TIDES Overview

Introduction and Brochure

NDU Demonstration

Understanding Infrastructure

Additional Resources

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Version 2
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Introduction and Brochure

What is TIDES?

TIDES

TIDES (Transportable Infrastructures for Development and Emergency Support) is a volunteer, low cost, **research** project. The goal is to **inform interested communities** about rapidly deployable, sustainable infrastructures for use in disaster relief, stabilization and reconstruction, humanitarian assistance and refugee support. This supports DoD roles in Homeland Defense as well as the guidance in DoD Directive 3000.05 that stability operations "shall be given priority comparable to combat operations and be explicitly addressed and integrated across all DoD activities including...education."

Although DoD has legitimate interests in the TIDES area, there will be many times when DoD will not, nor should, be in the lead on these types of projects. For example, USAID's Office of U.S. Foreign Disaster Assistance (OFDA) is the lead coordinator of U.S. Government responses to disasters in foreign countries. DHS has the lead for Homeland Security contingencies within the US. In addition to USAID and DHS, other USG agencies, including the Department of State and DOD, as well as multilateral organizations, non-governmental organizations, and the private sector, also have interest in and capabilities to assist during crises.

Thus, TIDES is working to build as broad a partnership as possible with participants within the US government and with non-governmental organizations, domestic and international partners, educational institutions, businesses and private citizens. One of the primary goals of TIDES is to use collaborative, cross-domain approaches to understand how solutions can be applied more effectively in real world conditions. All information developed under TIDES will be placed in the public domain. Participation in TIDES does not imply endorsement by the US Government.

TIDES is not trying to address all problems associated with Humanitarian Assistance, Disaster Relief, Stabilization and Reconstruction, and related operations. For example, protection is a critical element – "the invisible "mortar," if you will, that holds all the assistance items together. It must be kept in mind in any planning. But this demonstration is focusing on seven infrastructures--shelter, water, power, cooking, heating/lighting/cooling, sanitation and Information and Communications Technologies (ICT). We welcome your visit to the TIDES site and encourage questions, critiques and comments.

The Problem

When disaster strikes, large numbers of people may be separated from their daily lives; their families, homes, communities and places of work. Support systems we take for granted daily – water, power, shelter, communications, sanitation – are often damaged to the point of not functioning. Stressed populations, such as refugees or war victims, also live in austere conditions, often for long periods and without protection or basic services.

Not only are many forms of support and assistance desperately needed, but the local leaders and outside relief organizations often have no physical structures to work from, no infrastructure to sustain them, and no means to house and care for thousands of displaced individuals.

Today, "tent cities" often appear, bringing with them severe limitations. Sporadic power, unsanitary conditions, inadequately refrigerated food, limited medical facilities, and a host of other challenges face both residents and relief providers.

We can do better. We must do more.

The Need

These complex challenges will not be solved by looking at one piece of the problem at a time. Simply adding more shelters, more pipes, and more generators will not be enough.

Linkages between problems need to be considered. We must re-think many aspects of the ways that support is provided to populations in stressed environments.

What is TIDES?

TIDES is a volunteer, low cost, research effort. The goal is to inform interested communities about rapidly deployable, sustainable infrastructures for use in a wide range of human needs, including disaster relief, stabilization and reconstruction, humanitarian assistance and refugee support. TIDES is a partnership that includes participants from US Government agencies, non-governmental organizations, and educational institutions.

The effort provides a set of processes, conceptual frameworks, information, collaboration tools and other resources, made available globally via the internet.

The "Hexayurt" is a public domain low-cost sheltering system.

TIDES

TRANSPORTABLE INFRASTRUCTURES FOR DEVELOPMENT & EMERGENCY SUPPORT

Initial Points of Contact

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james.craft@usmc.mil • (703) 693-3486

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Tim Lo • National Defense University (NDU)
lot@ndu.edu • (202) 685-3046

Reference Websites

http://star-tides.net

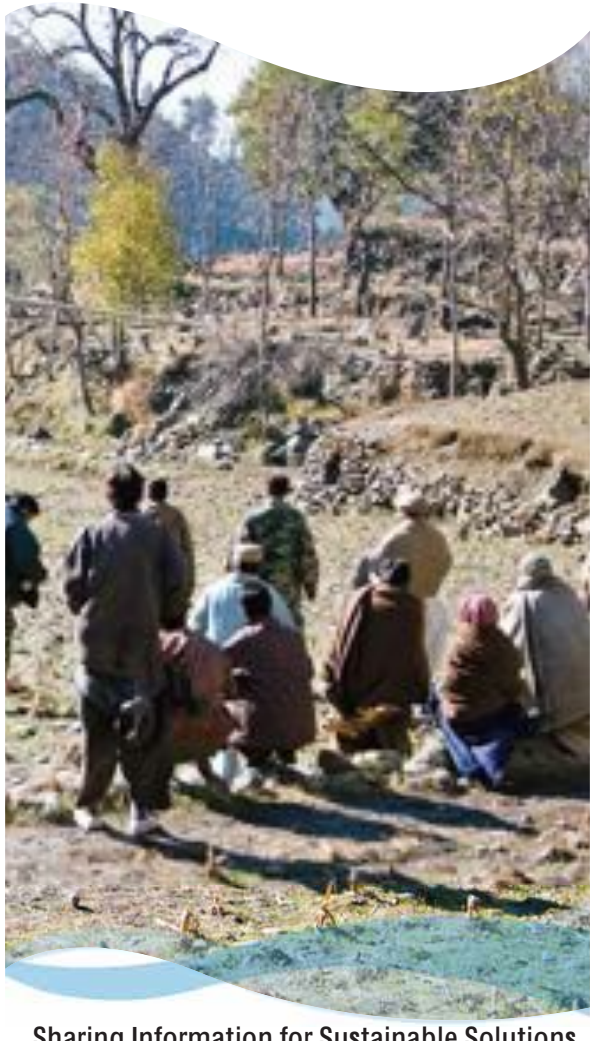
http://www.infosharehub.org/w157/index.php/Expedient_Infrastructures_for_Transient_Populations

http://appropedia.org/STAR-TIDES

TIDES Disclaimer

TIDES

TRANSPORTABLE INFRASTRUCTURES FOR DEVELOPMENT & EMERGENCY SUPPORT*



Sharing Information for Sustainable Solutions

* Formerly Expedient Infrastructure for Transient Populations (EITP)

TIDES

Sharing Information for Sustainable Solutions

Desired Capabilities

Broad
Shelter
Water
Power
Cooking
Cooling/Lighting/Heating
Sanitation
Information & Communications Technology (ICT)

Fast
Delivery
Set-Up

Agile
Multi-Use
Reconfigurable

Effective
Green
Secure
Low-Cost

The Plan

Schedule
October 2007 – Ft. McNair, National Defense University
- Prototype Demonstrations

Fall 2007 – Henderson Hall, The Pentagon
- Senior Leader Walk-Through

Winter to Spring 2008 – Extensive Exposure Testing

Summer 2008 – Golden Phoenix '08
- System Integration Exercise

Planned Teams
Strategy Development, Outreach and Integration
Facilitation and Advisory, Academic Partners, Volunteer Coordination, and Public Affairs

Solutions Development and Test Oversight
Solutions Team/Site Directors, Test Coordinators, Demo and Testing, and Proposal Pre-Screening

Follow-on
Documentation, Training, Validation, and Logistics Support Volunteers Welcome.

Procedures Include:
Infrastructures assembled in accordance with preliminary documentation.

Displays used for tests, student research from partner academic institutions and incorporation into applicable NDU courses during the first week.

Displays will then be adjusted, procedures and documentation updated, infrastructures again set up for testing and other uses.

Demonstrations Include:
9 to 10 Different Shelter Types

Simple Water Pasteurization Systems

Cooking Systems (Wood Gasification Stoves & Solar)

Solar Panels Charging Rechargeable Batteries

Cooling, Lighting, and Heating

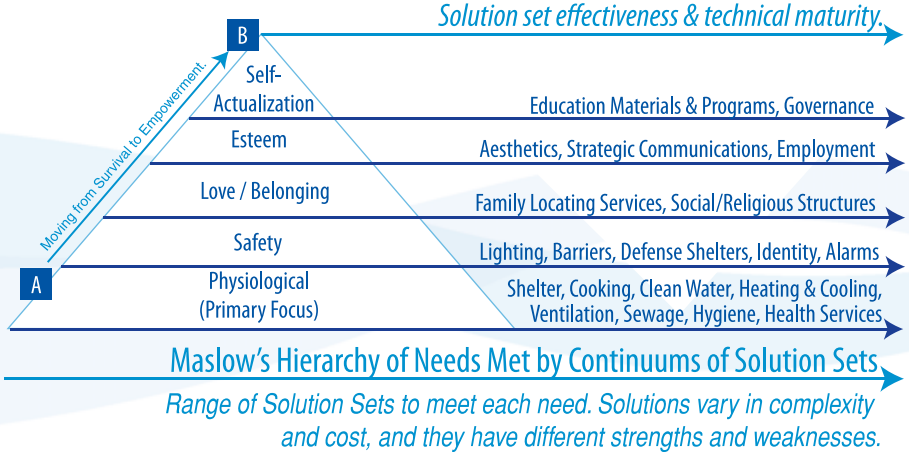
Sanitation Approaches

Rudimentary Information & Communications Technology (ICT) and Identity Management

The Way Ahead
- Validate the Concept
- Enlist Partners
- Recruit the Team
- Inspire the Innovators
- Design the Processes
- Test the Pieces
- Demonstrate the Capabilities
- Document the Procedures
- Train the Users
- Facilitate Deployment of Solutions

Initial Participating Organizations
American Red Cross, Hexayurt Project, Johns Hopkins University
National Defense University (NDU), NIUSR,
United States Marine Corps, San Diego State University

Understanding needs is not enough in a resource-constrained world. We need to understand how to meet them.



