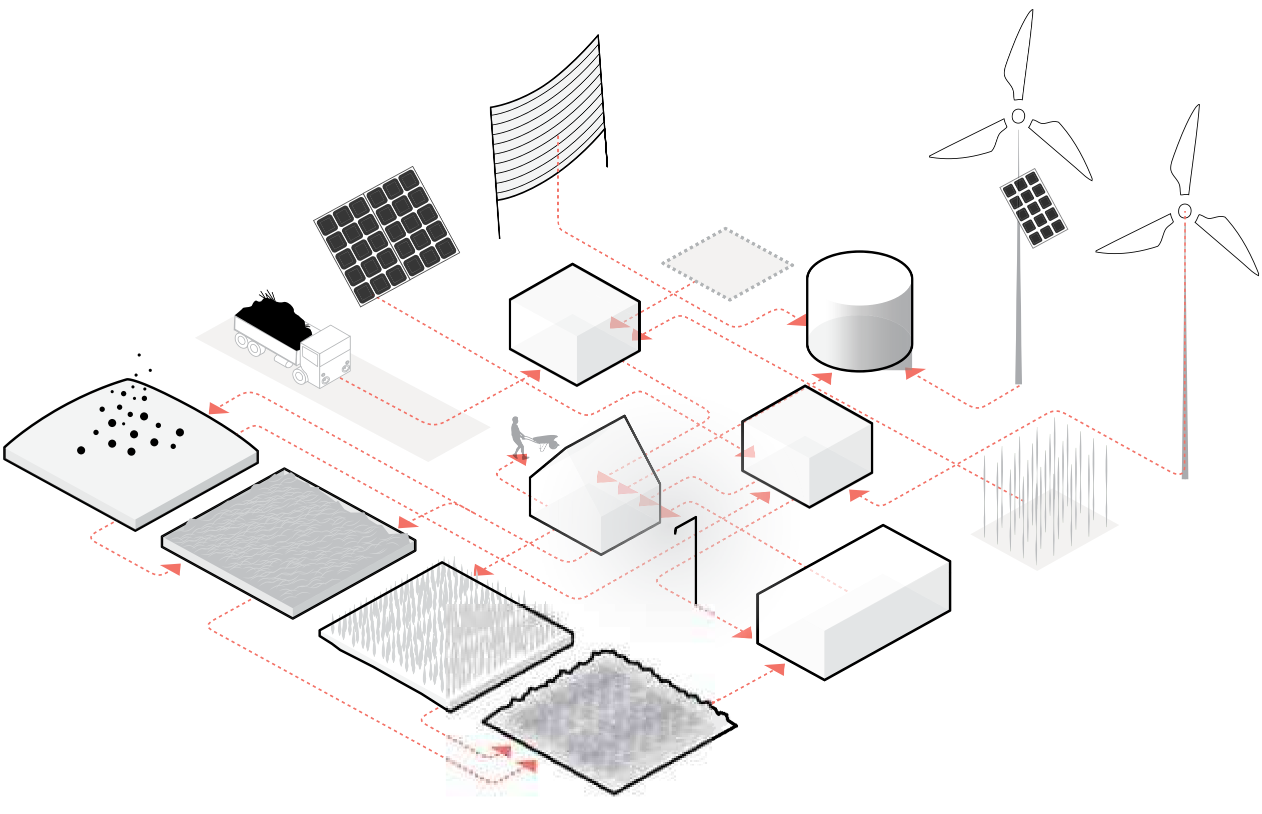
SUSTAINABLE SETTLEMENTS

MAXIMISING THE SOCIAL, ENVIRONMENTAL AND ECONOMIC GAINS IN HUMANITARIAN DISPLACEMENT SETTINGS



A CATALOGUE OF EVALUATED APPROPRIATE TECHNOLOGIES
AND A FRAMEWORK FOR GRADUAL IMPROVEMENT AND INCREASED EFFICIENCY

FLYKTNINGHJELPEN
NORWEGIAN REFUGEE COUNCIL

IKEA Foundation

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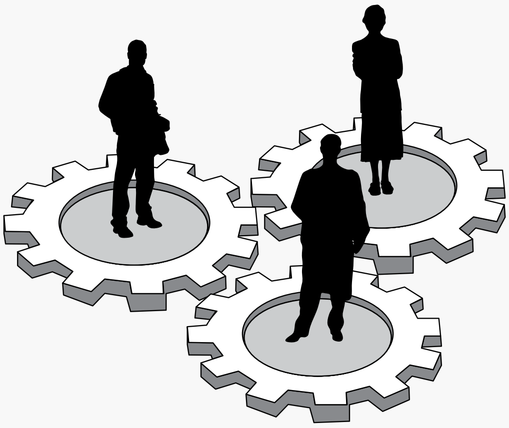

ABOUT

The Sustainable Settlements project is a framework of existing and emerging technologies and methodologies to improve the social, environmental and economic sustainability of settlements. Based on a holistic sustainability approach, the focus is on finding specific interventions which enable social improvement and sectorial collaboration as well as reducing negative consequences of environmental flows.

Options presented in this document can function as standalone interventions, but will be particularly efficient as mutually reinforcing community 'maximizers', generating value and opportunities for a life with dignity. With this 'catalogue' of options, the project will aim to further develop concepts for the implementation of on-site pilot projects.

This catalogue has been devised to present a synthesis of research into alternative and emerging technologies that have unrealised potential in meeting a range of needs in humanitarian emergencies and displacement scenarios. These approaches present opportunities for the humanitarian community to reduce impacts on the environment and lifetime costs of service provision whilst increasing value for money, impact and efficiencies.

The majority of interventions in this catalogue are well known within the development and appropriate technology sectors and have been selected as those seen as most viable for NRC to implement and evaluate in displacement scenarios.

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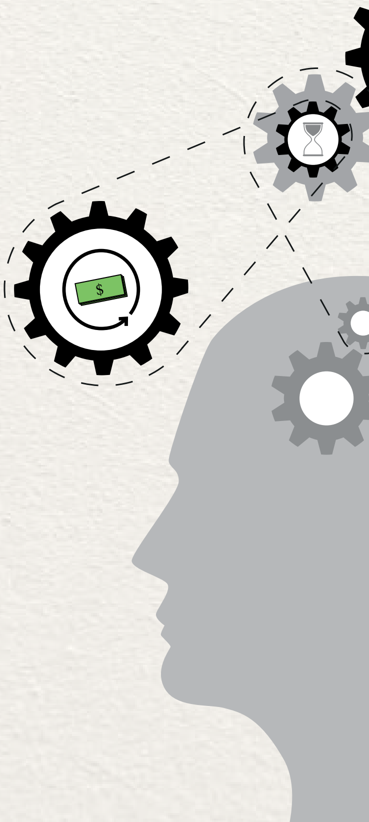
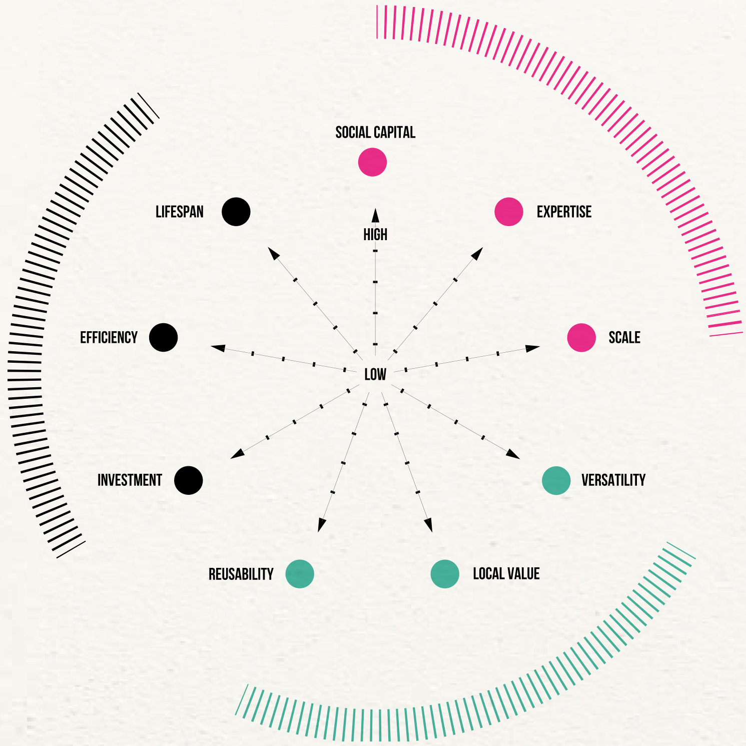
INTRO

