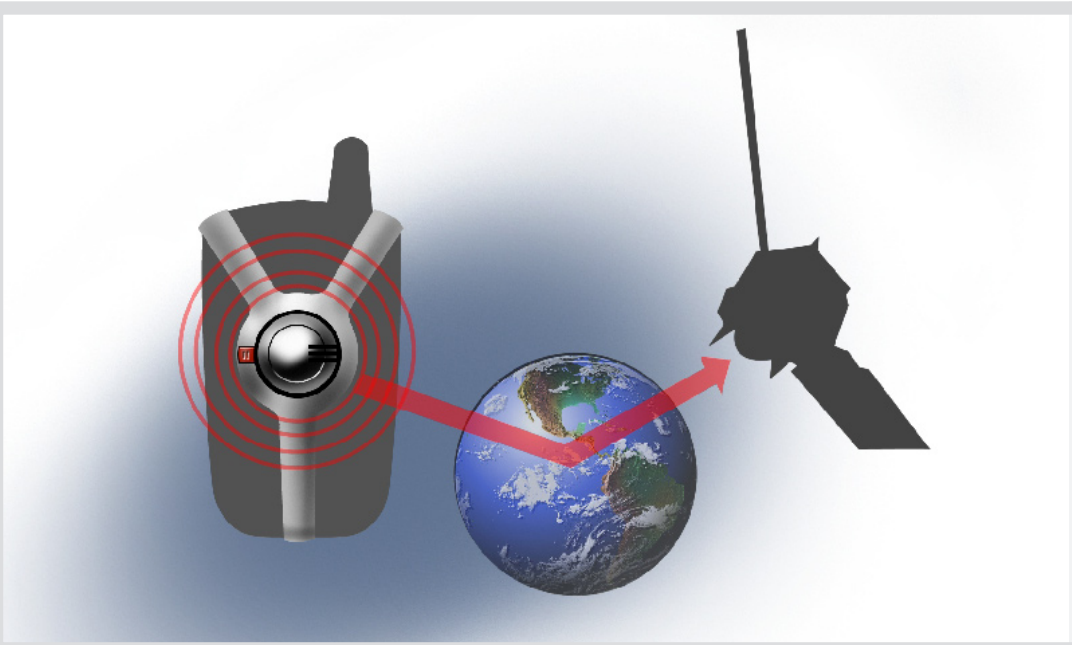
Medical Care



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

In the event of wet weather disasters it is important to be able to locate victims before situations become dire and even more so during the height of a disaster. Using cell phones as a means to locate victims works becasue individuals use their phones as a primary means of communication on a daily basis. Augmenting the service with a GPS locator will help disaster aid workers execute search and rescue operations. Additionally, as cell phone use increases it becomes an even more useful tool for locating victims.

However, not all phones are currently equipped with GPS capabilities making the precise location of a user unknown, especially when cell phone systems are damaged.

The Personal Locator allows any phone to be used as a GPS locator in the event of a disaster. The device is a flexible adjustable strapping system that encircles many current cell phone models. The strapping contains a GPS locator with a long lasting power source. The Personal Locator does not interfere with existing phone operations, and draws no power until activated.

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

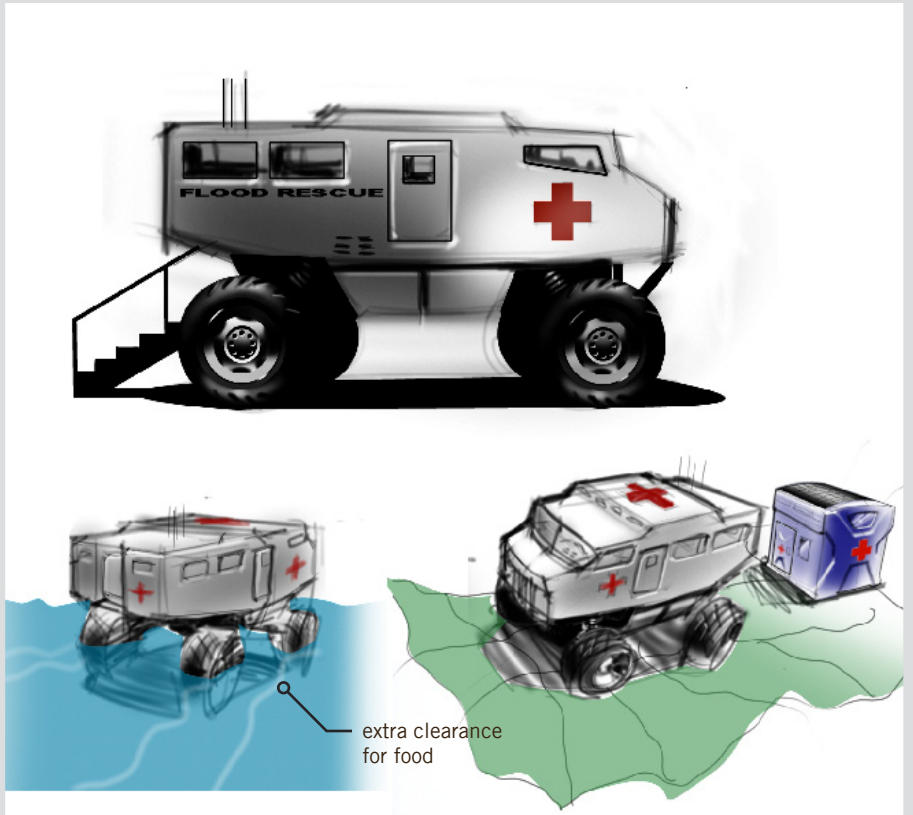
Medical Care

Super Ambulance

In wet weather disasters there will be a need to move victims quickly and safely to secure areas. At the same time these disasters often render existing transportation routes impassable, either from floods or heavy storms. Moving people to relief locations is important for providing treatment and identifying missing persons when there is still time to continue rescue operations.

The Super Ambulance is an all terrain vehicle which can travel through extreme climates securely. The vehicle is equipped with an extensive onboard medical facility - providing immediate care to victims. Additionally, MedicShelters can be carried and deployed from the vehicle, allowing medical facilities to be positioned in close proximity to victims.