Range of Solution Sets to meet each need. Solutions vary in complexity and cost, and they have different strengths and weaknesses.

"Craft's Pyramid of Needs Fulfillment"
This diagram illustrates the concept of pairing a structural understanding of human needs with a maturing range of technologies and techniques called "solution sets." It utilizes holistic design principles to create the efficiencies and synergies between solution sets.

NDU Demonstration

Staying Alive

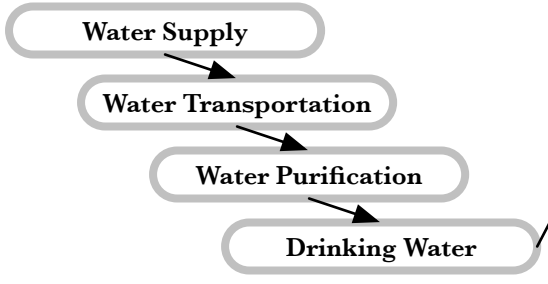
TIDES

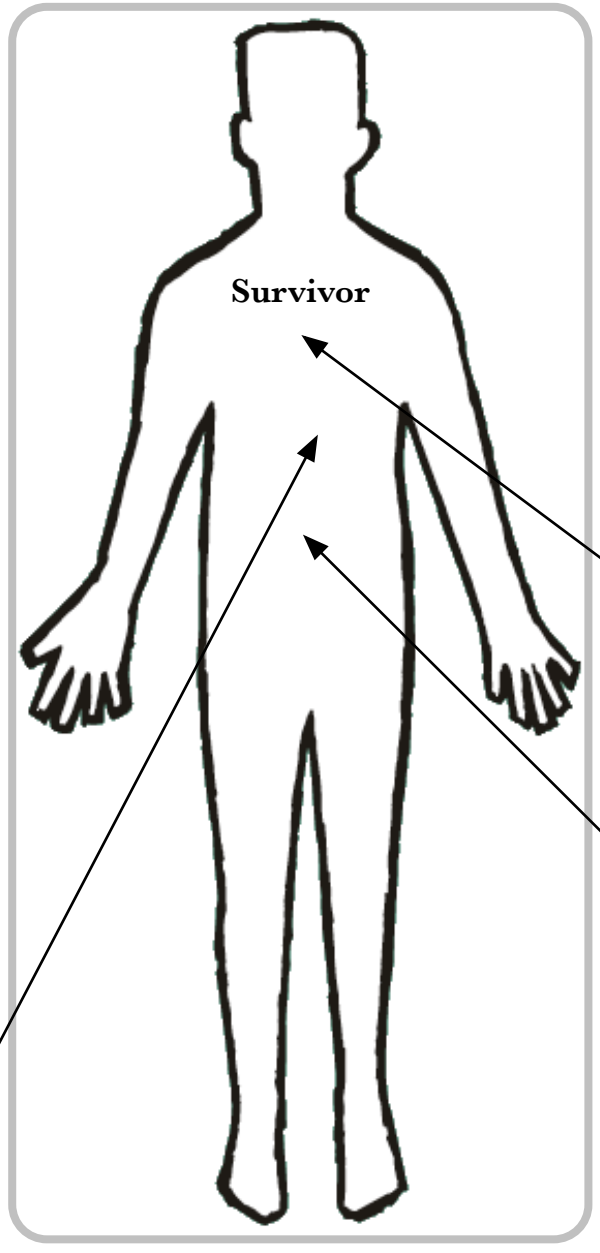
Covering the Essentials of Survival
The basic physical necessities of life are relatively simple: you need to be neither too hot nor too cold, you need water to drink, and after a few days you need to eat. Most disaster and emergency response focuses on meeting these basic survival needs as quickly as possible.

In a domestic disaster response scenario, there are well developed supply chains which stock the necessities of life. The crisis has a short duration. A natural disaster anywhere in the world often generates an enormous need for temporary relief. Refugees, however, are often displaced for decades and require long term support to survive.

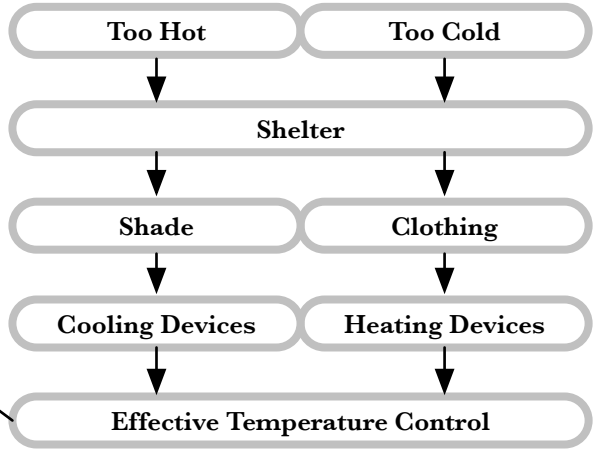
As you walk around the TIDES demonstration, please place yourself in the position of a person who needs help to survive. The equipment and systems you see might be all you have to sustain you: what seems most useful in meeting your basic survival needs? Imagine spending the entire day - or year - on this site. When you are thirsty, what do you drink? When you are hot or cold, where do you go? When you are hungry, what do you eat, and how do you prepare it?

Drinking Water
Humans need to drink liters of water every day to stay alive. Surface water, like rivers, is often contaminated. Water borne diseases are one of the biggest killers in some disasters.

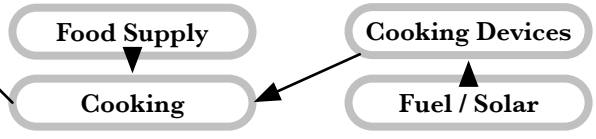




Protection from the Elements
People need to maintain a fairly even body temperature to survive. Shelter, bedding, clothing, shade, and cooling and heating tools all help us stay alive in the elements.



Food
Basic food stuffs are often brought into a refugee camp or disaster area, but often fuel to cook the food is the responsibility of each family.



As you walk around the TIDES demonstration, please circle the systems which meet your basic needs as you find them. Do you have everything you need to survive?

ShelterBox Disaster Relief Tent

TIDES

ShelterBox Disaster Relief Supplies

TIDES

Disaster Relief Tent

TIDES

- Lightweight, easy to transport
- Can be assembled in 20 minutes with practice
- Wide variety of models exist with broadly similar properties

- Designed for short term use (a few months)
- 6 months to 2 years in the sun, depending on materials
- Usually uninsulated but can have insulation packages added
- Costs $0.50-$2 per square foot depending on materials

- ShelterBox provides the tent plus a variety of extra equipment tailored to the precise needs of the people

- http://ShelterBox.org/ (Rotary Club of Helston-Lizard)
- info@shelterbox.org

Hexayurt Shelter System

Hexayurt Shelter System

TIDES

- Not a product - Free/Open Source integrated design
- In America, can be *field manufactured* from common items
- Raw materials to finished shelter in 2 hours or less
- Can be made from 4'x8' sheet goods with zero waste
  - insulation, plastic, hexacomb cardboard, laminates

- Designed for long term (decade) habitation for refugees
- Heavy duty units may last 5 to 10 years or longer in the sun
- Insulation R value of 6 - about half of an ordinary house
- Integrated design for utilities package provides light, heat etc.
- Costs $0.60 - $3 per square foot depending on materials

- http://hexayurt.com/
- Vinay Gupta Hexayurt@gmail.com

Shelter Systems Dome

Shelter Systems Dome

- PVC pipes form the rigid dome structure
- Special fabric skin keeps out the elements
- Set up in 30 minutes without tools
- Fairly robust - stands up to high winds, light snow loads

- Less than 2 year life exposed to the sun
- Waterproof shell resists mould and stay clean
- Not typically insulated, but the shape holds heat

- Costs around $1 per square foot for the 30' relief dome

- http://Shelter-Systems.com/
- Bob Gillis Bob@Shelter-Systems.com

UniFold Shelter

TIDES

UniFold Shelter

TIDES

- Made of durable corrugated plastic
- Packs flat for easy transportation
- Rapid Assembly - around 15 minutes
- Extremely robust - stands up to high winds, snow loads

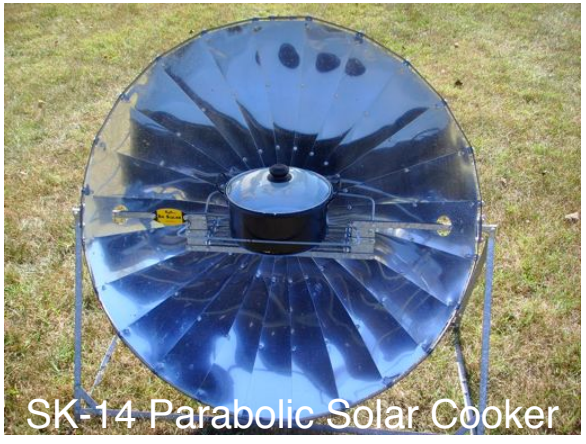
- Around 2 year life exposed to the sun
- Waterproof floors and walls resist mould and stay clean
- Insulation R value of up to 1.4