SUSTAINABLE SETTLEMENTS

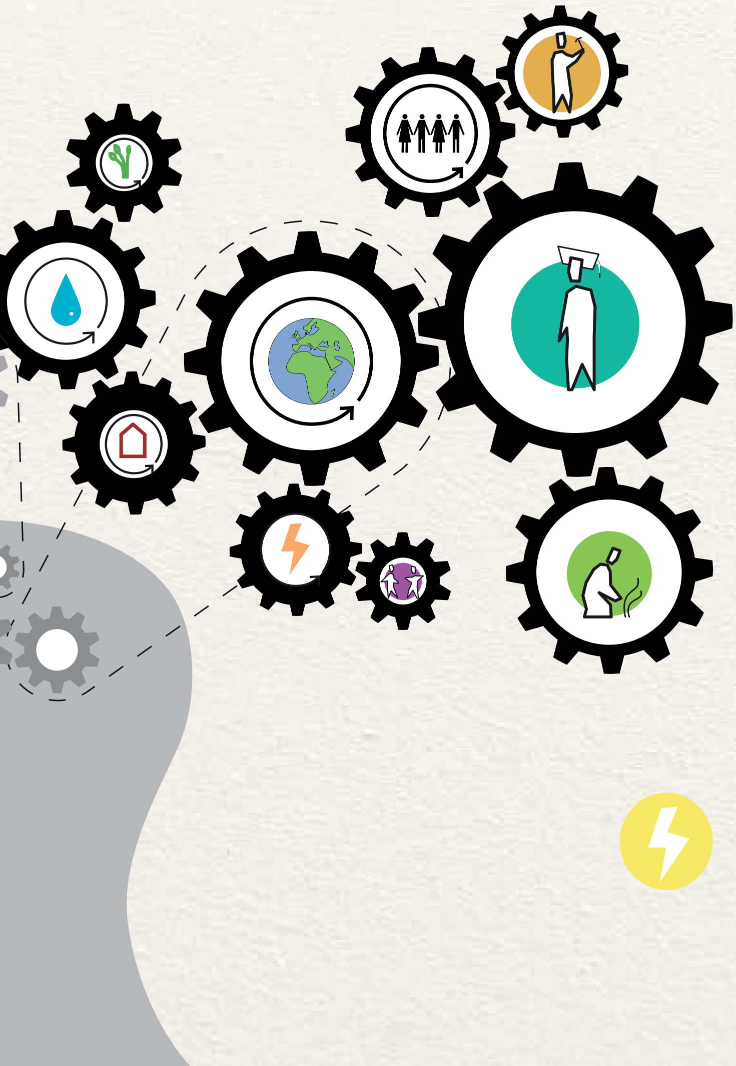
INTERVENTION CATALOGUE

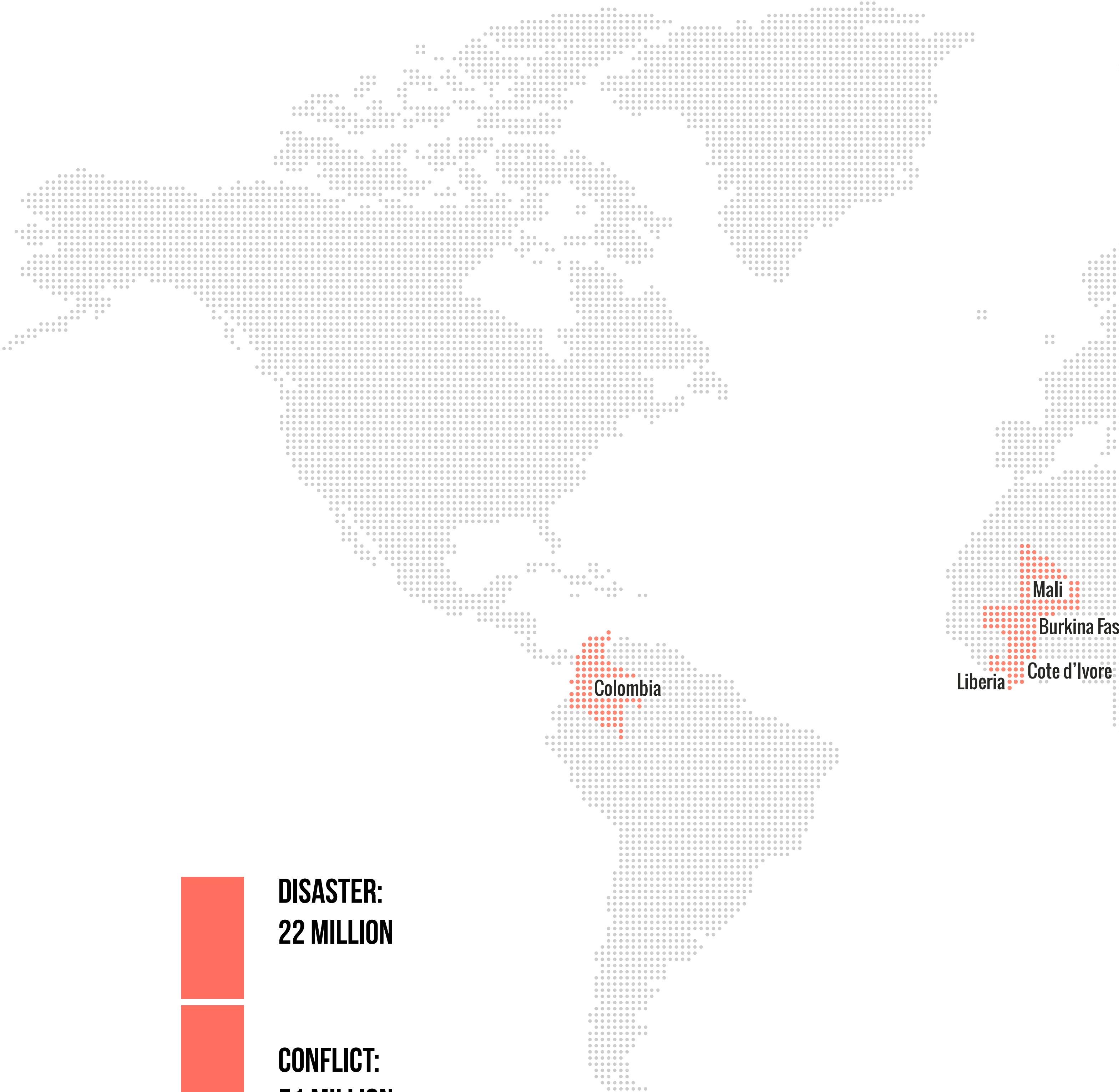
RESOURCES, CONTACTS AND CASE STUDIES LIBRARY





SOCIAL CAPITAL
EXPERTISE
SCALE
VERSATILITY
LOCAL VALUE
REUSABILITY
INVESTMENT
EFFICIENCY
LIFESPAN
HIGH
LOW

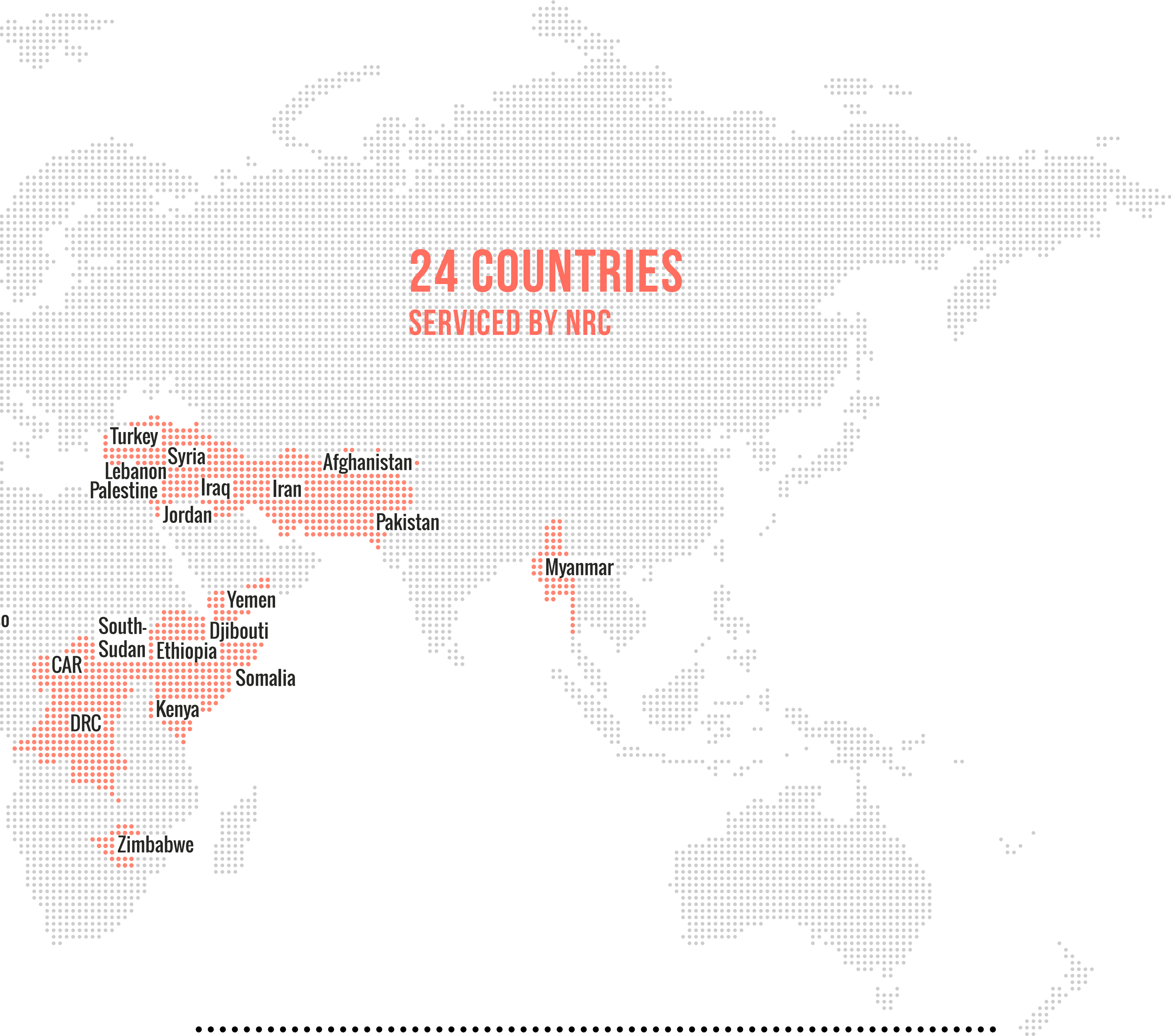




DISASTER:
22 MILLION

CONFLICT:
51 MILLION

DISPLACED
POPULATIONS AROUND THE WORLD



GLOBAL DISPLACEMENT – A GROWING PROBLEM

Current estimates show that over **73 million**[1] people are displaced by conflict and natural disaster in 2014. The bulk of this displacement is within the global South where access to services and support is already stretched and developmental and humanitarian needs are often interrelated and equally under resourced. Variable climates, cultures and contexts require different solutions to address the needs of displaced populations - yet an appreciation of the importance and methods of environmental strategies can help us achieve more sustainable humanitarian response.The map shows countries serviced by NRC in 2014 [2].

[1] www.reliefweb.int, www.unhcr.org.uk and www.nrc.no
[2] www.nrc.no

WHAT IS THE PROBLEM OF

WASTE

IN DISPLACEMENT SETTINGS?

WHERE ARE RESOURCES LOST?

AND HOW CAN WE INTERVENE?

WATER WASTE

- Loss of an increasingly valuable resource
- Stretches local water supplies presenting a source of conflict
- Using potable water for sanitation and other needs is costly
- Waste water acts as a pathway for disease presenting health hazards
- Wastewater treatment capacity is inadequate or nonexistent in most countries
- Waste water contaminates clean water sources and aquifers

ORGANIC WASTE

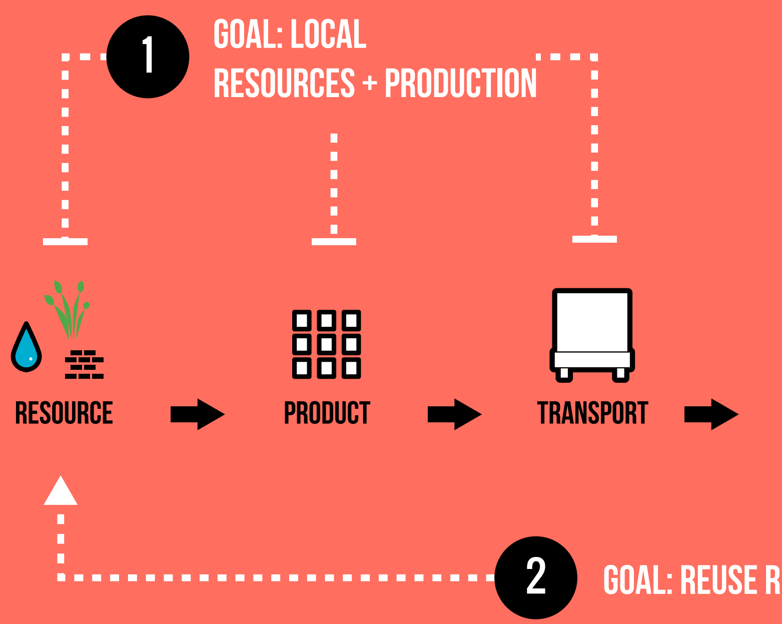
- Expensive methods are used for disposal, creating economic and environmental loss
- Mixing water and waste increases the complexity and costs of treatment and disposal
- Organic matter is a valuable resource
- The collection, transportation and disposal of waste is extremely costly
- Waste disposal capacity is inadequate or nonexistent in most countries
- Poorly treated or disposed of waste presents numerous health hazards

HOW CAN WE BREAK THE CYCLE OF LOSS?

In order to reduce losses and maximize local value, interventions should aim to improve existing resource flows.