Source:
http://www.mindef.gov.sg/imindef/publications/cyberpioneer/news/2006/May/05may06_news.html
http://www.greatwhitebeartours.com/vehicles.htm



PROPERTIES:

- An all terrain vehicle
- A mobile field hospital
- A delivery system for the MedicShelter

FUNCTION:

- Crosses difficult terrain
- Fords flood water
- Brings advanced care to victims
- Treats up to six victims
- Carries MedicShelters

Medical Care

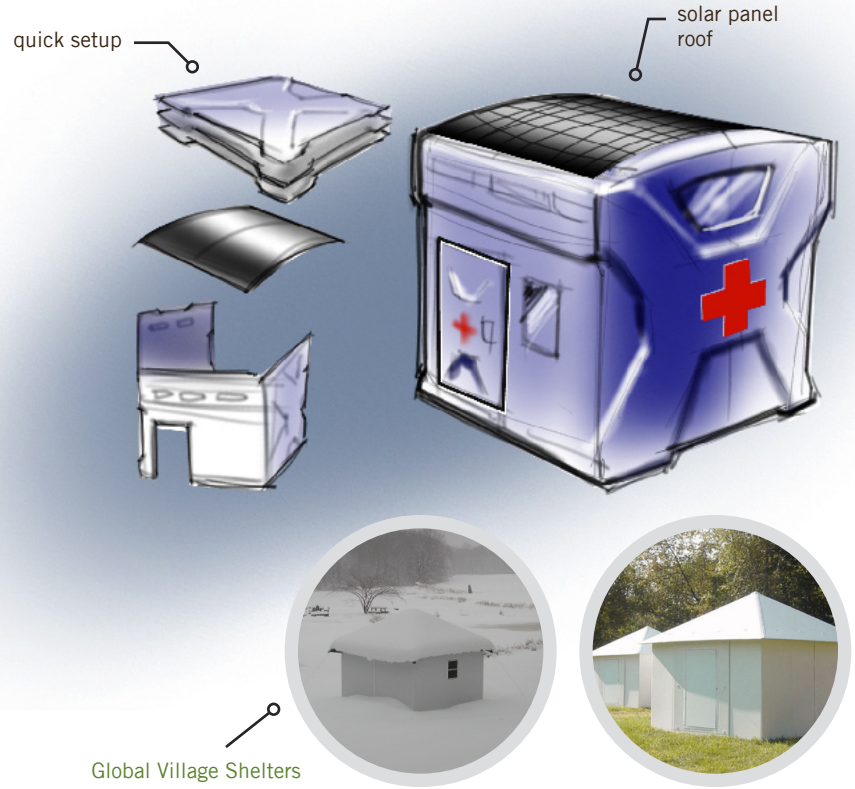
MedicShelter

During an environmental disaster, regions need to equip themselves for immediate medical relief efforts. Having full care facilities available both quickly and in close proximity to the disaster region can be a matter of life and death.

The MedicShelter combines several technologies: WaterClean, a water purification system, HandSanitizer, a water oxygenization and sanitizing system, and Digitized Personal History, identification and medical history transmission. Each technology is integrated within the fully equipped MedicShelter to provide substantial medical facilities as close to the disaster region as possible.

The MedicShelter is easily constructed from its flat pack shipping configuration. The center constructed of treated waterproof and fireproof paper composite. The majority of the shelter's energy is created from the attached solar panels. Additionally, the shelter can be configured with other MedicShelters to provide a larger facility.

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



PROPERTIES:

- Unfoldable paper structure
- Separate and light inducing roof
- Waterproof, fireproof walls
- Attachable solar panels

FUNCTION:

- Sets up in 20 minutes with 2 people
- Provides top and side protection against environment
- Portable, recyclable, and shippable packaging

Medical Care

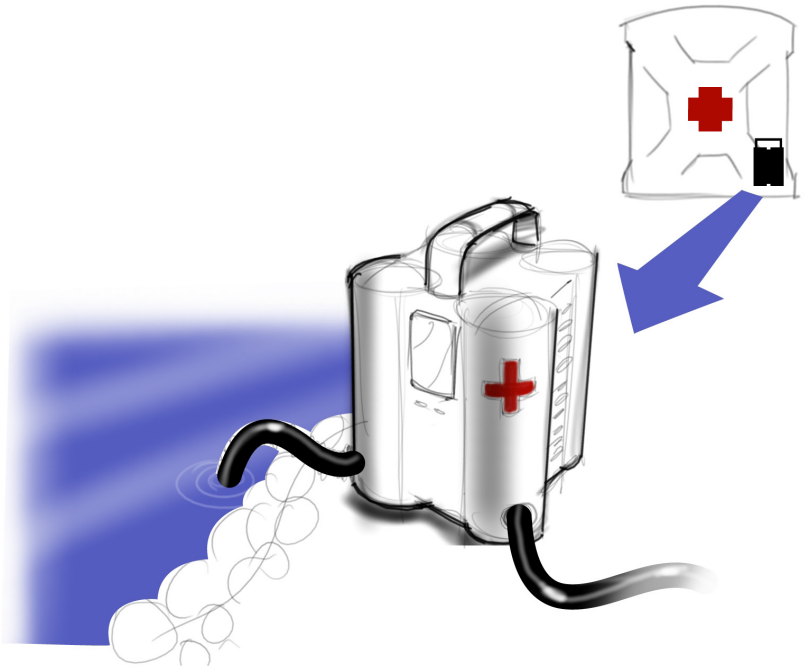
OzoneSanitizer

Maintaining clean medical care facilities during a disaster is extremely difficult, given the often large number of victims, the frantic environment and the tight work spaces.

The OzoneSanitizer provides a comprehensive mobile solution to maintaining a sterile environment. The OzoneSanitizer works by producing ozonated water, which quickly oxidizes contaminants and destroys bacteria and viruses, decomposing to natural oxygen in the process. The device can be moved within the MedicShelter to treat both people and equipment with the production of ozonated water.

The small compact device is easily applied to all tasks and provides relief workers with a Sanitizer that is natural, safe, and renewable product that gives off no undesirable by-products.