- Have been used by the UN, FEMA, American Red Cross, US National Guard, Canadian Armed Force etc.
- Costs around $3-$5 per square foot

- http://PerfectShelters.com
- Steve Ostrowski steveo@emscorp.com

Solar Cooker Designs


Solar Hot Pot


SK-14 Parabolic Solar Cooker


AquaPak


CooKit Panel Solar Cooker

Global Sun Oven


WAPI

Solar Cooker Designs

TIDES

- **CooKit** - a lightweight, panel-style solar cooker. Convenient for home, camping and emergencies, it folds flat to 13"x13"x2". Made of cardboard and foil. Reaches temperatures in the mid-200ºFs.
- **Hot Pot** - a durable panel-style solar cooker and pot system. Comes with foldable aluminum reflector and a five-liter black pot suspended in a tempered glass bowl for insulation. Reaches temperatures in the mid- to upper-200ºFs.
- **Sun Oven** - A high performance solar box cooker made of durable molded plastic and weighing 21 pounds. Reaches temperatures in the mid- to upper-300ºFs.
- **SK-14** - A German-made parabolic cooker that focuses light on a small area under a pot and reaches temperatures above 400. Useful for boiling and frying.
- **AquaPak** - a simple insulated black plastic bag heats water to pasteurize it, destroying all water-bourne diseases
- **WAPI** - a small wax indicator melts when the water in the AquaPak is hot enough to begin the pasteurization process. A stand-alone version for other cookers is also available

Stove Designs


Rocket Stove

Stove Designs

- **Rocket Stove -** combustion takes place in an insulated "elbow" which promotes high temperature burning (cleaner) and acts as a chimney to draw air through the fire
- **Sierra Stove -** forced air stove burns wood or other biomass efficiently using a battery powered fan
- **Thermette -** boils water efficiently by passing the heat of the fire through dual action chimney/kettle holding the water
- **Wood Gasification Stove -** extremely efficient stove design transforms wood into charcoal by heating it in an oxygen free area at the base of the stove and burns the gasses released to produce nearly perfect combustion
- **Jetboil -** an innovative cooking system which uses two new approaches to gain efficiency: insulating the sides and lid of the cooking pot and using heat sinks (the fins on the bottom of the pot) to increase thermal transfer to the food

Efficient Stoves

TIDES

The Open Fire
All over the world, people cook on open fires. At first this may not seem like a problem, but the cooking of billions of meals over open fires contributes directly to deforestation and desertification.

An additional unexpected problem is smoke inhalation. A lifetime spent cooking several meals a day, or life as an infant growing up in a smokey home, can significantly contribute to lung disease and early death. Because so many people cook this way, even the relatively small individual health effects turn into around six million deaths per year.

The open fire is nobody's friend.

The Most Efficient Fire is No Fire
Solar cooking (see the boards on solar cooking) provides a perfectly environmentally friendly way of cooking, without requiring anybody to spend their days gathering firewood. However, not everywhere has the required sunlight, and some cultures have a harder time using solar cookers than others. There also may be eye hazards with some kinds of solar stoves.

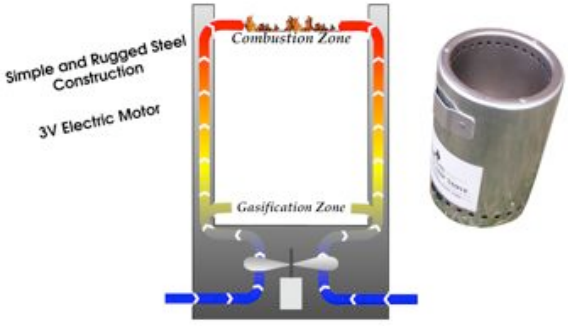
Hayboxing (placing a boiling pot into an insulated box, such as a carton filled with newspaper) also provides a fuel-free way of simmering food, and works very well for some cuisines.

Efficient Stove Options
There are many designs for efficient cooking stoves. Simple clay stoves that any potter can make are a major step forwards, but there are also some very high technology options which can still be mass produced cheaply. Stove designs vary not only in efficiency and smoke emission, but in areas like how they cope with large fuel, or dried fuels like cow patties. Two widely available stoves are discussed here, but many other designs exist.

The Wood Gasification Stove

Burns twigs, chips and debris cleanly and efficiently.

Uses 75% less fuel than a traditional three-stone fire, and 50% less fuel than a clay stove.

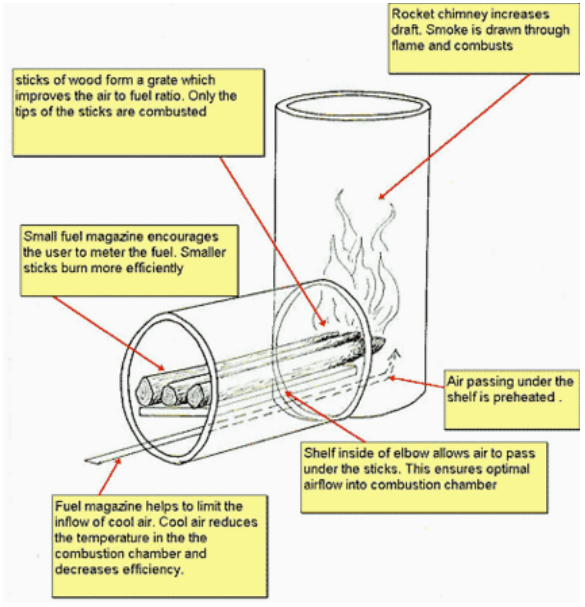


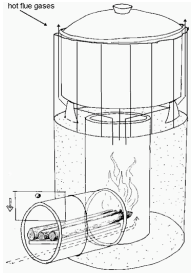
How It Works

The WoodGas stove effectively burns the fuel twice. Once to produce a smoke (or woodgas), and again to burn the smoke.
A small electric fan forces just the right amount of combustion air for complete, controlled combustion.

Understanding the Wood Gasification Stove
The key to the wood gasification stove is efficient gas combustion. The entire stove body is packed loosely with dense, hard fuel. In the first phase of combustion, the fire on top of the fuel pile is fed oxygen by the fan in the base. In the second phase, the hot stove body and combustion pile begin to boil volatile, combustible compounds out of the fuel in the lower part of the stove, and those fuel gasses rise and are burned at the stove top, producing a flame that looks like a propane burner. In the final phase, the charcoal (left behind when all the fuel gasses are consumed) is burned, producing an even simmering heat. Wood gas stoves are incredibly efficient, with almost no smoke (except when accidentally blown out,) but current models require batteries to function.

The Rocket Stove

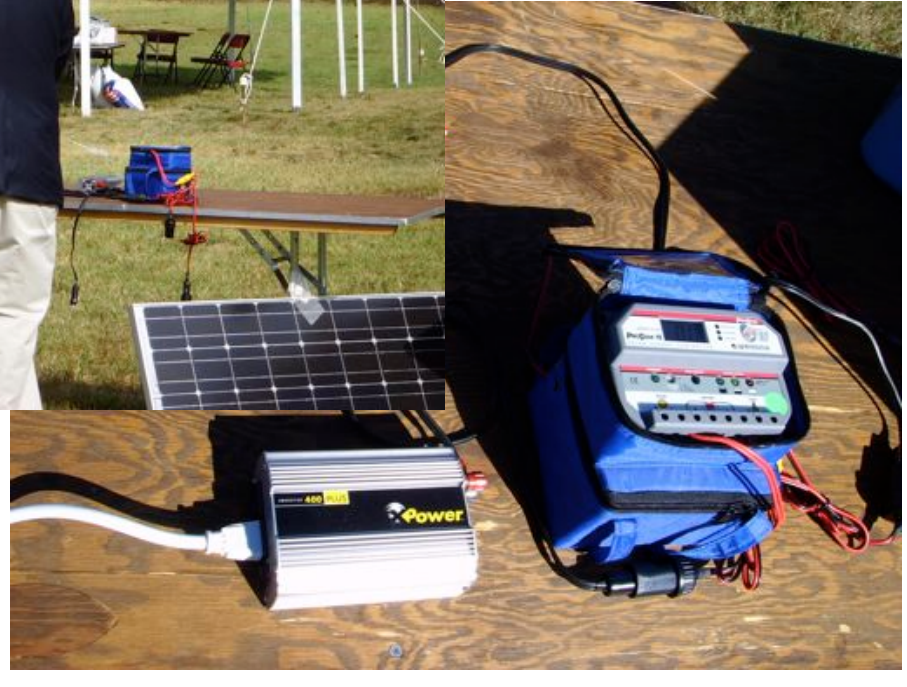




Understanding the Rocket Stove

The key to the rocket stove is the insulation around the "combustion elbow" which holds the fuel and the fire. By keeping the heat contained, the fire burns hotter and more efficiently. A metal sleeve (pictured left) channels the heat around the cooking pot, roughly doubling efficiency again.

AA Battery Microsolar



AA Battery Microsolar

TIDES

- **Rechargeable AA Batteries -** relatively inexpensive and can power small, useful devices like lights
- **Village Charger -** a large solar panel coupled with a fast (15 minute) battery charger will charge 40+ 4AA sets per day
- **Efficient Devices -** on such a spartan power budget every device must be efficient, such as CCFL (cold cathode fluorescent lights) which preserve night vision by producing a very even diffuse light, for best use of available watts

This system can provide basic electrical lighting for a village for around $25 per household at retail prices, and much less in bulk. Because the batteries and lights are small and cheap, services can be extended for a few dollars at a time. Stand-alone chargers would make the system even more modular, and better solar panel technology will make this effective soon.