Overall resource flow goals are to:

1. Use local resources and production
2. Reuse resources
3. Minimize loss to local community



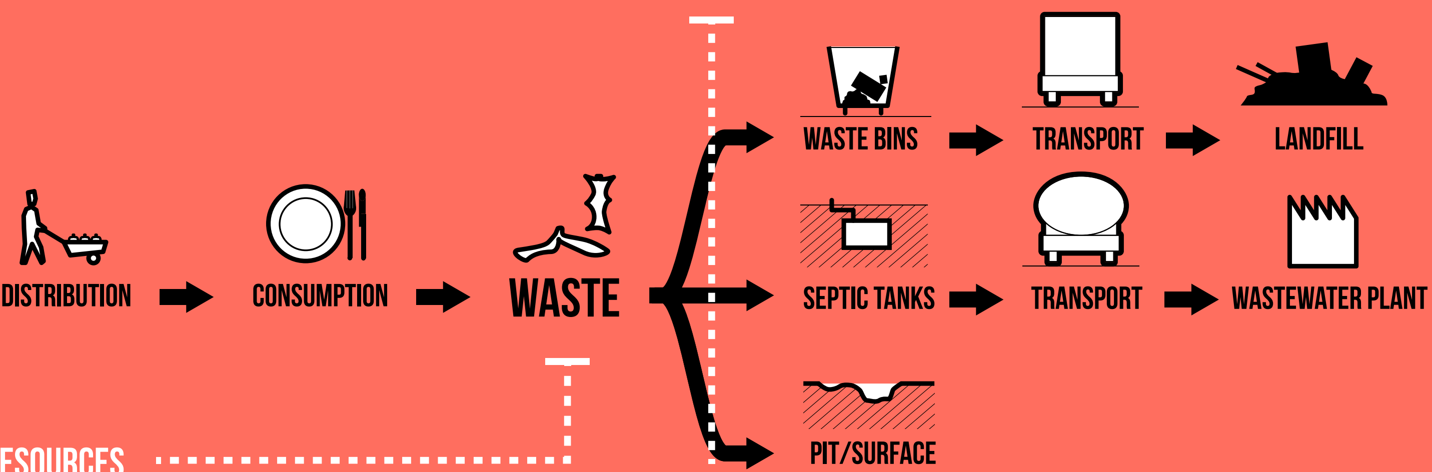
ENERGY WASTE

- Energy is expensive to produce and supply
- Most energy is from unsustainable sources
- Energy production requires large scale investment
- Tapping into local energy supplies presents a source of conflict
- Energy demands and needs are increasing and outstretch supply in many countries

MATERIAL WASTE

- Short term planning and focus results in increased costs due to;
- The frequent need to replace poor quality materials
- Repeat transportation of materials
- Inefficient and problematic structures (leakage, temperatures etc)
- Increased pollution from production, transportation and disposal
- Promotion of unsustainable practises

3 GOAL: MINIMIZE LOSS TO LOCAL COMMUNITY



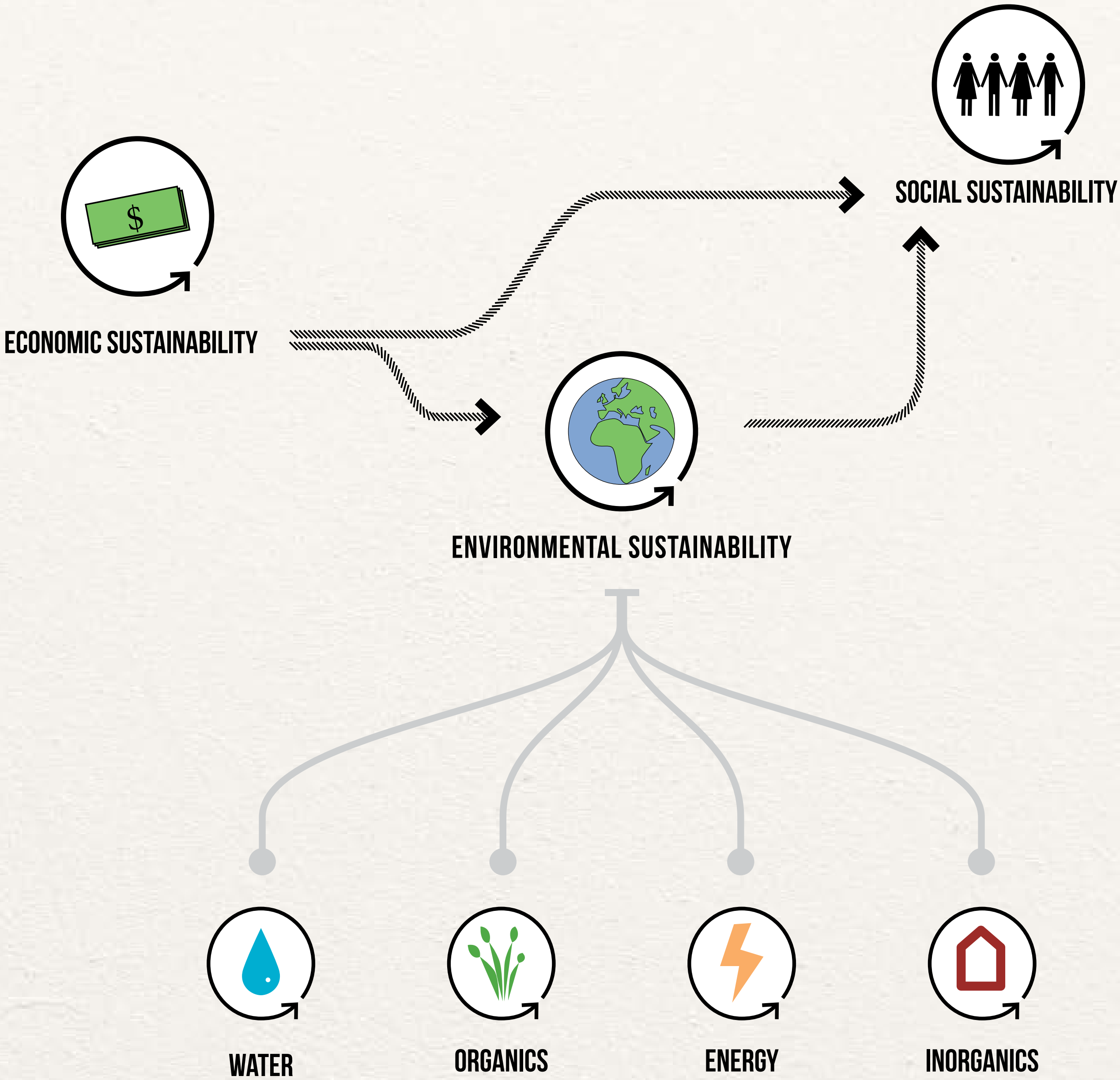
HOW CAN WE ACHIEVE SUSTAINABLE SETTLEMENTS?

In the majority of post disaster or displacement settings new technologies and approaches are introduced as a means to solve specific issues identified by the humanitarian community. Given short funding cycles, prioritisation is often placed on the delivery of physical products to beneficiaries with an assumption that the benefits of adopting this technology will rapidly become apparent to all. The reality and learning however, is that these benefits are often not considered to be a priority by the new users and are then significantly more likely to fail in meeting the initial objective.

To achieve the desired acceptance and ultimately sustainability, equilibrium must be found between the social, economic and technical elements of any intervention or process. If a new technology or approach addresses an issue and simplifies aspects of daily life then this is only half of the story. They must also be designed and delivered in ways that are culturally relevant and understandable, whilst presenting clear financial benefits and opportunities to enhance quality of life or status within a community. Once others see the benefits their friends and neighbours are enjoying they will also want to adopt the technology and this desire to replicate can then help establish a range of markets related to the production, sale or maintenance of this technology and any by-products or inputs associated with it. Once these economic drivers are established the technology or approach is likely to remain sustainable and self fulfilling until such time a better, cheaper or more convenient option is made available.

HOLISTIC THINKING

INTERVENTIONS MUST BE DESIGNED AND DELIVERED IN WAYS THAT ARE CULTURALLY RELEVANT AND UNDERSTANDABLE, WHILST PRESENTING CLEAR FINANCIAL BENEFITS AND OPPORTUNITIES TO ENHANCE QUALITY OF LIFE OR STATUS WITHIN A COMMUNITY.


ECONOMIC SUSTAINABILITY
SOCIAL SUSTAINABILITY
ENVIRONMENTAL SUSTAINABILITY
WATER
ORGANICS
ENERGY
INORGANICS

ACHIEVING SUSTAINABILITY IN A HUMANITARIAN SETTING

In humanitarian displacement settings the majority of resources are finite and very rarely are the systems and processes 'closed' which results in the production of waste. Waste as a concept can have varying meanings and does not necessarily denote something that is not useful, whilst dealing with any form of wastage has inherent costs.

A sustainable settlement could therefore be seen as one that focuses on efficiency, minimises wastage and makes use of all useful resources in as closed a cycle as possible. Efficiency and making full use of all resources available to a displaced community will therefore form the basis of this project.

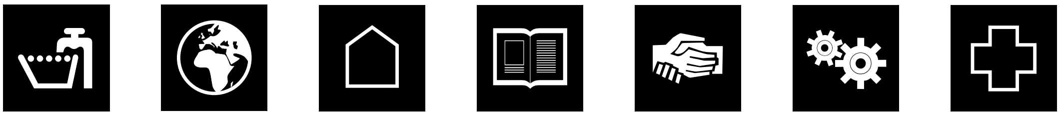
Displacement settlements hold great variations in terms of size, climate and culture, and thus have different needs. The project therefore aims at creating a framework for interventions which take specific problems and needs into account.

THERE IS NO SUCH THING AS WASTE

THERE ARE ONLY RESOURCES AND WAYS OF MANAGING THEM

A NEW PARADIGM OF "CROSS-CUTTING"?