Source: http://www.pacificozone.com/default.html
http://www.uniteam.org/shelter/mobilemedicalhospital.html
http://www.ozonesafefood.com/index.htm



PROPERTIES:

- Handheld OzoneSanitizer with adjustable spray nozzle
- Fuel cell battery
- Water supply hoses with filters

FUNCTION:

- Remote sterilization for equipment and wound sites with minimal water usage.
- No harmful by-products produced

Medical Care

WaterClean

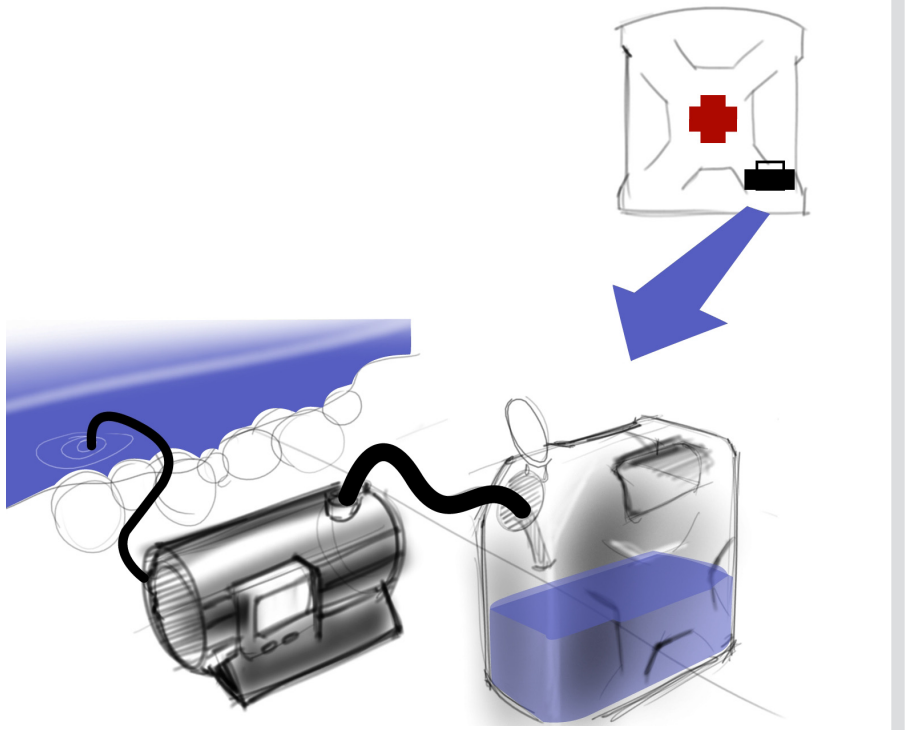
Supplying clean water for medical care during and after a disaster strike is necessary given the needs of the patients and aid workers.

While Soldis is highly effective in treating water for daily individual water consumption, a faster processing treatment system is needed in medical situations. At the same time bringing clean water into a disaster zone is often difficult given increased transportation difficulties.

WaterClean uses both UV light and a series of filters to decontaminate water quickly. The system can operate on solar power generated from the roof of the MedicShelter, or on fuel cell batteries.

Water is initially pumped into the breifcase-sized system where large particles are filtered out. Next, water is subjected to high power UV radiation, killing existing microbes, and readying water for use. While the water is awaiting application it can be held in storage while WaterClean continues to process water.

Source: http://www.tersano.com/lws-info.shtml
http://firstwaterinc.com/products.html



PROPERTIES:

- UV light water filtration system
- Solar power and fuel cell battery operation
- Input and output hoses
- Short-term local reservoir

FUNCTION:

- Produces clean usable water for treatment and hydration of aid workers and victims needing medical attention

Medical Care

PROPERTIES:

- Mailed kits with test equipment
- Kiosks that catalog a participant
- Remote data storage equipment

FUNCTION:

- Collects and secures personal data for use during disaster relief
- Transmits information to rescuers and medical personnel to aid identification and treatment in remote locations

Digitized Personal History

Providing the best medical care could be improved if victims' health information was readily available to response teams. This requires communities to store health and identification information. By instituting a triple coverage system of facial, fingerprint, and DNA identification aid workers as well as families can quickly begin to know where people are and how to treat them.

This solution suggests using a combination of three or single means of collecting identification information. First, a mailing where a participant receives a kit in which to send in a picture, blood sample, and fingerprint information to a secure processing plant. Another method is outreach through schools, where children influence adults to come into schools and become cataloged. Lastly, kiosks could be used at remote locations that require no operator to upload information to a secure and remote location. In all cases information is secure and unavailable until needed a disaster situation.

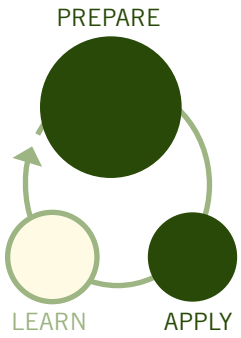
During a disaster specific information can be transmitted to an existing medical facility or to a MedicShelter for aid in treatment or identification. Medical information is withheld until a positive identification occurs. Outside of obligation to the community, financial incentives or damages could be attached to the process to increase compliance.

Source: http://www.cdc.gov/niosh/docs/2004-144/chap4.html#notes32to38

Prioritizing Aid

System Elements
Citizen Science
Flood Craft

Coordinating aid can be a cumbersome and overwhelming task. Especially when there are resources who wish to help, but don't exactly know what to do. Efficiencies in prioritizing aid will be even more important as more intense and frequent precipitation events occur. Tapping into citizen resources to help gather data and prioritize aid will help coordination teams diagnose and prioritize aid.



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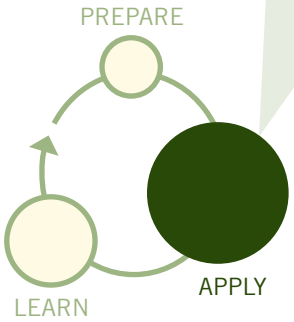

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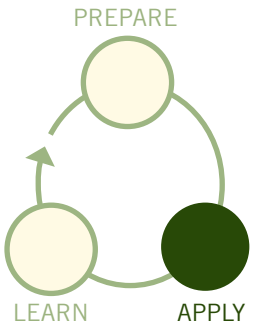