When Did You Last Sleep Well In The Heat?

SleepBreeze Ltd

equipping you for sleep

Common to all military services is the misreading of information when personnel are tired. Transposition of numbers in a grid reference for fire data can lead to “Blue on Blue” incidents. “Friendly Fire Isn’t!”

For the military and many key workers fatigue can lead to errors that cost lives.

Getting to sleep in hot, humid climates can be difficult. The reason is simple. The onset of sleep is linked to the nightly fall in body temperature. Evolution has equipped us with mechanisms to ensure that heat loss from the body is promoted in the evening. The different stages of sleep and the quality of sleep are directly linked to the resulting fall in body temperature.

However, when hot, humid climates prevent heat loss from the body, then sleep either eludes us, or its quality is degraded.

SleepBreeze Ltd is developing an energy efficient, portable, cost effective personal cooler. The cooler makes use of the body’s natural reaction to heat. *Localised* air movement enhances the evaporation of sweat - key to managing heat stress and reducing casualties.

Crucially we do this without wasting energy in moving air around a whole room. Air movement is concentrated on the individual.

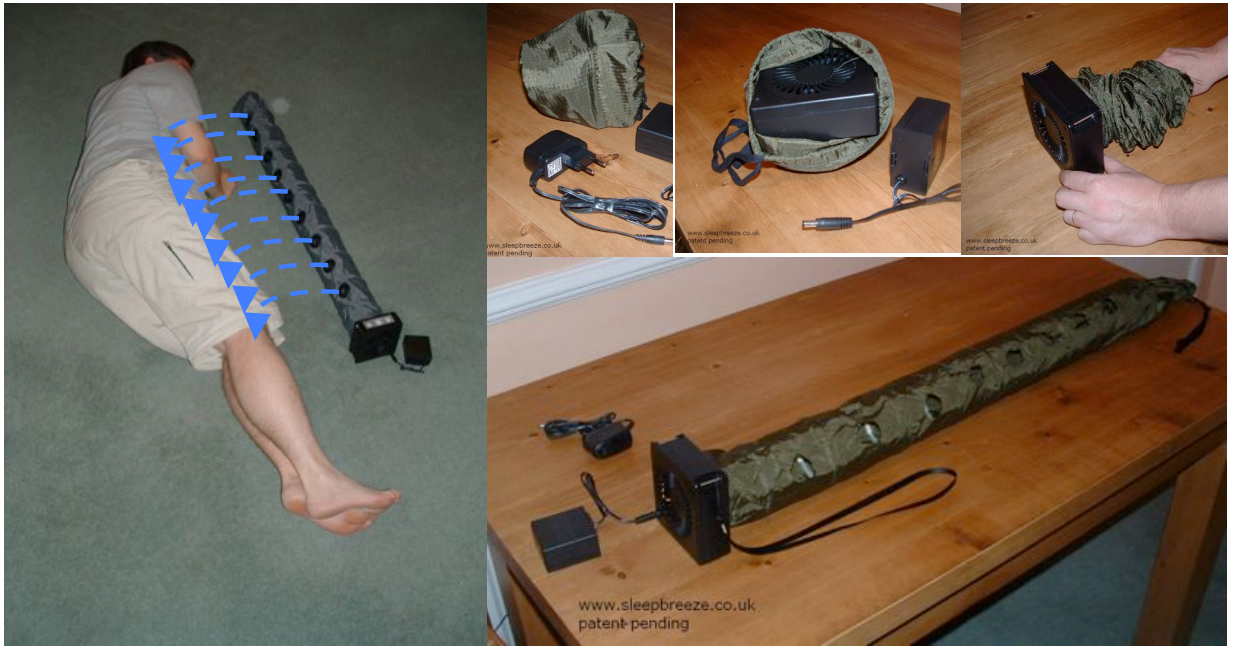
The benefits are lighter, portable personal cooling with minimal power budget.

So, not 2000 watts for room air con….

Not 80 watts for a desk fan….

But 4 watts.

That’s 20 SleepBreeze coolers powered for the equivalent of 1 light bulb.



Flexibility & Inter-operability

Power Sources

8 x AA batteries,
any 12 volt source,
mains – 110 or 240 volts.

Portability

The cooler weighs approximately 1 ½ lbs, including batteries.
Ease of stowage: Up to 3 packages – fan unit, battery unit / PSU, diffuser.
Shipping volume is a package approximately 6 x 6 x 5 inches.

Usability

Attachment points allow the cooler to be fixed to beds, stretchers, tent spas…

Air flow direction can be rotated for personal preference
3 Air flow rates for personal preference
4 function timer with “soft stop” feature
Removable diffuser – converts the product to a general purpose air movement unit.

TIDES technology appraisal

We believe the SleepBreeze personal cooler will improve night time thermal comfort for those sleeping inside mosquito nets. We would welcome specific testing in this area.

Support to TIDES

As internationally recognised experts in heat stress management we are willing to give our technical help and advice to the TIDES team.

Availability

Target for first production batch is December 2007.
Available for purchase through our internet site.
For bulk orders contact us at: info@sleepbreeze.co.uk.

About us

SleepBreeze Ltd. is a start-up company based in Hampshire, UK responsible for developing the SleepBreeze personal cooler. Andy Buxton, SleepBreeze’s founder and owner is a former UK MoD scientist with some 20 years expertise in human sciences, specialising in heat stress management and microclimate cooling for the military, F1 and World Rally teams. In 2000 Andy won an “Ergos” (Ergonomics Oscar) for his work in modelling the interaction between environment factors, protective clothing and thermo-physiological reactions. Andy is a past international editor for the Journal of Human Environment System.

Intellectual Property

More information

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www.sleepbreeze.co.uk/breezeblog

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SleepBreeze Ltd. Proud finalists in the 2007 Hampshire & Isle of Wight Sustainable Business Awards

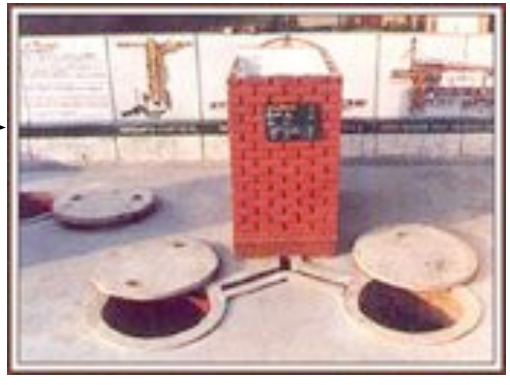
Hampshire and Isle of Wight Sustainable Business Awards 2007

Toilets and Sanitation Systems TIDES

BIPU / FSDS is basically a low cost, flat-pack sceptic tank system which uses a carefully designed absorption trench to process human waste.

Conventional Composting Toilets are well proven but expensive due to limited market demand. They look and function much like standard developed world toilets but require no external plumbing.

Sulabh Toilets can be as simple as a brick lined pit or more complex shared use village toilets. The simplest models cost as little as $10.



Thermophilic Composting Toilets are potentially cheapest of all, and sanitize waste in as little as three days through intense bacterial action.

Understanding Infrastructure

What is Infrastructure?

TIDES

The Invisible Grids
In the broadest sense, "infrastructure" is the enormous invisible grid, comprising networks of all kinds, cooperatively produce the standard of living enjoyed in developed countries and the richer cities of the developing world.

Infrastructure is the prize of modernity. Although we do not realize it consciously, every time we turn on a light switch or a faucet, quadrillions of dollars of industrial investment made over several centuries spring into service.

If you visualize the American national electricity supply systems for a moment, first you probably imagine the physical hardware of the grid. But all of those power stations and electrical cables have to be maintained. In fact, highly skilled maintenance crews work around the clock to maintain every aspect of the electricity system.

Then the power stations themselves need to be fed. Each one requires fuel, perhaps coal, oil, natural gas, or nuclear fuel. More infrastructure, like pipelines, carry fuels. Others fuels are carried roads, rail, or delivered by ships to ports.

Financial services efficiently move the money to purchase these fuels, and to hedge the risks associated with constructing a power plant. National infrastructure rests on national financial systems.

From a wholistic perspective, the appliances that depend on the grid also need to be considered since they affect how efficiently (or inefficiently) it's used.

Infrastructure always has all of these elements, whether it is a wood stove and a village well, or a multi-billion dollar national power investment program.

Infrastructure Around The World
In America, until only very recently, most people lived in a much simpler environment. Fuel, frequently in the form of coal or simple cord wood, was delivered by tradesmen. Light was provided by kerosene or whale oil. The simple tools of life might be an axe, a pot belly stove, and a clean river or well.

That simple lifestyle still exists all around the world. For poor or rural populations all over the world, living conditions are much like those of early American settlers. But that is changing!

In some rural areas, electrification is seen as being a vital part of educational initiatives because children who work or help their parents much of the day can study at night if they have light, but without it, they cannot learn. In other areas, people have observed a drop in birth rates associated with electrification.

Generations of Infrastructure
There are basically three classes of infrastructure in common use around the world at this time: pre-industrial or agrarian infrastructure, industrial infrastructure, and post-industrial infrastructure. You can recognize these forms by their very characteristic patterns of deployment, and particularly financing.