WHY SUSTAINABILITY IS IN EVERYONE'S INTEREST

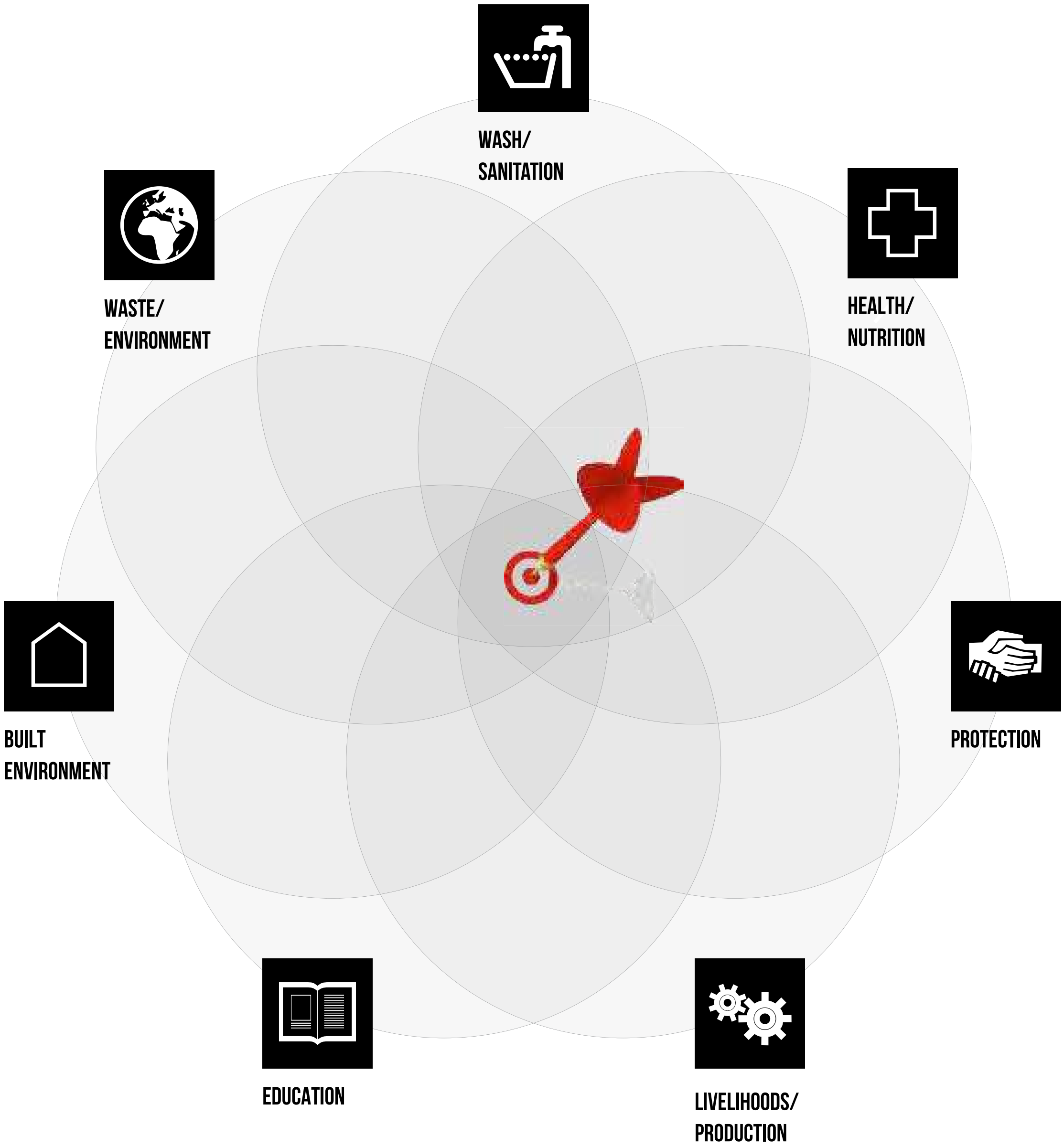


Current ways of working and approaching the support of settlements in humanitarian settings tend to address issues from within technical and sectoral silos, that whilst attempting to coordinate are often competing for scarce funding and attention. Prioritisation of these funds is often based on how best to solve the inevitable multitude of issues in the quickest and cheapest manner possible.

Such an approach - whilst fully understandable in the extremely difficult and pressured contexts of providing life saving assistance to large numbers of people - can ultimately prove inefficient with interventions having short life spans or causing new problems that require further investment. Recent analysis by NRC suggests that most conflicts are lasting for on average 11 years, whilst the average lifespan for a refugee camp is now estimated to be 12 years. As unpalatable as these facts may be they point towards a reality where longer term thinking should be the norm.

Decisions made at the start of a response often have long lasting ramifications for the evolution of a settlement and the issues faced by the displaced and hosting populations that live there. This fact and the inefficiencies that it can cause calls for broader approaches to planning, and looking at where sectoral overlaps might promote more integrated programme design. Collaboration and better understanding of the shared benefits that sector specific responses might have on the broader response and settlement development if done differently would help - and this is where sustainability concepts and approaches can positively influence humanitarian response.

By reviewing all planning in a sustainability framework where technical, social, environmental and economic factors are given equal importance, and the lifetime costs related to maintenance and operation of all interventions are considered, then opportunities may become apparent where savings can be made through efficient planning, design and integration or activities. Furthermore this broader approach could help incentivise host communities, local authorities and governments by making them a more significant part of the planning process and economic flow of the response. Addressing local settlement issues and utilising local capacities and work force as part of the response can also be more cost effective, promote good relations and reduce time lost through confrontation as well as spreading environmentally sensitive practise beyond the response itself.



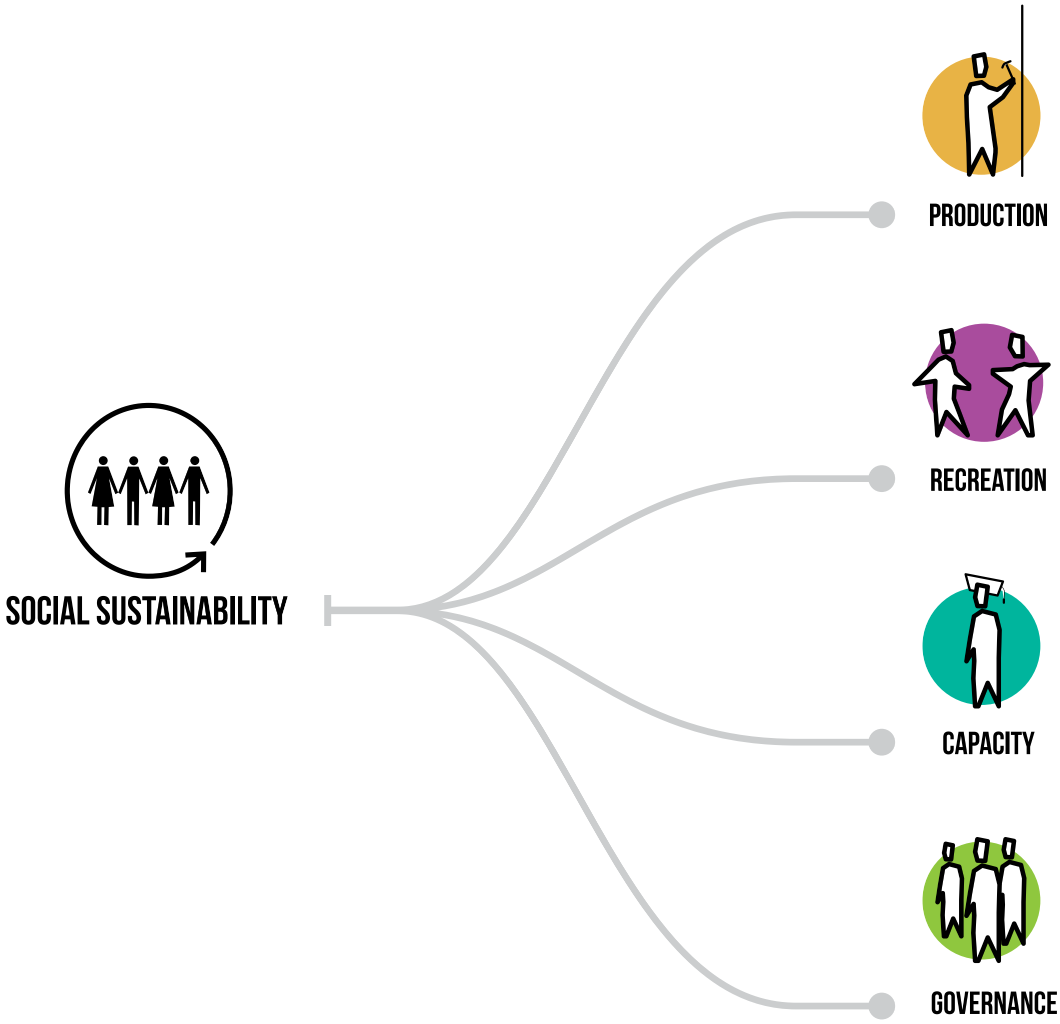
MAXIMIZE IT!

Themes affected by the interventions

Interventions should not only save costs, time and resources, but increase production, initiative, innovation and create new opportunities and benefits across sectors. These "multipliers" as part of a well planned settlement level approach are partially chosen for their potential to positively affect several sectors or overarching "themes" as described in this document. Although every approach described is related to WASH, environment or the built environment, locating intervention points and combining approaches in a way that multiplies qualities is a major focus of this project.

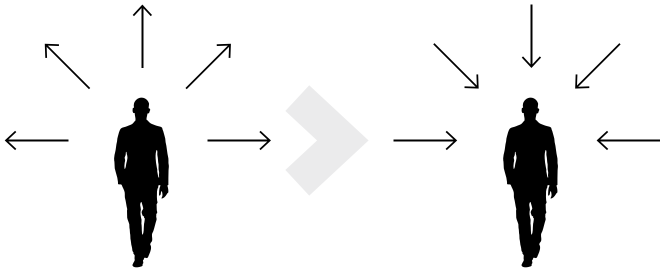
SOCIAL RESPONISIBILITY

THE SOCIAL AND ECONOMIC ELEMENTS OF SUSTAINABLE SETTLEMENTS



SOCIAL ENGAGEMENT

Within any people centred design process, extensive engagement with the end users is essential to understand how they understand and prioritise an issue, and what it is they actually require to help in addressing it. Detailed assessment and stakeholder discussion should not only show how a population might be able to engage but will indicate how they may be willing to adjust current behaviours or how they might prefer to access a particular service. Additionally engaging with communities not only provides opportunities for the mutual sharing of knowledge, but also helps identify what forms of training or education might best illustrate the benefits of a particular approach. Such broad focus on the social aspects of technology uptake and adaptation are essential in facilitating the required behaviour changes needed to make acceptance of new technologies and methodologies viable.



ECONOMIC ENGAGEMENT

Traditional humanitarian approaches have often relied on assumed principles that people affected by disaster or conflict can be considered a homogenous group and that they are easily motivated to adopt or engage in new approaches for the communal benefit of all. In reality such reciprocity is rare and the majority of people when faced with uncertainty and dislocation from their normal lives will instead focus on doing whatever is necessary to ensure the survival and comfort of themselves and their families. This instinct for survival often finds itself expressed through attempts to engage in economic activities which can present opportunities when introducing new technologies and approaches or developing means to promote their maintenance.

The potential to earn money and improve personal situations motivates individuals, and the more niches around an intervention that might support the development of a market, the greater the likelihood for acceptance. If markets can be established around the provision of an intervention that has clear benefits such as cost savings or improved health then others will find ways to replicate the approach which further assists in the scalability of delivery across a population. Humanitarian agencies may need to continue supporting aspects of an intervention within the settlement to ensure it remains viable but in some instances the benefits of a system will ensure its maintenance whilst competition between service providers will help keep costs down.

Achieving balance between the three pillars of sustainability takes a considerable investment of time and other resources - but it is essential in most instances and without such an understanding then many of the technical interventions within this catalogue are unlikely to work. This engagement with communities needs to be done over a longer time frame than the physical delivery of the intervention and project design must reflect some form of ongoing support, monitoring and mobilisation.

NRC's history and expertise in Camp Management with its focus on participation and support to community structures should be harnessed to compliment the delivery of technical solutions, and together with the growing understanding around markets and livelihoods can complement the delivery of projects to make settlements more environmentally sensitive and sustainable.

THE POTENTIAL TO EARN MONEY AND IMPROVE PERSONAL SITUATIONS MOTIVATES INDIVIDUALS, THE MORE NICHES THERE ARE AROUND AN INTERVENTION THAT MIGHT SUPPORT THE DEVELOPMENT OF A MARKET, THE GREATER THE LIKELIHOOD FOR ACCEPTANCE.

POLICY AND ADVOCACY

HOW TO ACHIEVE DEVELOPMENT WITHIN THE HUMANITARIAN SECTOR

Achieving increased efficiency and sustainability within the humanitarian sector requires more than an increased focus on innovation and investment in new technologies. For many new and existing approaches to reach their full potential a willingness is required to investigate the current ways of working and the architecture of the humanitarian sector so that the potential for this project to address broader systematic issues is not lost.

Humanitarian agencies are often the most visible partner in an emergency, but other partners can have significantly more impact on improving the sustainability of a response and these are primarily the governments of affected states and the donors supporting the response. The policies and priorities of donors and governments are often the key drivers of not only what interventions are possible but also how and when they are delivered which in turn impacts on the sustainability of the whole response.

Engaging with these and other key stakeholders on how to better influence sustainability and efficiency through funding strategies could be seen as a key area of potential for this project.

TRADITIONAL FUNDING APPROACHES HAVE FOCUSED ON QUICK FIX SOLUTIONS TO THE ISSUES ASSOCIATED WITH DISASTER AND DISPLACEMENT, AND THESE SOLUTIONS ARE OFTEN DIFFICULT TO INTEGRATE INTO A BROADER DEVELOPMENT AGENDA.