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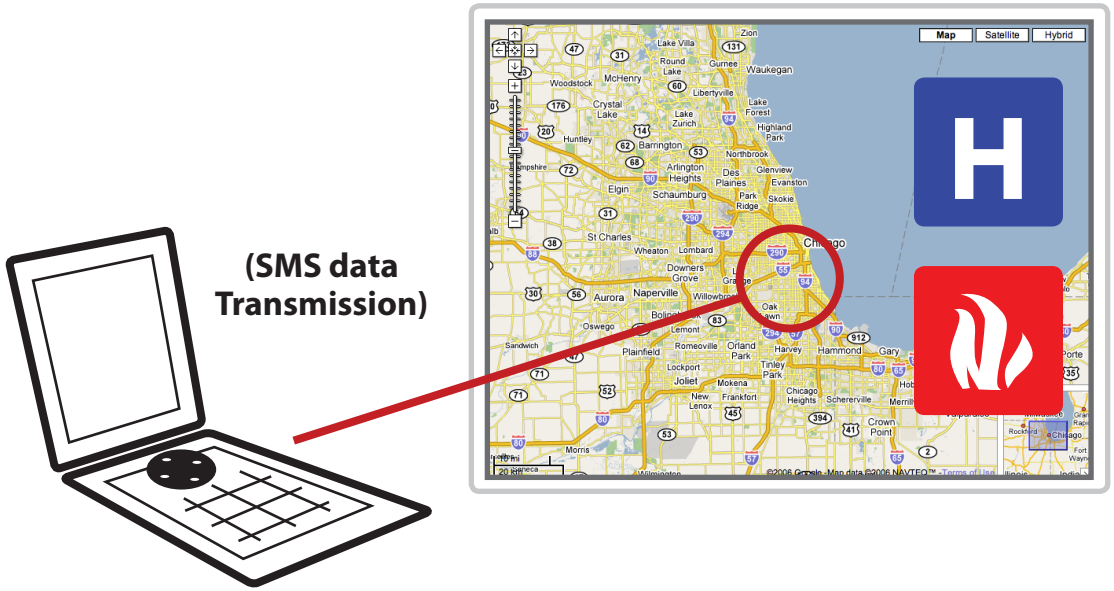
Prioritizing Aid



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

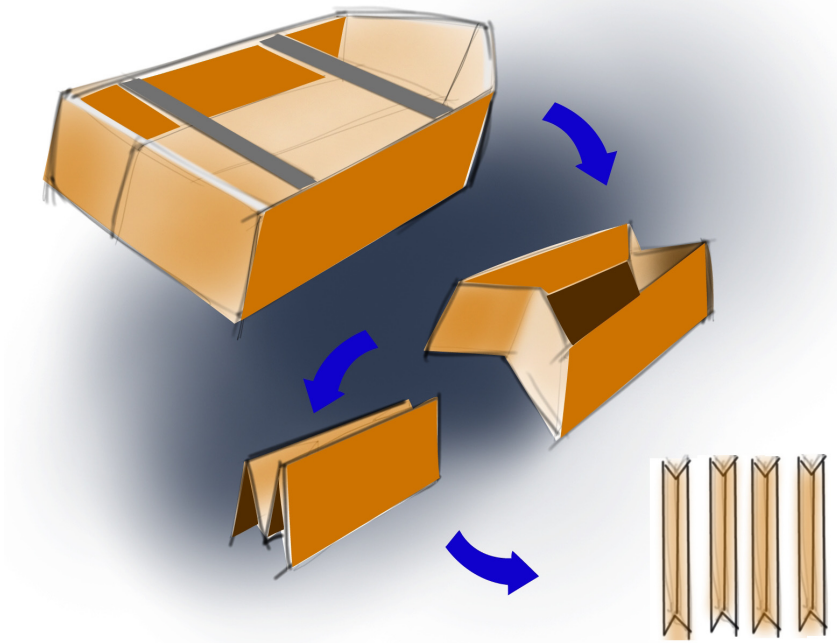
CitizenScience

System that gathers data from citizens; and then uses it to populate and route emergency response to more prone areas. Citizens can contribute either to help gather more weather-related data before a disaster and they can also use the system as a communication method during a disaster. Response coordination teams can use the data to help them prioritize the type of disaster occuring in various areas.

Leveraging citizens around the world to gather and collect weather data will increase in the future. As cheaper sensors are produced and more commonly available, this will help scientists studying water and air quality gather necessary information. The CitizenScience mapping tool uses SMS technology to gather information from its citizens through a procedural workflow, especially during wetter weather events. The data is gathered and stored in a shared database which is then placed on a map to show where the data points are coming from.

Source:
http://ocha.unog.ch/virtualosocc/(jyjybefdczbrws55mbv0lw55)/VOLogin.aspx

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

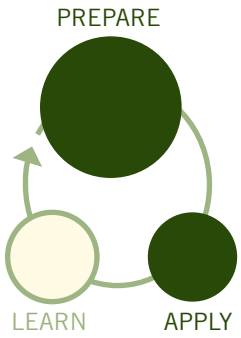
During flood disasters flotation devices are not always readily available for evacuation of victims. At the same time personal flotation devices, while keeping one afloat, do not protect against debris and water borne disease. Having community Flood Craft readily available will not only prevent drowning,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

System Elements
Self-Healing Power Grid

Securing Utilities

Securing utilities during a disaster event can create a backup plan to generate electricity when the main grid is down. Distributed energy sources that adapt and self-heal will provide a better way for communities to respond to disaster. Especially as one of the common problems when disaster strikes is the loss of light.



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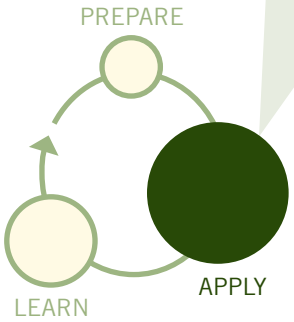

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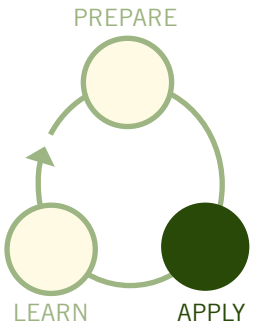

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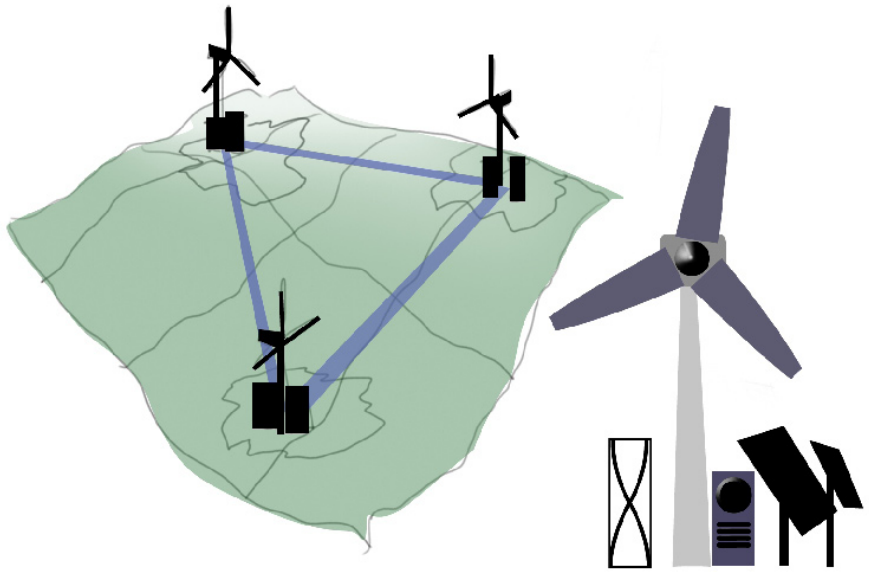
Securing Utilities