Pre-industrial infrastructure is simple tools and nature itself. Firewood and a clean river are the infrastructure of the pre-industrial period. Wood stoves of various kinds, simple machines like ploughs, and of course the well are all pre-industrial infrastructure. Lieutenant colonel T. E. Lawrence (of Arabia) describes the centrality of the well infrastructure to the desert campaign he fought in *Seven Pillars of Wisdom*. No amount of statistical analysis reveals the truth as clearly: the wells are life itself. Infrastructure is ancient.

Industrial infrastructure was the fruit of the Victorian era. Efficient material distribution and stable markets, coupled with innovations like steam and, later, electricity enabled the construction of factories which produced *services* like clean water or electrical power. The critical hallmarks of industrial age infrastructure are the pipes and wires that distribute the services to customers, and the billing systems which pay for those services. These capital management features are critical to the problems of infrastructure in distressed environments. Instability makes this style of infrastructure nearly impossible to deploy.

Post-industrial infrastructure is still being defined. The economies of scale which paid for power stations are being reduced by systems like combined heat and power (CHP) home energy systems, and efficient solar and wind power. Science has discovered new ways of purifying drinking water. Rising transportation costs push supply and demand closer together, while the networks create new options for supply chain management and integration even for basic services like electricity supply. Few industrial infrastructure systems will remain in 100 years time.

Many of these infrastructures can be made deployable, and sustainable, to improve support to populations in stressed situations, such as disaster victims or displaced persons in long-term camps. TIDES draws on work by many organizations and individuals to share information about recent progress and promote further research.

Interdependent Systems

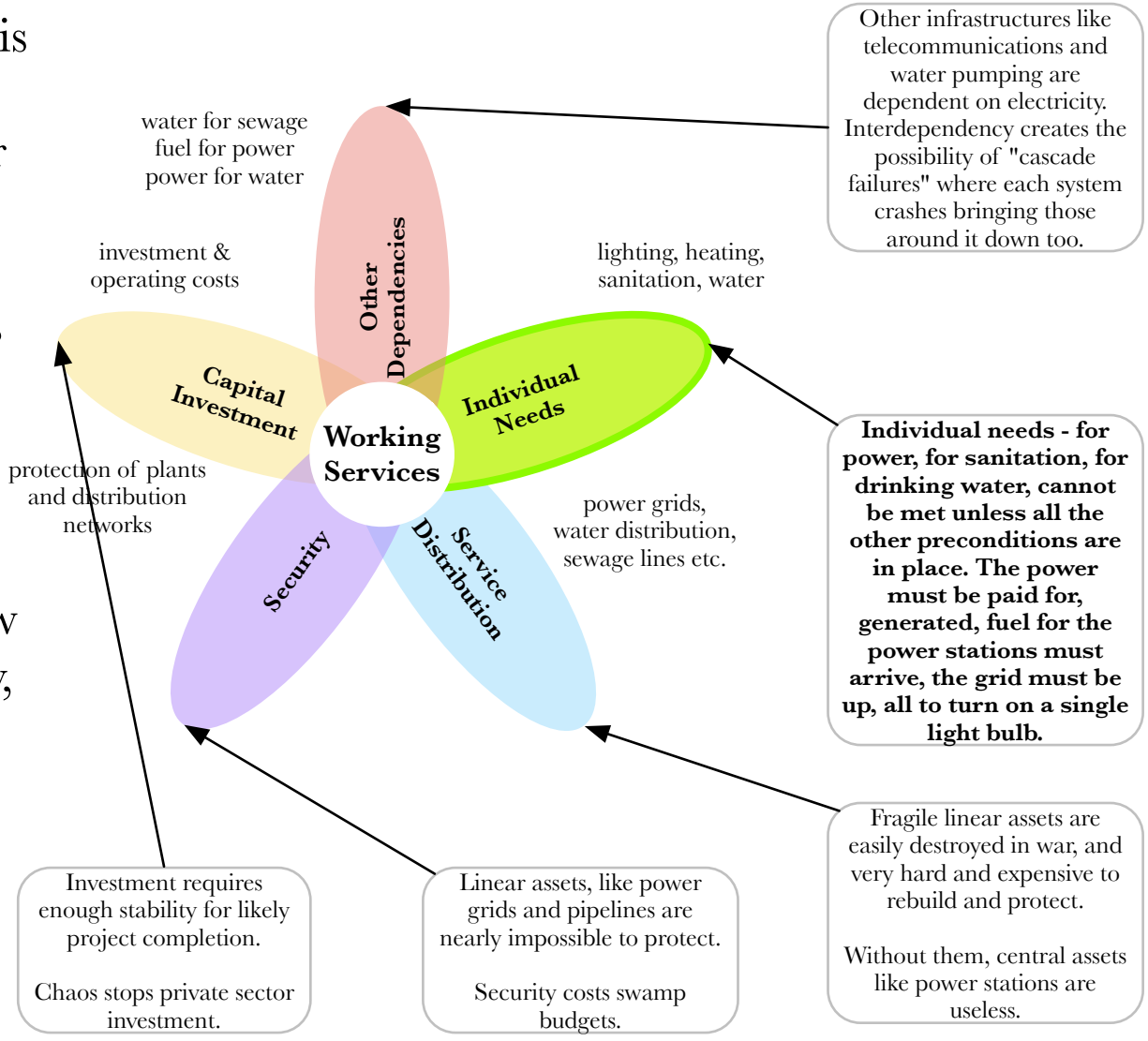
TIDES

✦ Conventional infrastructure is designed for lowest service cost in a stable environment, not for stability in war zones.

✦ Conventional infrastructures are very interdependent.

✦ Difficulties multiply and compound - lack of capital weakens grids and security. Low quality services cripple industry, destroying the tax base, and so goes the vicious circle.

✦ Fragility increases fast with interdependence. 5 systems, each 80% reliable, make one 33% reliable combined system when they are interdependent.

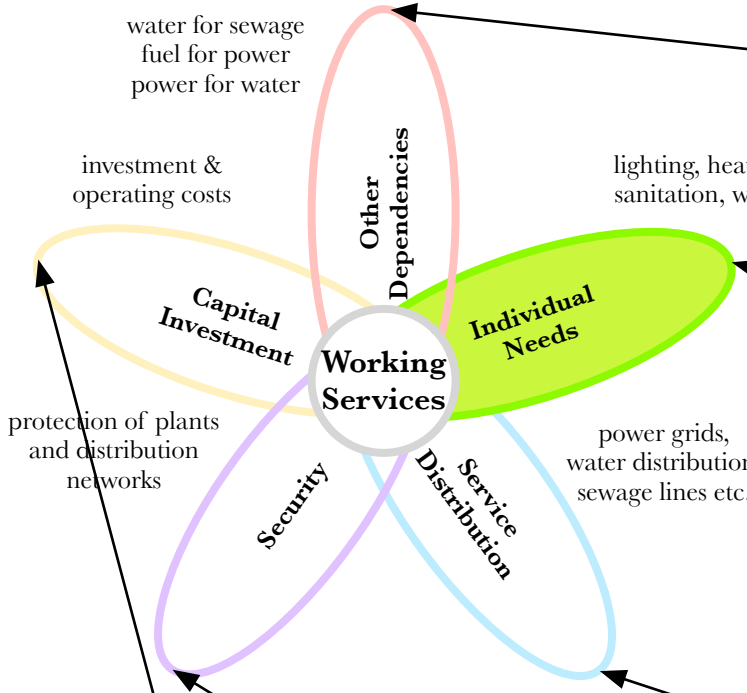


Reduced Interdependence Through Local Infrastructure

TIDES

✦ A solar panel is a very common kind of local (or distributed) infrastructure. It has no external dependencies. The capital cost is small. It is often sited where the power is used, meaning there is no need for a grid. The person who owns the home usually owns the panel on their roof. There is little security burden for the panel as it is part of the home.

✦ The total cost per watt is higher than for grid power ***in a stable country***. However, the total system costs for a solar panel are often far lower than the total system costs for grid power in a country without basic service stability.



Distributed infrastructures are typically not interdependent in a way which allows the failure of a remote system to affect local services. This means the local lights say on regardless of what happens at the power plant. However, in absolute terms, they are still expensive per unit served.

Individual needs - for power, for sanitation, for drinking water, can be met efficiently because the systems are not interdependent, but are autonomous, robust and resilient.

Individual ownership of infrastructure makes people feel like they are in charge of their own lives to some extent.

There is no service distribution network in a distributed infrastructure system.

There is simply no target to protect.

Distributed infrastructure can be purchased a few units at a time, as needed, and large installations are not much more cost-effective than small installations.

This means capital can be raised and spent in small chunks, and changes in needs and strategy can be made fluidly. This brings down toal project risks.

Because distributed infrastructure is typically mounted where the systems are used, there are few additional security overheads.

Each household or other building which has these services is responsible for protecting the assets they own, which cuts down on the complexity of administering security for infrastructure systems.

Key Benefits of Local Systems

TIDES

✦ There are **hundreds of benefits** from using local or distributed infrastructure. *Small is Profitable* from the Rocky Mountain Institute lists 207 such benefits, including lower project risk, smaller capital requirements (many small loans, not one huge one), reduced system interdependence, and assured future service cost (from renewables energy systems.)

✦ In an SSTR context, one **key feature** of local infrastructure is that the systems are typically mounted directly on or in the buildings that need the services. This also means that the infrastructure systems are **owned** and therefore **protected** by the same people who own the building in question.