Traditional funding approaches have focused on quick fix solutions to the issues associated with disaster and displacement, and these solutions are often difficult to integrate into a broader development agenda. To bridge this gap, ensure greater impacts, and facilitate increased value for money a greater appreciation of the importance of longer term planning and upfront capital investment is required. This along with greater degrees of flexibility and appreciation for the constraints and complexities of implementing meaningful projects within tight timeframes would benefit all parties - especially the effected populations.

Additionally private sector actors are playing increasingly important roles as providers of new expertise, products, approaches and tools and there is little doubt the humanitarian community can be influenced by learning and experience from the private sector on a range of issues. Sustainability and efficiency in particular would appear to have particular resonance for this type of exchange given companies are obliged to simultaneously maximise profits and reduce their environmental impacts which they often achieve through being highly efficient. The humanitarian sector struggles in this area given the requirements to plan within a broad range of constraints which make efficiencies hard to measure, define and indeed enforce.

POTENTIAL AREAS OF FOCUS INCLUDE:

INTERNAL TO THE HUMANITARIAN SECTOR

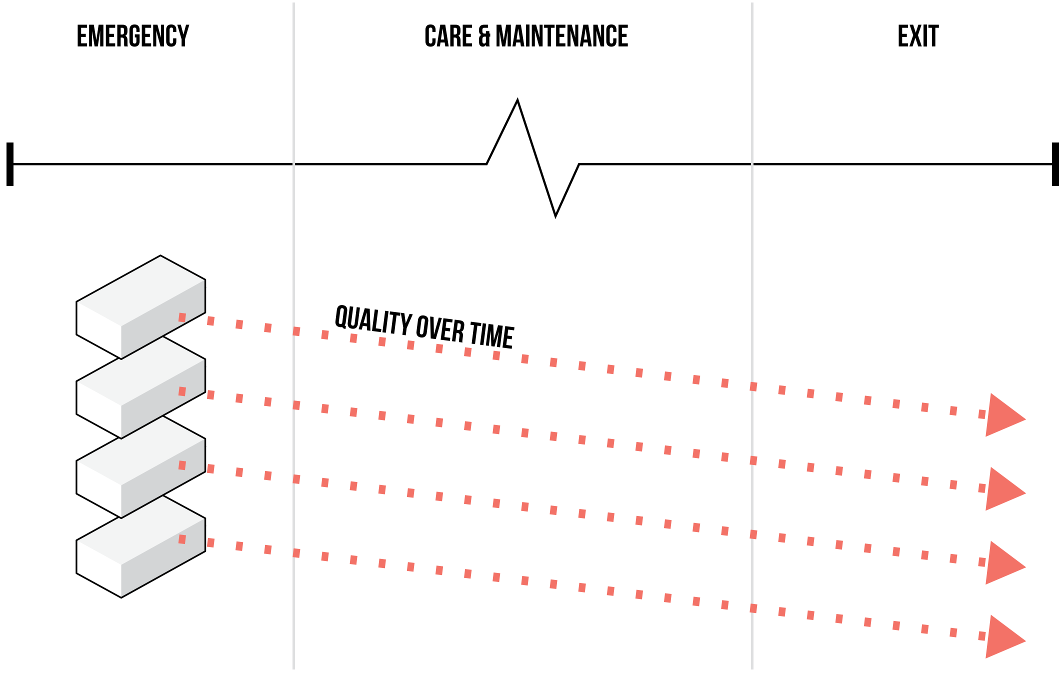
- Engaging with agencies around following and implementing activities according to existing environmental policies - or developing new ones as required.
- Developing operational guidance and tools related to supporting the implementation of such policies
- Developing operational guidance and tools to facilitate the collection of information and evidence to support more strategic funding investment
- Investigating alternative funding options and opportunities – engage with ongoing sectoral discussions around alternative humanitarian funding approaches.
- Encourage increased dialogue between the humanitarian/development sectors with the environment sector – especially given predicted impacts of climate change.

Engaging with donors

- Lobbying of traditional donors around funding strategies with a focus on increased capital investment for longer term cost saving and additional efficiencies. Current funding processes are neither reflective of displacement trends or promote cost efficiencies or investment in greener technologies or approaches.
- Work with donors to advance more innovative funding approaches – 'Hire Purchase' of large scale environmentally friendly technology and infrastructure systems for humanitarian use
- Develop guidance around 'risk sharing' related to use of innovative products or approaches –the current system does not encourage the sector to take risks with new ways of working.

Engaging with the private sector

- Work with the private sector and others on identifying ways to share learning around approaches around increased efficiency, sustainability and the constraints of scalability
- Development of strategies to facilitate engagement or marketing of approaches to local authorities, donors and other stakeholders.
- Engage with ongoing sectoral discussions around alternative humanitarian funding approaches and the role of big business and the private sector



INSTEAD OF FOCUSING ON MAINTAINING OR REPLACING INTERMEDIATE SOLUTIONS, INVESTING EARLY IN SYSTEMS DESIGNED TO BE GRADUALLY IMPROVED OVER TIME CAN CONTRIBUTE POSITIVELY TO THE LOCAL ENVIRONMENT AND ECONOMY

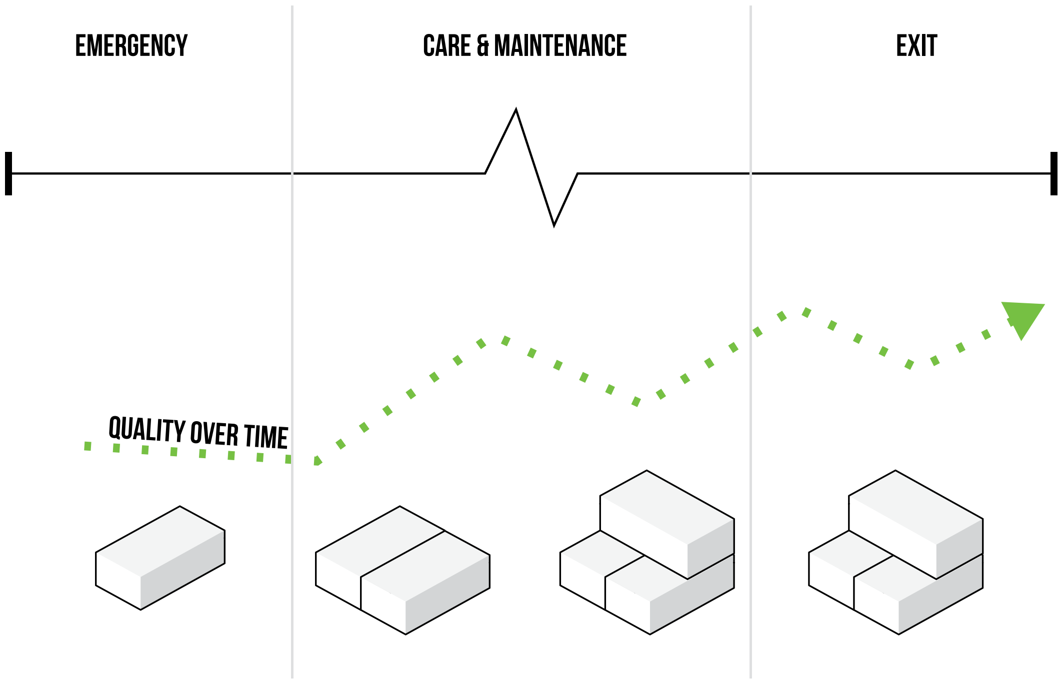
CURRENT SITUATION

Quality decreasing over time

The bulk of investment is made in providing emergency solutions with a short term focus to meet immediate needs. Very quickly the quality of infrastructure and services decreases due to high maintenance requirements and costs, and minimal provision for care and maintenance activities in planning or budgets. The quality further decreases until such a time that expensive replacement activities become unavoidable requiring significant reinvestment to maintain the same or similar standards. This approach of deploying entirely new solutions and replacing existing structures at different stages of settlement development is often extremely wasteful and inefficient in both time and financial investment, and negatively impacts beneficiaries whilst presenting low value for money to donors.

THE GRADUAL APPROACH

WHY INTERVENTIONS SHOULD BE MODULAR AND INCREMENTAL



GRADUAL DEVELOPMENT

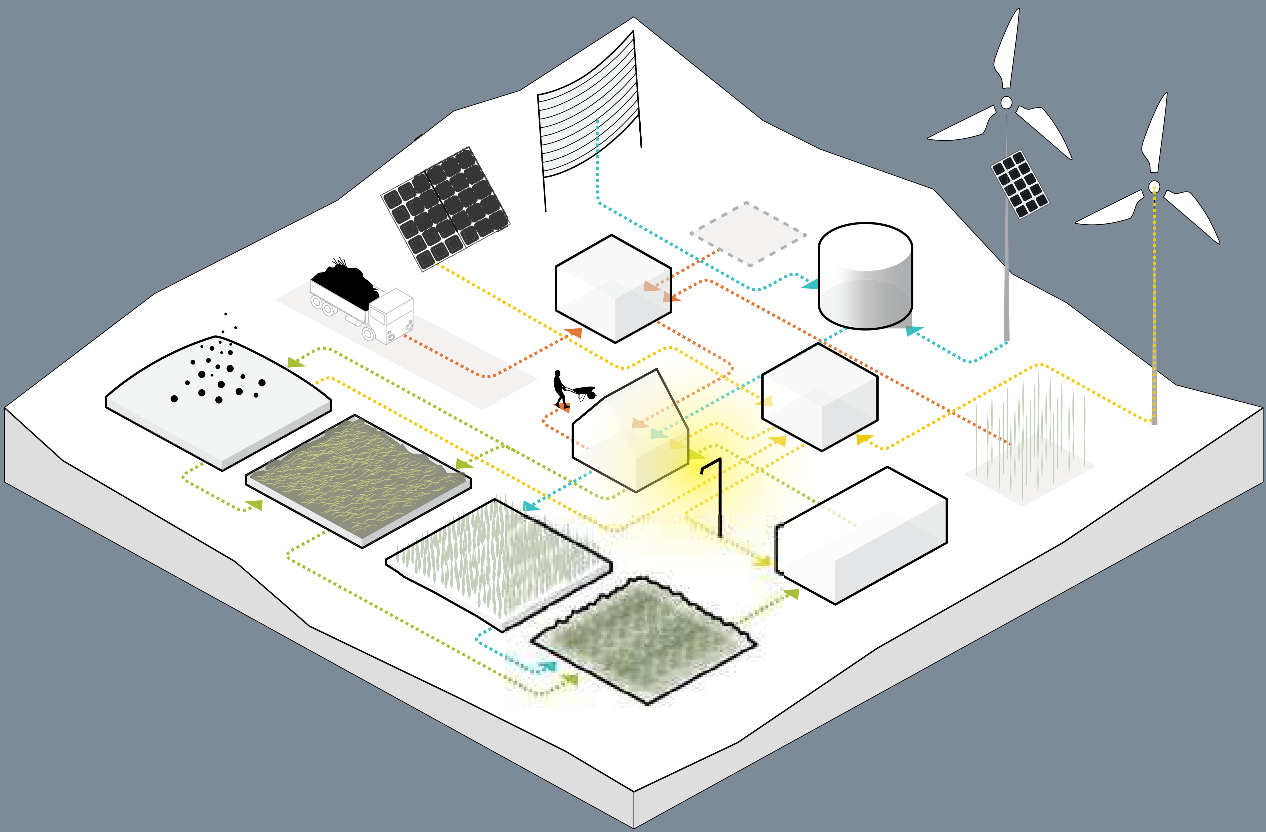
Leaving value behind

By planning for incremental growth and investing more in the initial interventions, maintenance requirements are reduced allowing secondary investment to focus on expanding and improving systems rather than replacing them. Good design allows for improvements to be built upon, utilising and adding to existing materials and components where possible and gradually increasing quality. Investing time and resources earlier in a response can still deliver low-tech solutions that are quick to implement and respond directly to people's needs, but that have the flexibility to evolve into larger, more permanent structures whilst presenting lower running costs over the lifetime of the intervention or settlement. More detailed investment in the planning process may also add the significant value of interacting more directly with users, creating educational and livelihood opportunities, strengthening the local economy and increasing sustainability. Although permanence is often controversial in humanitarian settings the delivery of higher quality services and infrastructure support can ultimately present opportunities to host communities and governments which in turn can be used as strong advocacy and negotiation tools.