Common Currents

Common Currents is a self-healing power grid based on a co-op network of community based power generation sites that utilize renewable energy generation technologies to create a distributed energy grid that can respondrapidly to regional outages. By incorporating a wide variety of renewable technologies, the system alows the flexibility that communities need to harness the energy afforded by the natural resources of a region. The technology would be designed to operate above capacity during a storm to save energy in using devices such as batteries, flywheels, and using the potential energy of water pumped up into cisterns. The excess energy could be stored or sold back to the power grid. The co-op would exist as a seperate legal entity and members could profit from the sale of excess energy.

Rather than implement renewable energy technologies in isolation, there is opportunity to use emerging smart-grid and net metering technology to rapidly assess the contribution of each node and adjust distribution and billing accordingly. A co-operative is a democratically controlled business enterprise. Members work together to meet their individual and collective needs. Each member has a say in how the business is run. This implementation would also foster acceptance of renewables in general by making it a revenue stream rather than an additional cost.

Source: www.windshare.com

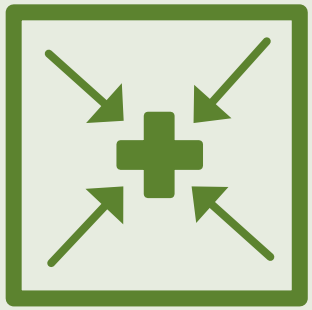


PROPERTIES:

- Selection “Wizard” for choosing the optimal mix of power solutions for a region
- Energy storage technologies such as utility batteries
- “Net metering” and Smart-grid technology

FUNCTION:

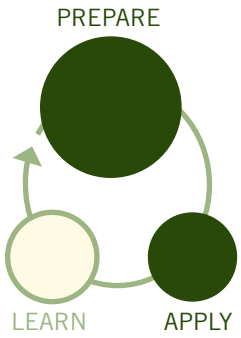
- Provide uninterrupted source of energy
- Increase acceptance of renewable energy
- Strengthen communities through resource sharing



System Elements
Super-Hub

Gathering Equipment & Materials

Climate change is a world problem. We will depend on networks to provide adaptive solutions in case of wetter weather disasters. No single town will have all the capacity to deal with catastrophic events, but we can enable the mutual aid of regions and towns with resources, equipment, and volunteers to help mitigate loss and help communities recover faster.



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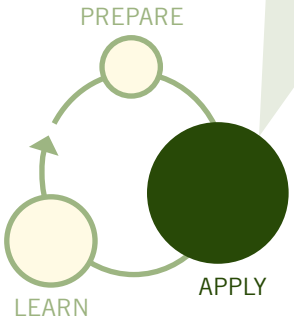

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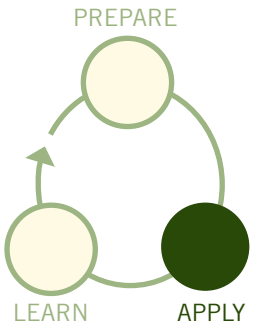

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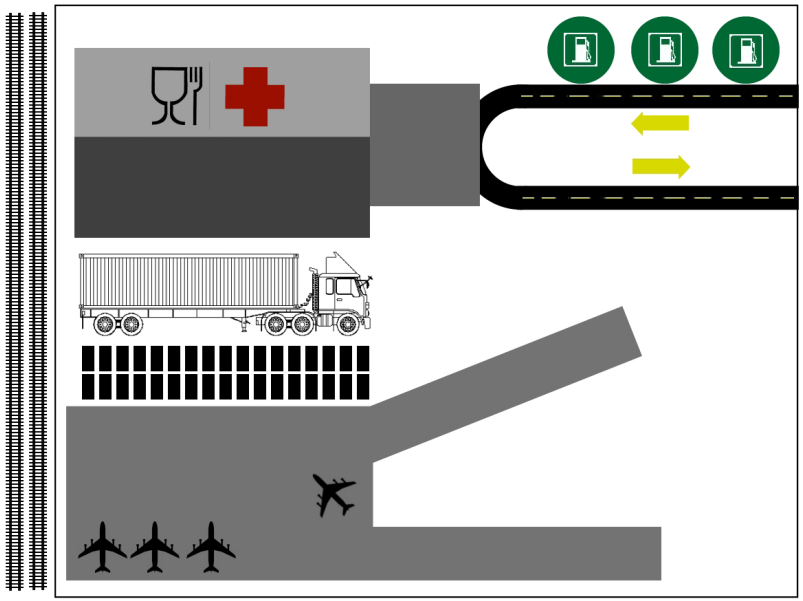
Gathering Equipment & Materials



PROPERTIES:

- Networked warehouse system
- RFID tagging with just-in-time processing equipment
- Motor pool and shipping docks with repair and maintenance staff

FUNCTION:

- Collects, organizes and ships, physical disaster relief resources
- Checks, catalogs and maintains equipment, restocks critical items

Super Hub

The super hub is a networked warehousing system storing disaster relief and infrastructure repair resources. A single facility organizes and allows for rapid fulfillment of disaster supplies for transportation to areas in need. The facility also maintains heavy and light equipment for use in rescue and rebuilding. Similar in many ways to a fast food drive through and airport rental car lots, the super hub has high efficiency order processing systems that reduce the decision making lags that could prevent critical supplies and equipment from reaching victims.

At the same time the system reduces the size of its inventory by sharing resources amongst several other strategically located networked locations. Together the network maintains and organizes

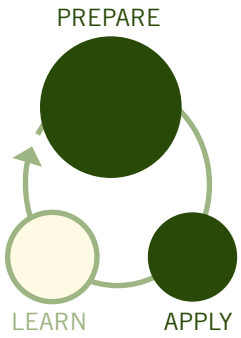
supplies for all types of disasters. The system also manages stocks of critical items and handles reordering when necessary. The system can take input from a variety of sources, ultimately taking order requests from the victims themselves who input exactly what they need via SMS submissions. The reliance on victim ordering assures all stakeholders that victims are getting what they need and without wasted quantities. As the system organizes an increasing number of responses to disaster, it will be able to forecast needs and supply resources even more quickly.