✦ Unifying **ownership**, **use** and **protection** of infrastructure resources as a single administrative domain simplifies resource allocation. There is no issue with figuring out who can use how much power. There is no issue figuring out who is responsible for guarding a specific regional subsystem. This benefit only applies to infrastructure systems which are associated with specific buildings - large scale renewable energy plants do not necessarily have this property.

✦ Plausible distributed infrastructure systems exist for all basic services, ranging in sophistication from simple diesel generators through to complex multi-source renewable energy systems.

Local Infrastructure for SSTR

TIDES

Centralized, Industrial Infrastructure
Industrial age infrastructure is marked by a simple template: a factory that produces a service like power or sewage processing and a grid which carries that service to the homes of consumers. You can see this template all over the developed world.

In an SSTR context, this industrial age infrastructure template has four central problems.

1. **Maintaining and protecting the "linear assets" is difficult and expensive.**
   Power lines, gas lines and similar infrastructure are too spread out to guard and damage to one system can affect an entire city.

2. **The infrastructure is often extremely interdependent.**
   If the power fails, it takes down everything too. The water pumps fail, taking down the sewage processing, and before you know it you have a severely impaired civic environment. Cascade failure is the enemy of stable services.

3. **Large amounts of capital** are committed to multi-year projects in order to repair and expand war-torn infrastructure systems. A great deal can change between a project being commissioned and the project's completion. There is no room for adaptation to what is, after all, a highly dynamic environment.

4. **Political exposure from interdependence**
   In the event of state partition or breakdowns of civil authority, control of power stations and similar centralized resources can be a major area of conflict. Partitioning a highly interdependent system creates enormous problems, and may leave no functional system standing at the end.

In short, industrial infrastructure is extremely problematic in unstable environments.

Examples of Local Infrastructure
Autonomous building power systems
At its simplest, this means solar power or wind power systems on the roof of buildings or in the back yard. Coupled with efficient appliances like CFL lights, these systems generate enough power for a high standard of living for relatively low capital costs when compared to constructing a national grid or building power plants.

Composting Toilets
In many climates the complex sewage treatment systems can be abandoned in favor of composting toilets. These toilets safely digest human waste to a few percent of its original volume, and remove all pathogens as they go. Current models are expensive because of a limited market, but a city-sized installation could bring the price down sharply. DIY models, including the extremely simple thermophillic composting toilet, also exist.

Household Water Purification
Homes all over America purify their own well water using a variety of technologies. In an SSTR context, water may still be distributed through pipes, or it may be delivered by truck or carried by hand. There are many household water purification approaches, from high tech reverse osmosis filters through to slow sand filters and solar water pasteurizers.

Consider how much the challenge of restoring basic services to a city would change if 85% of the homes in the city generated their own power, purified their own water, and disposed of their own sewage.

In this situation, municipal services could be scaled back enormously, and that money re-invested in household-level utilities.

Local Infrastructure for Resilient Services
Local infrastructure, also called distributed, decentralized or post-industrial infrastructure, can compete directly in financial terms with industrial infrastructure in peace time as shown by the extremely rapid expansion of decentralized energy resources like wind power. However, the complex and interwoven nature of the national grid and particularly the accounting principles used to finance large energy plants make it hard for these systems to compete when there are alternatives.

However, in the SSTR context, the problems with reconstruction based around industrial infrastructure are well known. With the best will in the world, reconstructing a power grid in a war zone is nearly impossible.

Using local infrastructure is essential in an SSTR context. At least until reconstruction is well under way, most services have to be provided locally. You start where you are.

Improvised local infrastructures are often extremely durable and resilient, but are often inefficient and can be under-engineered. For example, the use of near-disposable diesel generators makes short term financial sense but in many cases a well-chosen wind/solar installation would perform better at lower long-term cost. Because these systems currently require deeper understanding to install at the right size using the right technology to get optimal performance, local energy systems often tend towards the improvised and the low-tech, lowering living standards.

For more information please see *Small is Profitable* by the Rocky Mountain Institute, and *Brittle Power* by Lovins et. al.

Local Infrastructure Resilience

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	Conventional Infrastructure is a Target Rich Environment			RED is primary targets	YELLOW is vulnerability through interdependency
	Resource Type	Household Infrastructure	Municipal Infrastructure	National Infrastructure	Global Infrastructure
Conventional Infrastructure	Electrical Power	Appliances	Substations, Local Grid	Power Stations, National Grid, Fuel Terminals	Commodities Markets, Fuel Supply Chains
	Gasoline Supply	Generators	Gas Stations, Local Storage	Terminals, Pipelines	Commodities Markets, Fuel Supply Chains
	Natural Gas Supply	Some Propane Tanks	Gas Lines, Tank Refill Stations	Gas Pipelines, Terminals, Refineries	Tankers, Terminals, Markets
	Water Supply	Some Wells	Resevoirs, Water Pipes, Treatment Stations	Aquaducts	
	Sewage Processing	Toilets	Sewage Pipes, Processing Plants		
	Telecom Systems	Phones	Local Exchanges, Phone Lines	Regional Exchanges, Long Haul Lines	International Fiber Optics Cables, Satellites

	Local, Modern, Decentralized Infrastructure is Likely More Resilient			Independent, Resilient Systems	
Decentralized Infrastructure	Electrical Power	Building mounted solar, wind	Large installations on municipal buildings	Power stations for industry; fewer, guarded	Less dependence on imported fuels
	Gasoline Supply (**unchanged***)	Generators	Gas Stations, Local Storage	Terminals, Pipelines	Commodities Markets, Fuel Supply Chains
	Natural Gas Supply	Woodgas or Biogas generators	Municipal Biomass Plants?		
	Water Supply	Wells, Delivery Trucks, Household Water Purifier	Reservoirs	Aquaducts	
	Sewage Processing	Composting Toilets			
	Telecom Systems	Cell Phones	Cell Towers, Microwave Backhaul	Microwave Backhaul, Fewer Long Haul Lines	International Fiber Optics Cables, Satellites

* Gasoline supply is highly problematic from a resilience perspective.

Transportable Infrastructure

TIDES

The Starting Point
To understand the refugee condition, imagine you are one of 100,000 people settled in an open area, with a river five miles away and enough firewood for a few weeks, diminishing fast. Food comes in twice a week by truck, and you queue for hours for your share of the incoming shipment. A handful of aid workers try to provide basic medical and other services, but they are so few, and new refugees come in every day, many in worse condition than you are.

You have no idea if you will be here for six months or ten years. Your uncle was a refugee for half of his life. He might be somewhere in this camp too.

Everything you own is gone, and you have no employment or hope of employment. But at least you survived.

What Can Infrastructure Do?
The river is dirty. You're 40 miles downstream of a town, and sanitation is poor. Hauling water is a huge task, and when it arrives, it often makes people sick.

Those are infrastructure problems - water transportation might need a truck, or a water line. Water purification might need a solar pasteurizer, or perhaps a high tech unit that serves the whole camp.

Then there's the firewood situation. The three stone fire you cooked on before the stove came required a firewood gathering expedition three times a week. Now you go once every ten days.

The situation is still terrible, but it's less terrible because you have better tools to survive.

	Developed World Civilian Infrastructure	**Military Infrastructure**	**Transportable Infrastructure**
How is the service supplied? **- power, water etc.**	Systems - power stations - water plants	Objects - gensets - RO units	Objects - hand crank / solar - solar water purifiers
How are services distributed and resupplied?	Pipes and Wires - national grid - water pipes	Trucks and Planes - fuel supply chain - bottled water	Limited Supply Chain - some trucking - favor stand alone systems
Who owns the infrastructure?	Companies and Individuals	Governments	Often Individuals - goes home with them
Cost	Cheap - huge capital investment provides very cheap services	Expensive - reliable, global, secure, resilient	Intermediate - solar $ > grid $ - but there is no grid - make do with less
Readiness	Proven	Proven	In Development

Conceptual Development
In 2002, 84 people from a wide variety of backgrounds, including representatives from UNHCR, UN Development Programme, the World Health Organization, the World Food Programme, Refugees International, US AID, the US Navy and others, met at the Sustainable Settlements Charrette, a design workshop hosted by the Rocky Mountain Institute, an environmental think-and-do tank with a specialization in infrastructure. The goal was to understand and improve how refugee situations are handled.

The conclusions of this Charrette became the input to the Hexayurt Project, a volunteer-run free/open source design projects which applied RMI decentralized infrastructure concepts to the needs of refugees, slum and rural populations in the developing world.

The Strong Angel demonstrations, directed by Dr. Eric Rasmussen, laid the foundation for the approach of a broad, diverse, collaborative group including all relevant and affected parties, working together to find new avenues for cooperation and improved practices.

All of these efforts together focussed attention on infrastructure as an area where there is room for a significant improvement in current practices, by identifying promising candidate technologies which have the right dynamics: small, low cost installations which refugees can take home with them when the crisis is over, blurring the line between disaster relief
and aid.

Hexayurt Infrastructure

Hexayurt Project

Pipe/Wire	Developed World Civilian Infrastructure	Hexayurt Utilities Package
Electricity	National grid	Solar with rechargeable AA battery storage
Gas	Natural gas system (pipelines, terminals)	Wood Gas Stove Wood and other biomass fuels
Water	Water treatment plants, viaducts	Solar Water Pasturizers
Comms	Wired phone network, cell towers	$100 computers? Cell phones?
Sewage	Sewer system, sewage treatment plants	Composting toilet
Storm-water	Storm drains	Drainage ditches

The Hexayurt Utilities Package
The Hexayurt Project developed a very simple approach to providing the same essential services as developed world infrastructure systems, but for a total cost of $100 - $200 per home. The infrastructure is self-contained and portable, so it can be transported with people when they are resettled at the end of a crisis. These infrastructures are mostly at early stages of development, or adapted commercial products. A full program of testing and additional development will be required before this system is ready to save lives. However, as you can see, the essential systems are very simple and inexpensive.