MODULAR SOLAR SYSTEM

The project "Indigo pay-as-you-go solar" by Eight19 is an example of how a low-cost modular household energy supply system can bring energy to off the grid locations through incremental payment and expansion.

www.eight19.com



INTERVENTION CATALOGUE

A RESOURCE BASED APPROACH

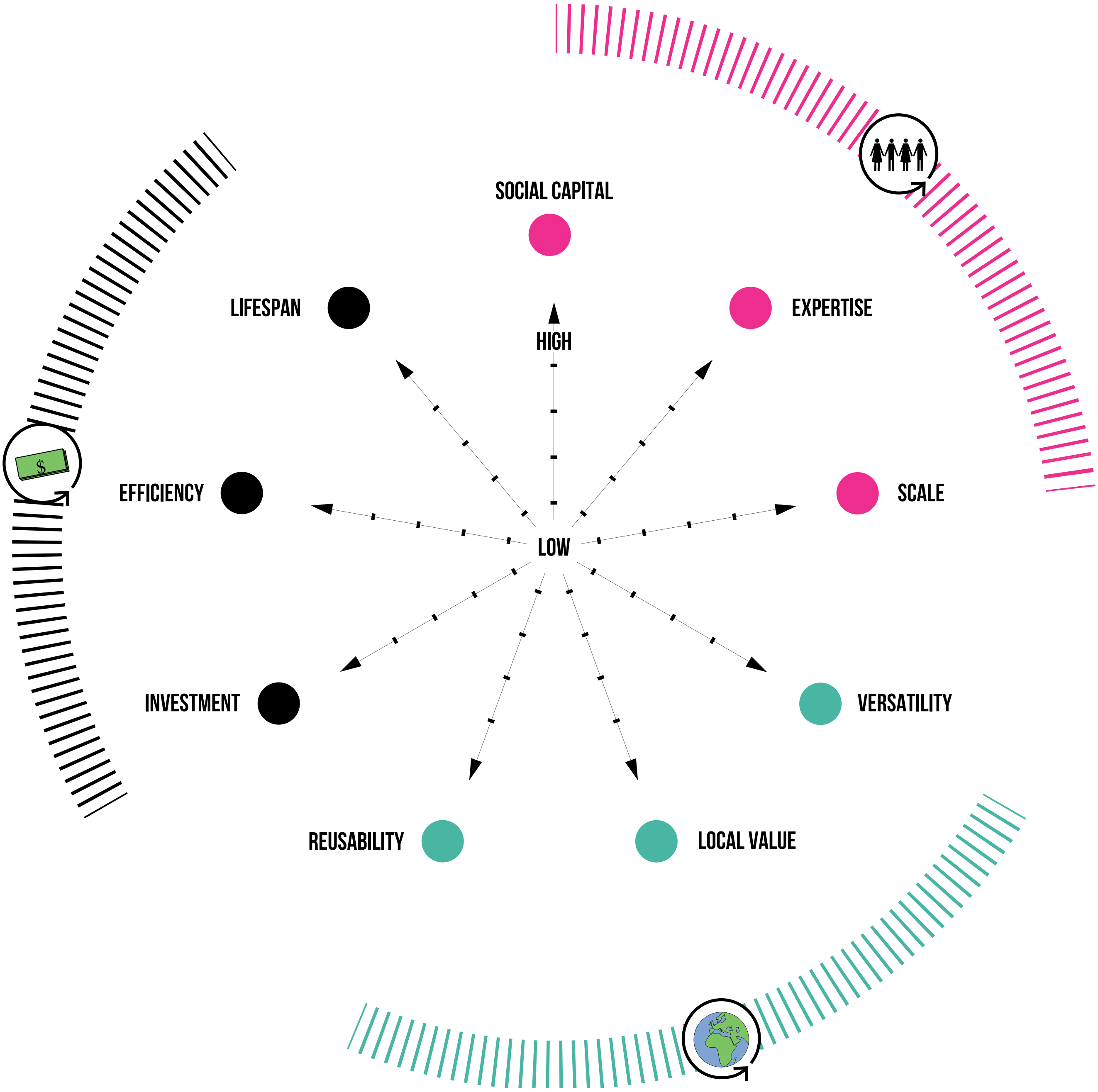
A series of overlapping "cycles" or resource flow concepts are set up to maximize the impact of each intervention. The goal of the cycles is to improve existing resource flows and also create new opportunities where possible. All interventions are part of a cycle, and while able to function alone, each will function better in combination with other - complimentary - interventions.

WATER
Provision and reuse

ORGANICS
Turning waste into nutrients

ENERGY
Production and reduction

MATERIALS
Inorganics and building materials



ECONOMIC PARAMETERS

SOCIAL PARAMETERS

ENVIRONMENTAL PARAMETERS

PARAMETERS

Variables by which to evaluate quality and applicability of solutions among a multitude of available techniques

Each of the three sustainability areas are broken down into parameters which each intervention will be evaluated by, on a rudimentary scale from low to high. Many parameters are hard to measure, and vary greatly depending on circumstances. The "sustainability score wheel" is therefore to be considered a basic indicator for the expected viability of the intervention.

ECONOMIC

INVESTMENT

How much does it cost initially?

Initial investment per unit, including materials, construction and transportation.

Will vary with the complexity of the technologies used and must be seen in relation to running costs and lifetime.

COST EFFICIENCY

How high are running costs, and how long is payback time?

Energy and resources needed to run and maintain the process over time.

Interventions with shorter payback periods which potentially save costs over time compared to existing methods will be prioritized.

LIFESPAN

How long can the method or product last?

Does the intervention have a lifespan appropriate for the expected period of displacement? Must be seen in relation to investment and running costs.

Capacity for incremental growth and improvement.

SOCIAL

SOCIAL CAPITAL

Does it create and sustain local opportunities?

Livelihood opportunities

Interactions with local economy

Using local resources

Creating values to host community

EXPERTISE

How easy is it to construct, use and maintain?

Interventions may require training to construct and maintain, which needs to be provided as part of the solution and has an intrinsic educational value.

Ease of use also includes changing of behaviour, cultural values (e.g. unusual or collaborative systems like home based/collective waste management systems).

SCALE

How many people can it serve?

The number of people serviced by the smallest whole unit of the intervention.
Scale:
Individual > family > neighbourhood > district > settlement

Solutions which function alone while also effectively connected to potentially serve large populations will be prioritized.

ENVIRONMENTAL

VERSATILITY

Can the solution be applied in varied climates and cultures?

Temperature, climatic zone, altitude, humidity, inclination.

Cultural issues, local traditions and special circumstances need to be taken into consideration (e.g. public facilities may be acceptible in one country but inappropriate in another).

LOCAL VALUE

Does it improve the local environment?

"Environment" covers local ecosystem, water quantity and quality, air and soil quality and microclimatic conditions such as temperature and humidity.

Solutions must, as a minimum, not worsen the state of the local environment or microclimate.

REUSABILITY

Can it easily be reutilized, upcycled or repurposed?

Design for disassembly (planning for the separation of materials to be reused or recycled)

Modularity (additive systems)

Secondary uses (adaptability for reuse in other settings)