Source: http://www.rentalbooking.com/acc.html

System Elements
Roll-out Roads

Environment: Transportation

Efforts to maintain thoroughfares and distribution networks are important during wetter weather events. Roads, in particular, can be destroyed and the thoroughfare is disabled. Adaptive solutions that patch roads as they become damaged can help maintain movement.



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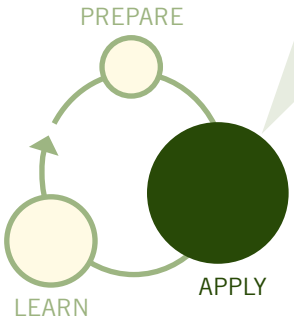

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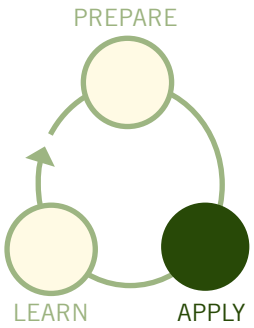

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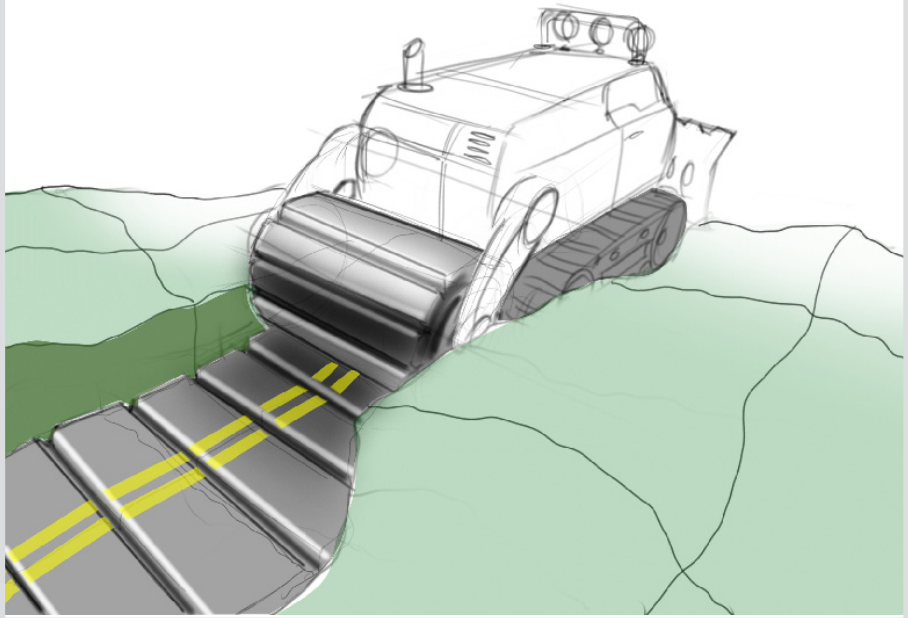
Environment: Transportation

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.

Roads are positioned based on a real-time analysis of accessible transportation routes. Roads can either be laid on top of existing surfaces or generated in places where roads previously did not exist. The system uses interconnected GPS systems to both establish new roads, and also to route relief vehicles and equipment more efficiently given available means.

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
- GPS coordinating support

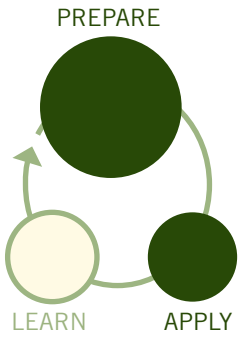
FUNCTION:

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

Communicate Danger & Response

System Elements
Concrete Displays

Communicating danger during a disaster will help mitigate panic and psychological effects of disasters. In addition, it can help organize the chaos disaster brings. Robust communication methods will help establish protocols for disaster evacuation, communicate with those concerned, and aid those in coordinating relief efforts.



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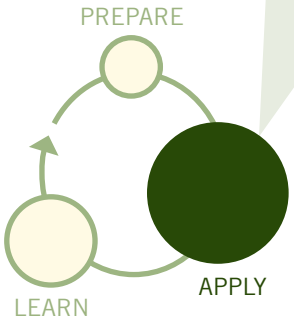

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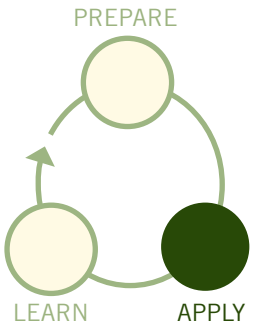

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Communicate Danger & Response

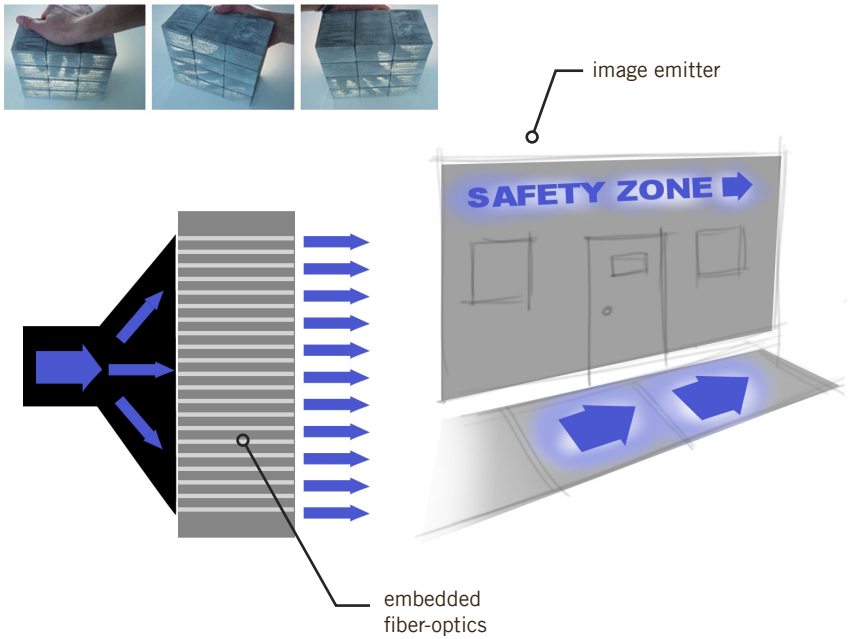
Concrete Displays

In the event of a wetter weather ,disaster, one of the biggest problems is communication. This stems from the chaos of the situation and damage to the information infrastructure. The problem extends to even the most basic information, including escape routes, street names and navigation info. If street signs are knocked down in a strong storm, as they often are, then resucuers can have a hard time finding the victims they are seeking.