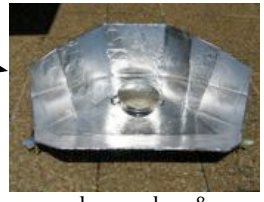
Household Infrastructure Systems


all day solar charger


cold cathode fluorescent room lighting


nimh AA rechargables

wood gas stove


solar cooker & pasteurizer


thermophillic composting toilet system

Property & Ownership
Household systems are typically owned outright by individuals, where as village systems may either be shared or operated as businesses by an owner or a collective. Items like a personal battery charger might be purchased by more affluent families to give the same services that others get from the shared systems. Over a period of time these incremental improvements could lead to a higher standard of living even within a refugee camp.

Village Infrastructure Systems

15 minute fast charger


large solar panel

At 15 minutes per set of batteries, a single solar panel can charge around 40 sets of batteries per day. That might be enough to keep the lights on in 40 to 80 homes. Pull-cord chargers might offer even better performance.

Cooking can be done with either the solar cooker or the wood gasification stove. Solar Cookers International calls an approach like this Integrated Cooking and has boards about it here. We favor the wood gas stove because we include electrical supplies and it is more efficient, but without electrical supply, the Rocket Stove is an excellent choice.


inexpensive cell phone


low cost, low power computer

Communications systems and the internet rely on regional infrastructure like the cell phone networks, or relatively expensive municipal infrastructure like a satellite internet connection.

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Additional Resources

State in a Box

A different approach to SSTR/ HADR based on free/open source and whole systems thinking.

Hexayurt Project

Household Systems

Hexayurt Project

Supports family life during crisis

Purpose
Get individual families the essentials of life in a way which permits refugees to be resettled and also works in permanent encampments or slums.

Hexayurt
Housing for families in emergencies, and for the very poor to use year round.

Hexayurt Utilities Package
Very cheap distributed infrastructure package including water purification, efficient stoves, incredibly small scale electrical power systems and so on.

Distributed Infrastructure Retrofits (concept still in development)

Provides a higher standard of living than the Hexayurt Utilities Package, suitable for more developed world areas.

Municipal Systems

Citadels (concept still in development)

Supports civic life during chaos

Purpose
Provide a generally standard set of basic utility functions for municipal government, universities, larger schools, hospitals, libraries and businesses.

Infrastructure
"Autonomous building" retrofit provides existing structures with stand-alone power and sanitation services along with water purification and storage.

Telecommunications
Strong points for telecommunications equipment, including microwave and satellite backhauls.

Open Source Ecology (concept still in development)

A sister project of the Hexayurt Project, which focusses on light industry provided at a small scale.

National Systems

CheapID

Supports national continuity

Purpose
Create a case-hardened identity services architecture to safeguard human rights and enable states to guard against genocide. Also secures financial transactions and allows refugees to regain their identities. Particularly good for areas with insurgency because of biometrics components which can put real pressure on foreign fighters.

National Extranet (concept still in development)

Extends national and international services over the network

For example, tax databases with international backups and software support, satellite based land registries and so on.

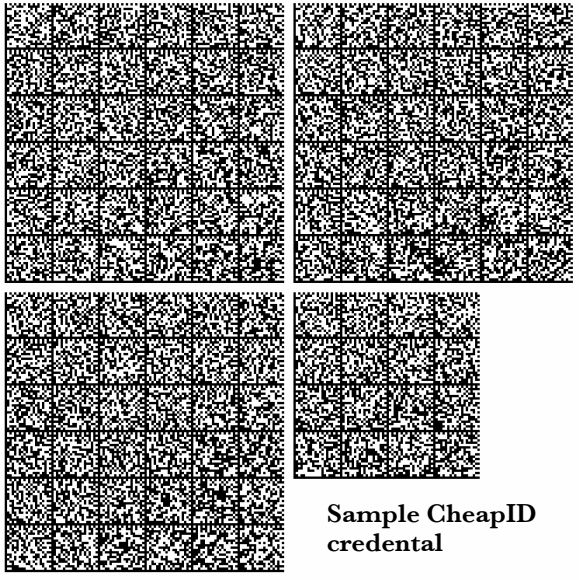
TIDES

Identity for HADR/SSTR

CheapID

CheapID is an identity standard designed for austere environments with intermittent network connectivity.

- ✦ CheapID stores your picture as a 2D bar code that is printed on site
- ✦ Digital signatures prevent abuse
- ✦ Biometric features provide security
- ✦ Cryptography provides privacy
- ✦ Readable by generic camera phones
- ✦ Cards can be captured by untrusted parties without revealing even a name
- ✦ Part of Identity Services Architecture for SSTR, with support for trade, banking and legal processes



Sample CheapID credental

Safe Personal Identity Credentials

In a distressed environment, particularly a refugee situation, a person's identity can put them in danger. For example, in an ethnic conflict, a family name can reveal membership of a targeted group. The CheapID standard hides all identity information in two ways. Firstly, the card itself has no unencrypted fields other than a person's picture. Secondly, the keys required to decrypt sensitive fields can be kept off-site and used remotely over the network, allowing them to be used only as part of a legal process, or revoked in an emergency like capture of reader equipment.

TIDES

Shelter for Catastrophes

Hexayurt Project

Worst Case Scenarios
Hurricane Katrina left hundreds of thousands of Americans homeless, and seriously stressed immediate disaster sheltering options.

The Bay Area of California, including San Francisco, is overdue for an earthquake that may leave hundreds of thousands of people homeless.

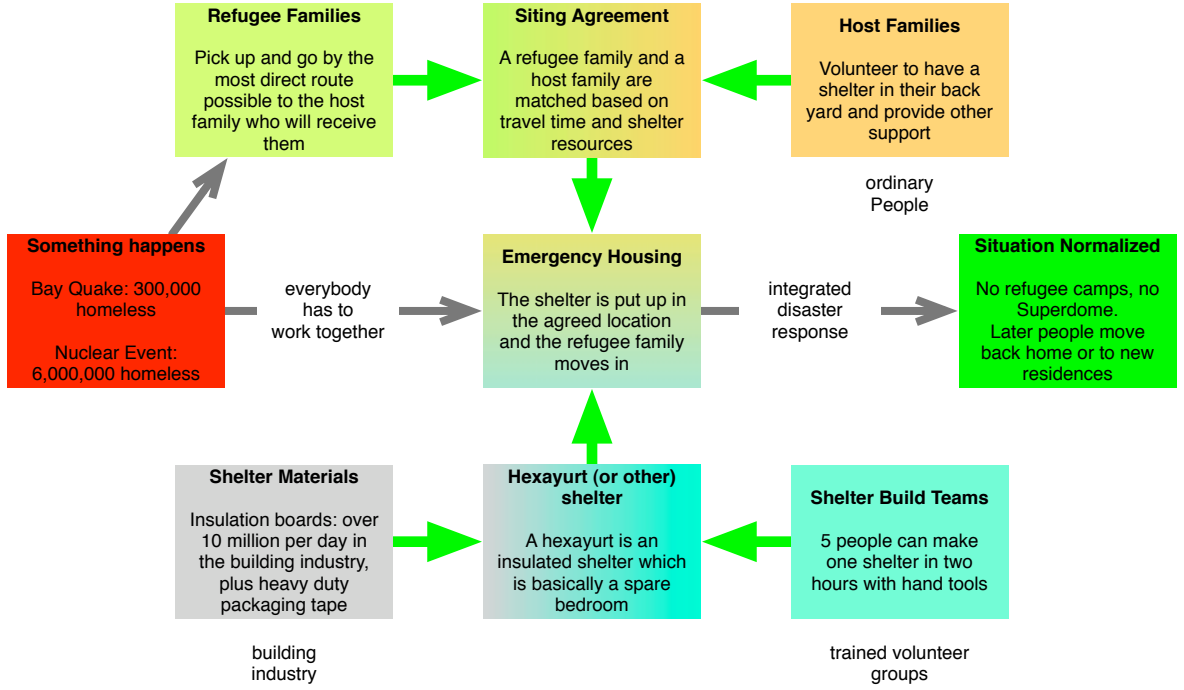
A nuclear event on American soil, either from an accident at a power station or terrorism, could easily displace ten times times as many people as were displaced by Hurricane Katrina.

Against this landscape, a reliable approach is required to sheltering vast numbers of people very quickly.

Emergency Housing Stockpiles?
Even if we assume emergency housing as inexpensive as a light duty tent, a national reserve of emergency housing for 5,000,000 people would cost around $300,000,000 plus storage and distribution costs. In a cold weather situation, such lightweight options might not be useful. A similar national reserve of trailers like those used after Katrina would cost tens of billions of dollars.

Using Existing Resources
The building industry uses enough insulation boards every day to build (for example) hexayurts for 600,000 people. In a catastrophic emergency that requires housing for millions of people, an "all hands" approach would likely have to be employed: hotels all over the country might absorb as many people as possible, with overflow being channeled to other housing options, and only finally to the improvised housing stock. However, the ability to create temporary housing for hundreds of thousands of people per day provides a great deal of additional national resilience.