Healthy and recyclable materials

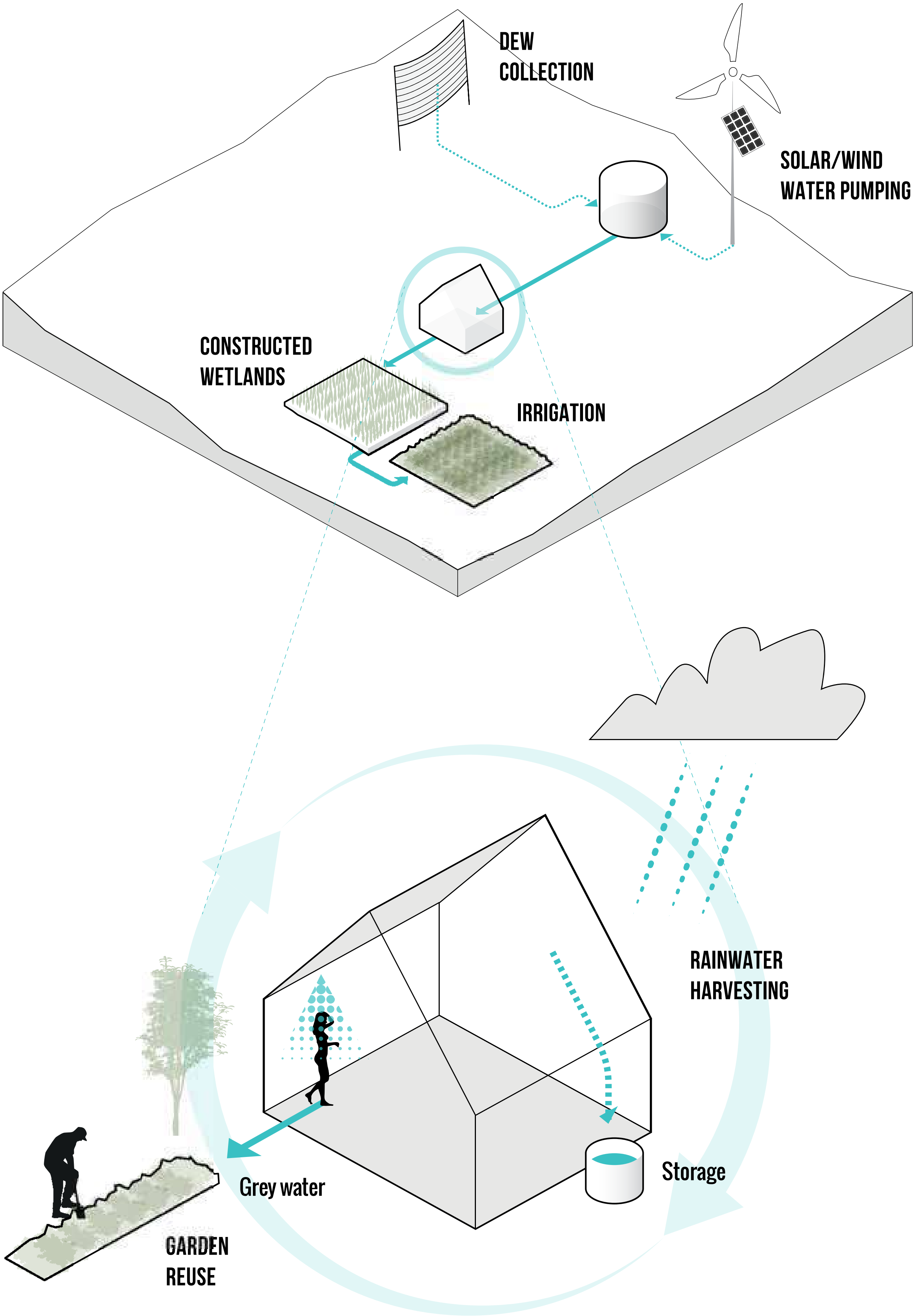
WATER

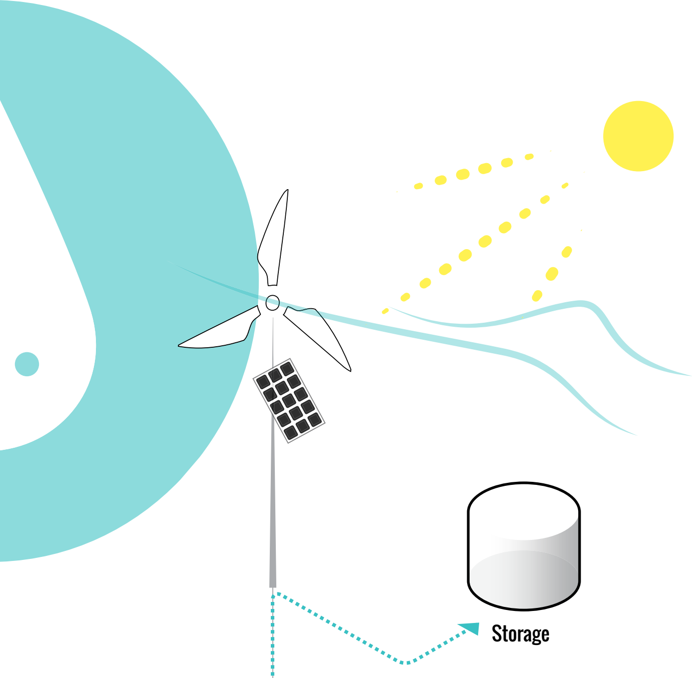
LEARNING FROM NATURE'S CYCLES

Water is essential for life and an increasingly valuable resource. The aim of this section aim is to ensure healthy and sustainable use of water resources. By designing processes where water is used in several stages, utilization is maximized for the benefit of the environment, economy and most importantly, the users.

Interventions are relatively low-tech and focus on how to locally procure and reuse water on community and household levels.

For Water resources, contacts and case studies, see **page 85**


DEW
COLLECTION
SOLAR/WIND
WATER PUMPING
CONSTRUCTED
WETLANDS
IRRIGATION
RAINWATER
HARVESTING
Storage
Grey water
GARDEN
REUSE



SOLAR/WIND POWERED WATER PUMPING

Accessing local aquifers with local energy

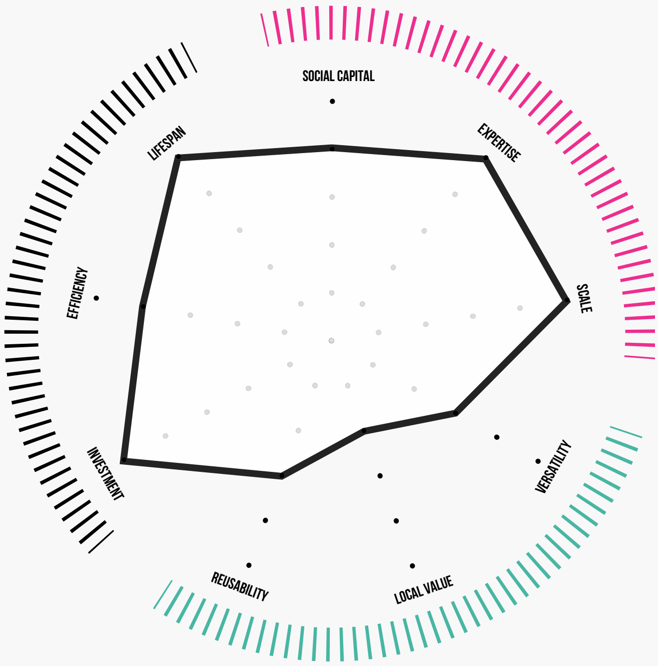
Water provision is one of the most essential activities within humanitarian emergency response or the running of a camp. Pumping water from boreholes or moving it through piped networks within camps and other settlements requires significant amounts of energy which is generally provided by diesel generators.

Windmills have been used for centuries to power the mechanical pumping of water and more recently have gained in popularity for the direct production of electricity which can be used to power electrical water pumps. With ever increasing costs and issues of access, providing reliable supplies of fuel for generators is becoming an increasing issue within humanitarian settings.
Given that significant areas of the world have reliable enough wind speeds to make the use of windpumps either mechanically or for the production of electricity to run pumps then the use of wind is increasingly being seen as an economically sensible and viable option.

Photo voltaic solar systems are becoming increasingly affordable and efficient and as such are now seen as entirely suitable for use in humanitarian settings given their relatively quick payback time frames and efficiencies.

Combining wind generators with solar systems provides a highly adaptable means to power electrical water pumps - or any other component of a water system that requires or benefits from electrical power.

Affected themes:



SUSTAINABILITY SCORE

Gains:

- After initial investment provides 'free' pumping of water.
- Unattended operation and low maintenance.
- Mechanical wind pumps can run 24 hours a day assuming correct wind speeds, are cheap and relatively low tech.
- Solar technology is improving rapidly and costs decreasing - rapid payback.

Challenges:

- Water storage capacity is required as reliant on wind or sun to work (combined wind/solar system with battery pack would reduces risks for electrical run pumps)
- Electrical systems require specific technical skill sets for set up and maintenance.
- Wind speed data is not available for many parts of the world and requires detailed planning.
- Mechanical pumping works best for pumping from shallow depths (under 75 metres). Large generator windmills can be expensive increasing 'payback' times.
- Solar only works during the day and high capacity batteries are very expensive and have comparatively short life spans.

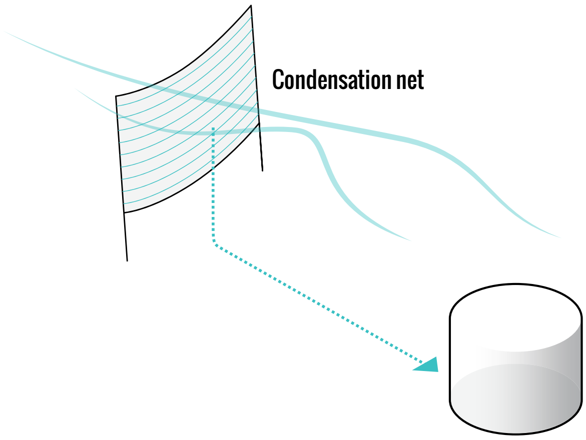
RECOMMENDATION

NRC already has experience of using solar systems for the pumping of water in Dadaab and Somalia and as such sees this as a key area of intervention. The use of wind for electricity generation needs to be considered as either a stand alone or to compliment solar systems whilst mechanical wind pumping has significant potential in areas with high ground water. Replacing diesel generators with alternative energy sources should become a standard NRC intervention.

PUMPING, DADAAB

Diesel powered generators were replaced with solar systems in Dadaab refugee camp in Kenya to pump water for thousands of people.

Read more **here**



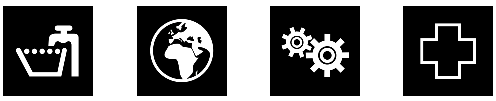
DEW COLLECTION

Harvesting fog in high altitudes

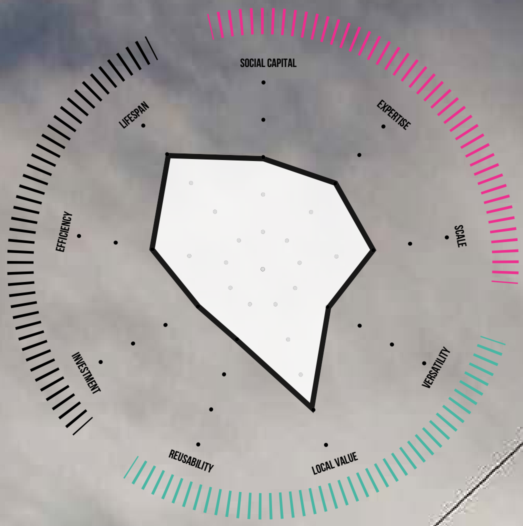
Dew harvesting takes advantage of water vapor in the atmosphere to harvest clean and potable water through condensation. A large surface such as a plastic sheet is laid out over the ground with an air gap underneath overnight and any humidity in the air will condense on this once the surface temperature is cooler than the surrounding air. The condensed dew then runs down into positioned collection vessels.

Fog harvesting makes use of a fine plastic mesh to capture enormous numbers of tiny water droplets from windblown fog. The water droplets condense and accumulate on the mesh and simply run down into collection vessels. Typical fog harvesting in a well selected desert environment would be 5 liters of water per square meter of mesh per day.

Affected themes:



Wash Environment Livelihoods Health / Nutr.



SUSTAINABILITY SCORE

Gains:

- After initial investment provides ‘free’ potable water
- Unattended operation and low maintenance requirements

Challenges:

- Produces low volumes of water
- Dependant on specific climatic and weather conditions

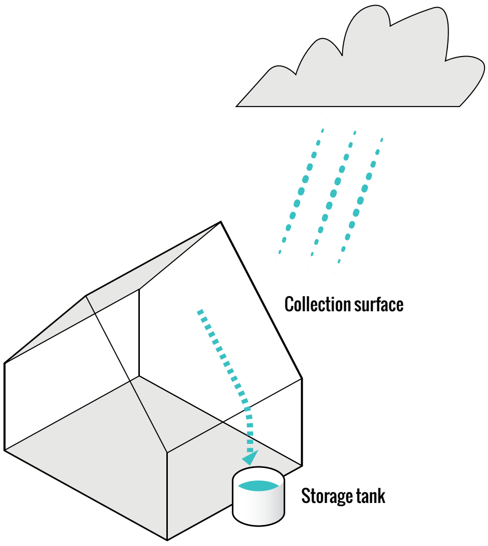
RECOMMENDATION

The small volume of water that these technologies produce along with their dependence on specific climatic conditions does not make this a widely applicable option within humanitarian settlements. However, in particularly water-scarce regions fog nets can produce a useful supplement, providing that the highly specific climatic conditions are met. Also, research into wind powered water condensers is at an early phase and worth following.

FOGQUEST, CHILE

Fog nets at the Atacama Desert Center in northern Chile provide on site gardens with 300 l of water daily each.

www.fogquest.org



RAINWATER COLLECTION

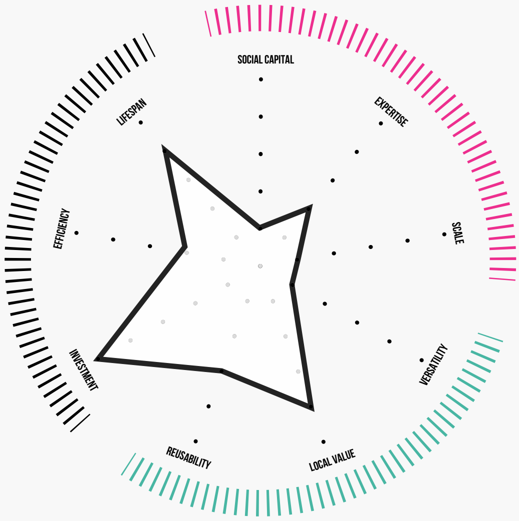
Supplementing supply

In many humanitarian settings water is an extremely valuable resource and may have to be transported long distances, pumped from deep underground or perhaps contaminated with chemicals or human waste. In these cases harvesting rainwater can be an effective and low-cost option for meeting at least a portion of a community's water requirement, enabling households as well as community buildings, schools and clinics to manage their own water supply for drinking water, domestic use, and income generation activities. Additionally having on site stored water relieves the burden of water carrying, particularly for women and children.