The ConcreteDisplays utilize fiber optics embedded in new transparent concrete developed at the Innovation Lab in Denmark to project images from the inside out. Transparent concrete could be installed in building facades as well as in the street surface itself and important navigational information could be routed to them.

This would be especially useful for directing traffic. If installed in an interstate highway, the directional signage could be switched to direct all lanes out of town for an evacuation. Integrated with a region wide information system like the EarthModeler, real time safety information could be easily and reliably transmitted due to the robust nature of these displays.

Source: http://www.innovationlab.net/sw22811.asp



PROPERTIES:

- Transparent concrete installation
- Imbedded fiber optic display
- Networked city directional signage

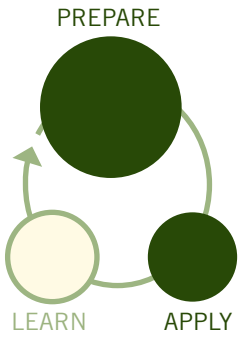
FUNCTION:

- Allows real-time update of routing
- preserves signage in storms

Managing Secondary Disasters

Managing secondary disasters will be necessary to prevent disease and help communities on the road to recovery and rehabilitation. Safeguarding and distributing potable water and controling disease expansion will mitigate the second-order effects of wetter weather events.

System Elements
Mold Prevention
WaterSafe Board
Insect Natural Predator



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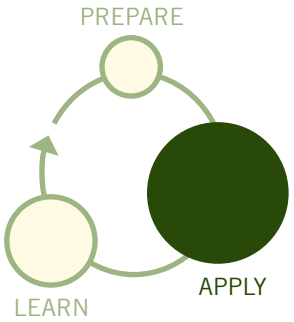

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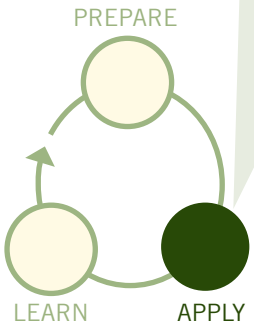

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Managing Secondary Disasters

DeltaDry

Recently the building industry has taken a different track in dealing with mold; instead of a remediation strategy, the industry is looking at ways to prevent it from occurring. Damages from mold happen when the environment is humid; mold damages walls, floor, and personal property like photographs and other documents.

Building restrictions nowadays are creating more airtight structures which prevent buildings from "breathing" properly. This, in effect, creates a better environment for mold to grow in.

One solution is to deal with how houses are wrapped and create a weather-resistant barrier that allows interior and exterior water to dry out, thus preventing a humid environment for mold to grow in. The Delta-Dry system manages moisture through the interior and exterior to protect the wall cavity from moisture.

Source:
http://www.buildingonline.com/news/viewnews.pl?id=5292
http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2006/09/09/HOG53L0DUU1.DTL

PROPERTIES:

- Impermeable membrane made out of high-density polyethylene
- Protective weather-resistant barrier
- Double-sided dimple structure of the membrane

FUNCTION:

- Provides two-sided drainage through dimple and groove design
- Protects building from water intrusion
- Allows water vapor from interior to escape

Managing Secondary Disasters

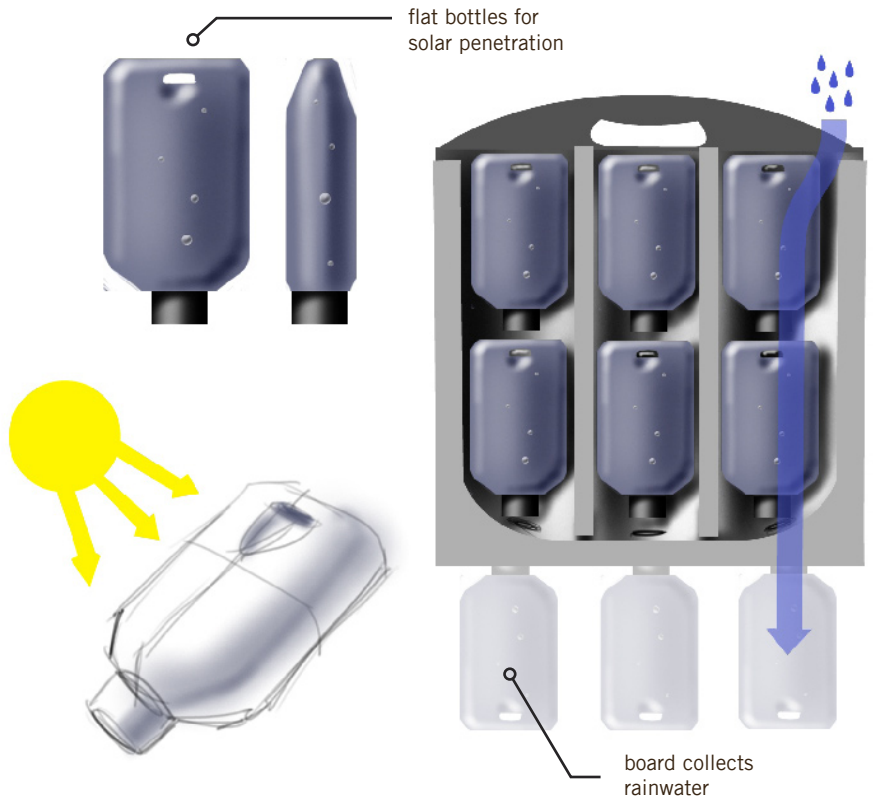
WaterSafe Board

"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. Most importantly, this type of water disinfection can be maintained easily by local populations long after disaster aid has pulled out.

Using the simple concept of Sodis the water safe board organizes and speeds Sodis. Water is treated by subjecting the included clear plastic water bottles to sunlight over several hours; in normal light conditions 6 hours are required. The board is designed to house several bottles and allow for easy transport and movement of the water to high sun areas. The board is designed to be placed on low level roof-tops for maximum exposure to the sun. The board also utilizes heat trapping materials to help raise the water temperature – reducing the overall disinfection time. The board also comes with visual instructions on how to properly decontaminate water.