Networked Domestic Disaster Response



Coordinating Response
A mass response plan of this kind requires sophisticated resource planning software to match resources with needs. For example, in the improvised housing case, it is anticipated that most units would be put up in the back yards of ordinary people who would provide displaced people with basic infrastructure like electricity and a shower until the crisis passes. Rapidly matching a refugee family with a host family, in an area which has available building materials and building teams, is a job for a geographical information system (GIS) database. The system might operate over the cell phone network, providing people with directions to their designated shelter site using GPS and mapping software.

Personalized Advanced Planning
The "Networked Domestic Disaster Response" proposal envisages a national level preparedness program. Skills like preparing an improvised shelter and using the crisis response software to find shelter for a family would be trained years ahead of time. In one version of the plan, every American family has a disaster relocation plan, including driving directions, modeled on the simple fire escape route maps that are seen in every public building. These maps could be personalized for special needs and established area-specific risks like earthquakes.

TIDES

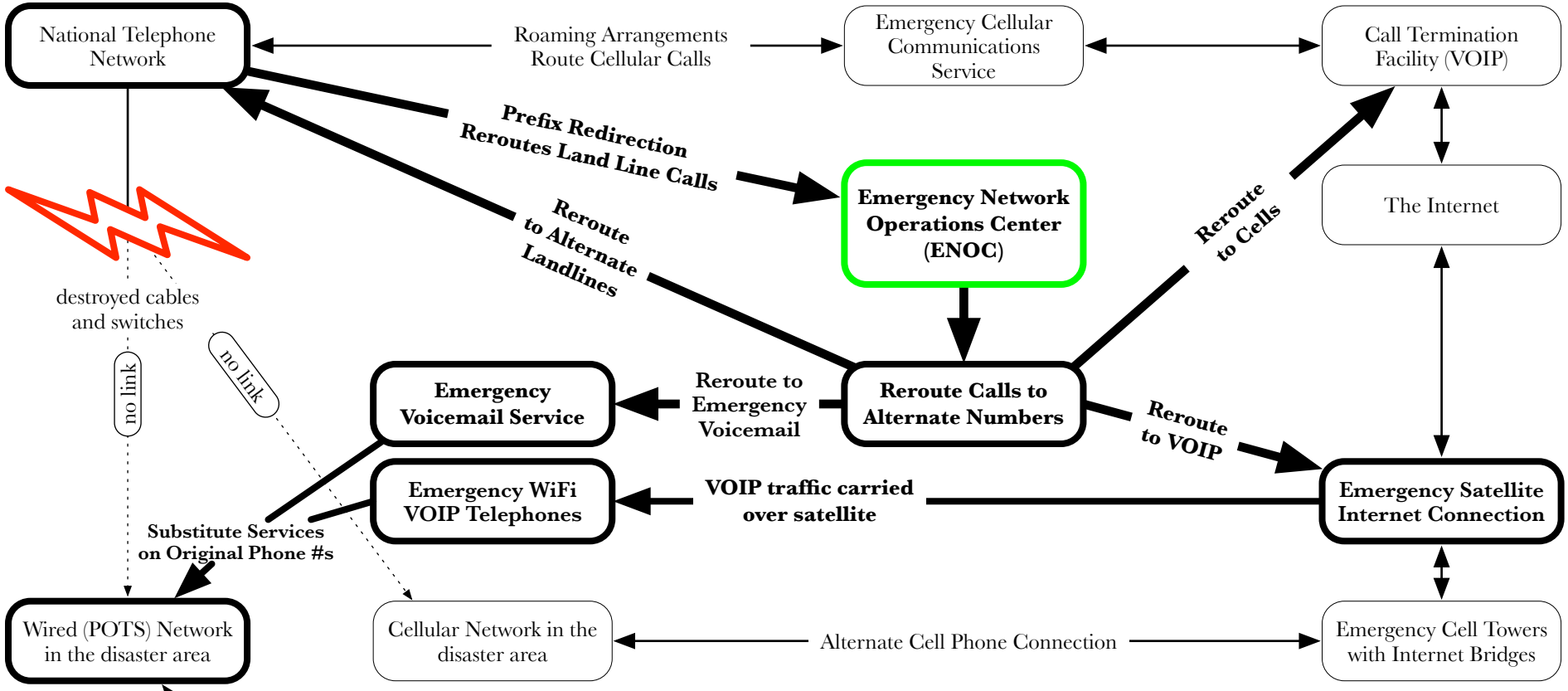
Disaster Phone Routing

TIDES

In a disaster, being able to reach institutions like hospitals is crucial. However, most institutions use land lines which cannot be effectively rerouted around damage in a crisis.

Prefix Redirection is a simple hack for routing emergency telephone traffic correctly. For example, an "access code" of +XXX followed by the phone number like +XXX 555 222 1212 reroutes the call.

The Prefix Redirection number is distributed in the disaster area, and the Emergency Network Operations Center reroutes calls and provides voice mail services ensuring continuity of operations.



Regular telephone services will take time to restore, but substitute services that ring at the pre-disaster numbers keep people connected.

Dynamic management of routing information is one of the critical benefits of computer networks. The **Prefix Redirection** concept applies it to POTS.

NDSI & Hexayurt Project

TIDES Documentation Strategy

Information Sharing in TIDES
A key goal of the TIDES project is to promote information sharing. All documents generated by/for TIDES are in the public domain. An on-line library has been created at www.star-tides.net which includes documents created by/for TIDES, documents which have been approved for storage in the library, and links to documents hosted elsewhere.

Documents within TIDES should be easy to find. Therefore, both the catalog of the documents in the library, and the search features related to it, are being aided by "metadata," which is information that helps in the search for information. More detail on TIDES Metadata is on the right-hand panel.

Findability is important
Rights and privileges are important
We are using DoD Discovery Metadata Specification (DDMS). All documents housed in the STAR- TIDES online library are either generated by/for TIDES (and are in the Public Domain), documents for which permission to copy to the library has been obtained, or are merely links to documents hosted elsewhere for which we have generated metadata and/or other finding

Future Issues for consideration include
✦ The creation and/or sharing of XML schema for other metadata elements in the documents
✦ The maintenance of the search catalog – will the Google custom search application work in the long term?
✦ The permanent site for archiving digital documents and/or metadata
✦ The relationship between TIDES Documentation Team and other information science / librarian teams and infrastructures (catalogs and databases)
✦ The physical storage and readiness of documents supporting objects in archives, and the linking of objects and data

TIDES Info-structure
Objects themselves (such as shelters) should contain as much information as possible (see the example of first aid and other instructions that could be printed on shelter walls). Moreover, objects should be able to communicate information about their status to other objects (perhaps through some kind of identification tags). Finally, the people who use the objects should be able to access information.

The three-tier strategy for TIDES Info-structure is:

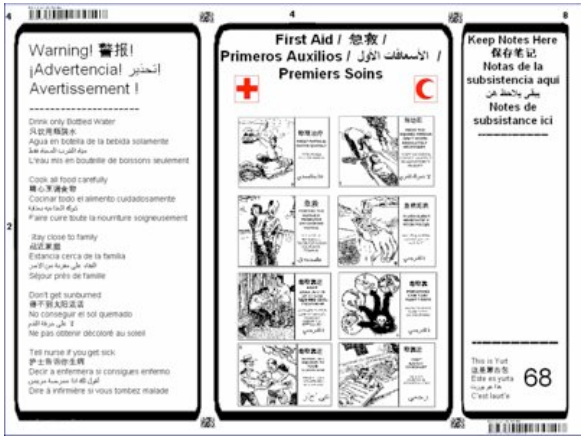
1. Make documents easy to access
2. Make shelters and tools information-rich
3. Make camps themselves informational on a macro-scale

Examples:
1. Use metadata to aid searchers in finding information.
2. Use current mobile communication technologies to access, update, and edit records for people and objects in camps, and print first-aid and sanitation guidelines on shelter walls.
3. Make the arrangements of shelters and infrastructure in camps information rich for aerial devices.

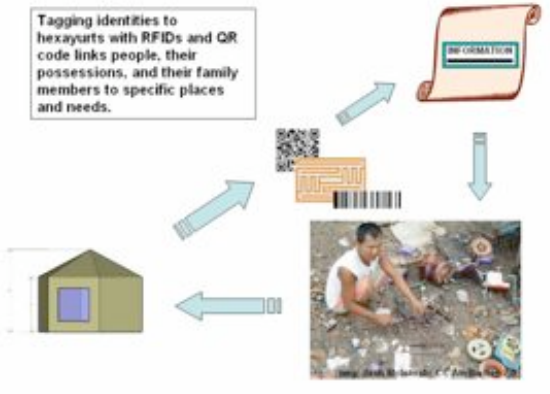
As technology improves, we anticipate finding new ways to apply “documents” and other useful information to “objects” and infrastructure in the field. Current technologies like Radio Frequency Identification tags (RFIDs) and Quick Response code (QR) will jumpstart these processes.

TIDES Metadata
Documents in the TIDES library should be easy to find. Both the list of documents in the catalog, and the catalog search features are aided by "metadata". Metadata is information that helps us find information. We use the DoD Discovery Metadata Specification (DDMS). DDMS is entirely compatible with other standards, such as Dublin Core. DDMS adds elements for security features, and has helpful geolocative properties. Using DDMS will not keep documents from being found by the non-military community, but will only increase the findability of documents for military and government users.

Example of a printed shelter wall



Example of linking people and objects to useful information



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