Should sunlight be an issue Solar disinfection can still take place, albeit over a maximum 48 hours. When raining the board serves a dual purpose as a rainwater collector, by attaching bottles to the bottom of the board.

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



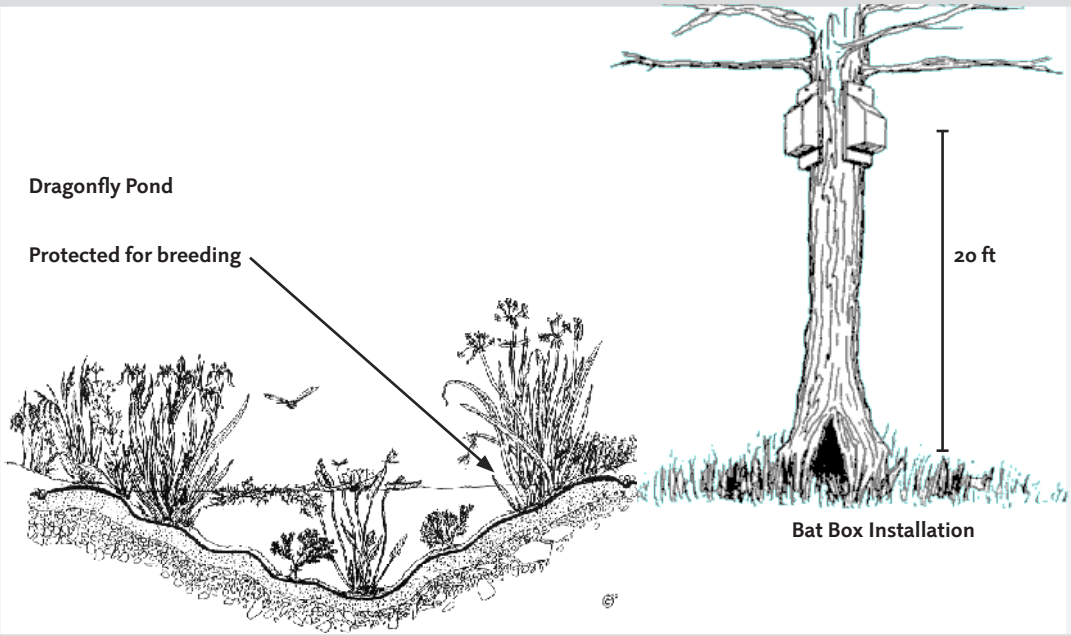
PROPERTIES:

- Lightweight plastic board with heat trapping coating
- Supports rainwater collection
- Clear PET semi-flexible durable plastic containers

FUNCTION:

- Provides a stable and heat attractive surface for positioning containers for Sodis
- Hangers/handles allow containers to be moved easily

Managing Secondary Disasters



PROPERTIES:

- Introduction of natural mosquito predators
- Bat boxes and dragonfly friendly ponds where needed
- All-natural garlic repellant

FUNCTION:

- Control mosquito population full-time
- Reduce number of disease-carrying insects

MosquitoNet

The association between mosquitoes and disease was very real in the early days of mosquito control. As recently as 1880, 20,000 lives were lost to malaria in the Mississippi River Valley, and malaria was endemic in the Tennessee Valley.

Henry R. Rupp, U.S. Environmental Protection Agency

The MosquitoNet takes a lesson from Integrated Mosquito Management (IMM), but improves upon it in a number of ways. The problem with standard IMM is that it uses a number of environmentally damaging techniques, namely habitat destruction and insecticides. Also, it is often a reactionary measure. Rather than wait for a rise in mosquito population, the MosquitoNet aims to control the population of disease spreading insects before an outbreak occurs. It also employs environmentally benign measures rather than some of the destructive or chemical solutions that are common

place today. This includes bio-control with natural predators such as larvae-eating fish, dragonflies and bats as well as natural active repellants specifically garlic concentrate. The mosquito net creates ideal habitat for the predators, allowing them to thrive and consume the pests. This includes bat boxes and dragonfly friendly ponds which must be sheltered with plant growth and permanent. Because mosquitoes are so resilient, the natural predatores need help establishing themselves.

source: http://www.cdc.gov/ncidod/eid/vol7no4/rupp_letter.htm; http://www.dragonflysoc.org.uk/

CONCLUSION

ADAPTING TO WETTER WEATHER

In conclusion, we should support the efforts to mitigate carbon dioxide levels along with adaptive solutions to future climate change. The effects of global warming are already in action. Even at current levels, we will see the effects of climate change in the next 50 years. The solutions presented here are in addition to other toolsets that are available to manage disaster or mitigate the effects or more severe and frequent precipitation events. .

Our primary focus on the project was to create a system of solutions that would help prevent the negative effects of wetter weather by looking at the lifecycle of wetter weather events. Though there are procedural solutions for dealing with disaster, not much research has been done on how to deal with natural disasters at earlier stages.

These tools should work as a system of solutions, linking together to provide a greater benefit when they are used in combination with each other. The portfolio of solutions shown here tried to touch points along the entire lifecycle of wetter weather events. They are but a small sample of the full set of solutions that can be developed in dealing with imminent climate change, but a good start to analyzing what solutions already exist and in the forefront of adaptive strategies.

Solution Map

Environment: Land Use

Environment: Water Management

Environmen: Erosion

Environment: Agriculture

Environment: Transportation

Communicate Danger & Response

Securing Utilities

Environment: Land Use

Medical Care

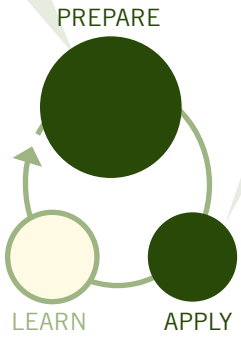
Gathering Equipment & Materials

Prioritizing Aid

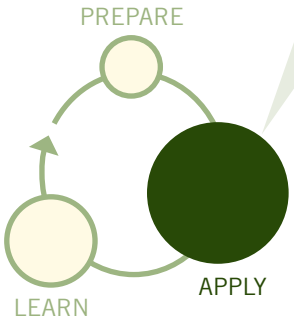
Communicate Danger & Response

Securing Utilities

Managing Secondary Disaster



(before)



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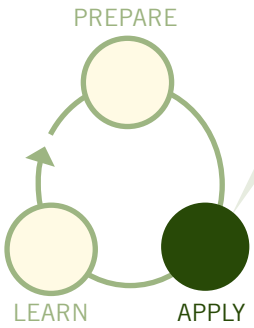

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