Rainwater can be intercepted and collected in many different ways with the most common being collection from the roofs of structures such as houses or schools using guttering and some form of storage tank. Rainwater harvesting can be suitable even when a roof is small. E.G a 5 x 6 meters house, with 500 mm annual rainfall, receives 15.000 litres of rainwater on its roof each year which is a useful and valuable resource.

Different catchment types can also be used such as surface catchment and river and snow run off diversion, which collects surface water into underground cisterns. No matter the source of water the key to the success of any rainwater harvesting is the size of the tank which is usually a compromise between cost, the volume of water required, and the length of the dry season.

Affected themes:



SUSTAINABILITY SCORE

Gains:

- Possible in almost any climate with more than 100-200 mm annual rainfall
- Well-designed systems generally meet drinking water quality standards
- However using stored water for sanitation and irrigation purposes reduces the need for flushing systems and maintenance requirements
- The bigger the volume of the storage tank, the lower the material demand (and costs) for construction per m3 of tank volume

Challenges:

- Large and expensive storage tanks are needed to store enough water to bridge dry periods
- Water usage needs careful oversight - ownership and understanding of the value of the system are key to ensure maintenance
- Generally expensive to provide at scale to household level
- If used for drinkning purposes, regular storage tank cleaning and foul-flush diverters are required
- Uncovered tanks can become contaminated or provide a breeding place for mosquitoes
- tank size, design and management are essential as system must meet significant water needs during key periods of the year
- The system should be checked and cleaned after every dry period exceeding one month

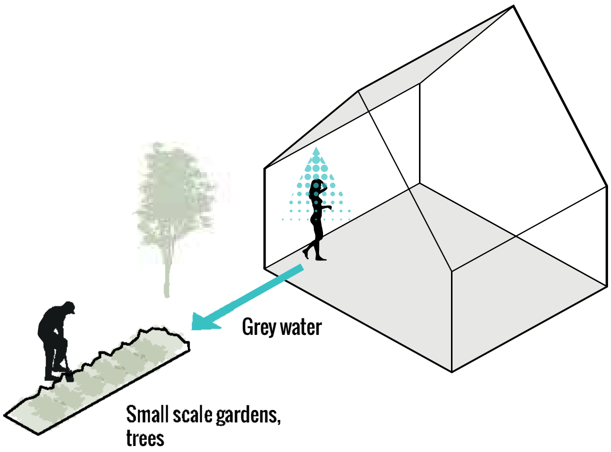
RECOMMENDATION

Rainwater harvesting has a mixed history within humanitarian settings as sufficient efforts to ensure people understand the value of a well managed system are not factored into the project design. Small volume storage also provides only short term benefits and maintenance demands mean that the viability of such storage for use as drinking water is often questionable. NRC therefore should consider the implementation of such systems with very large scale storage for use in communal facilities such as schools and clinics in areas with long dry seasons and where other sources of water are hard to access.

WEDC/TEAR FUND

A range of low cost rain water harvesting techniques were trialled in South Sudan to provide clean drinking water for an influx of returnees

Read more **here**



GREY WATER REUSE

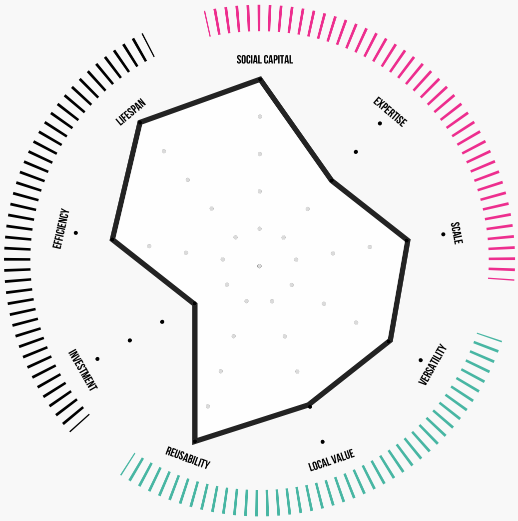
Small-scale gardens absorb contaminants

Households and settlements produce large volumes of ‘grey water’ - waste water that has been used during washing or cleaning of people, food, clothing or belongings. Although not suitable for drinking, this water is generally only mildly contaminated with chemicals and organic matter and is therefore entirely suitable for re-use for sanitary purposes such as flushing toilets, or for the irrigation of plants at both a household level or for agricultural purposes. These approaches can either function in a standalone capacity to reduce the volumes of water required by a household or community and the volumes of waste water produced and requiring treatment, or as part of a broader waste management system.

For irrigation and agriculture the grey water not only needs to be safe to handle but must also have concentrations of detergents and other chemicals that are low enough for plants to process and no presence of pathogens that could enter the food cycle. The high nutrient content of the wastewater reduces the needs for fertilisers and the reliability of supply helps increase the productivity of gardens and fields whilst also reducing the volumes of water requiring treatment or that may accumulate in low areas forming stagnant pools suitable for mosquitoes and other disease vectors to proliferate.

Affected themes:

Wash | Environment | Built env. | Education | Protection | Livelihoods | Health / Nutr.



RECOMMENDATION

Utilisation of household grey water is talked about in the majority of humanitarian settlements yet rarely receives the attention it deserves as a standalone activity. NRC should focus on this activity as a means to improve the local environment within settlements, reduce the negative health implications of standing water and maximise the use of a valuable resource. Links with nutrition and livelihoods can also be easily made depending on the situation.

SUSTAINABILITY SCORE ▲

Gains:

- The high nutrient content of the wastewater helps save on the fertilizer costs
- Reduces volume of water being supplied
- Reduces volumes of waste water requiring treatment
- Provides a reliable supply of irrigation water as wastewater is available all year round
- Irrigation of gardens and fields can increase food security and employment opportunities
- Disease vectors are inhibited - waste water provides mosquitoes with breeding sites
- Vegetation improves the local environment

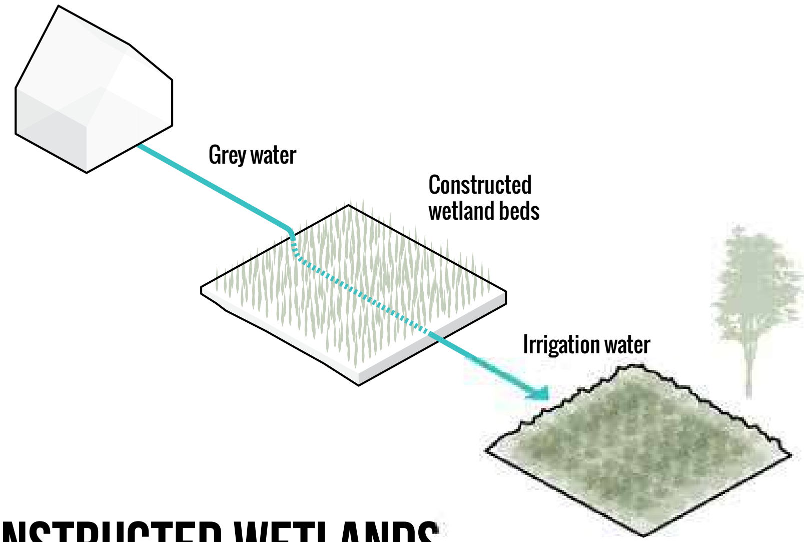
Challenges:

- High salt content of detergents can over time cause soil salination and the accumulation of heavy metals in the soil
- Salts and chemicals will kill some plant species or reduce growth and productivity
- Waste water may contain pathogens harmful to health

IRC IN ETHIOPIA ▼

Grey water reuse in a variety of small scale household gardens was promoted in Ethiopia to help the growth of food crops and improve food security and nutrition. The image shows a “keyhole garden”, a layered bed with a walkway for easy access.

Read more **here**



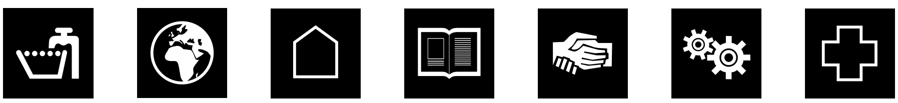
CONSTRUCTED WETLANDS

Natural biofiltration using local plants

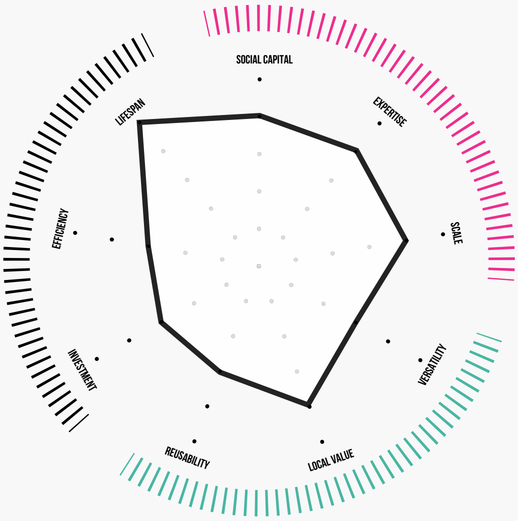
Constructed wetlands are engineered systems that treat waste water by replicating the naturally occurring processes of a wetland, marsh or swamp. As water slowly flows through the wetland, particles settle, pathogens are destroyed, and organisms and plants utilize the nutrients, cleaning the water. Constructed wetlands are optimally used as secondary treatment process for black water or primary treatment for grey water, although theoretically waste water can be treated in constructed wetlands to the point that it is once again suitable for human consumption. In humanitarian settings however treated water would be most suitable for small-scale irrigation or recharging of local groundwater sources.

Wetlands are constructed by lining a wide, shallow channel or basin with an impermeable barrier (clay or geo-textile) and then covered with a filter medium of rocks, gravel and soil and planted with native aquatic plants (e.g., cattails, reeds and rushes). Water then flows through the gravel which acts as a filter for removing solids, a fixed surface upon which bacteria can attach, and a base for the vegetation. As the water moves through the wetland, simultaneous physical, chemical and biological processes filter solids, degrade organics and remove nutrients from the wastewater. Through specific design variations different kinds of constructed wetland promote varied processes depending on the levels of treatment that are required. When combined with other physical treatment methods such as bio-digesters constructed wetlands clean waste water to the point it is safe for irrigating crops and can even be made potable with a few additional treatment processes.

Affected themes:



Wash | Environment | Built env. | Education | Protection | Livelihoods | Health / Nutr.



SUSTAINABILITY SCORE

Gains:

- Low operating costs
- No real problems with odours if designed and maintained correctly
- Aesthetically pleasing and provides animal habitat
- High reduction of BOD and solids

Challenges:

- Requires expert design and construction
- Not appropriate for untreated blackwater, so septic tanks or other systems are also required
- Long start up time to work at full capacity
- Risk of clogging, depending on pre- and primary treatment - gravel will need replacement approximately every 10 years
- Best suited for warm climates

RECOMMENDATION

Building on from household level irrigation utilising grey water, constructed wetlands offer opportunities to process larger volumes of water. Given constraints of space, wetlands might be most viable as part of community level septic or bio-digestion systems but as a relatively simple and effective technology they should be considered for all settings where there are large volumes of water requiring secondary and tertiary level treatment.

INSTITUTIONAL SCALE, TANZANIA

Constructed wetlands were provided as part of institutional waste water treatment systems at schools and colleges in Tanzania which has provided valuable learning around ensuring successful replication.

Read more **here**

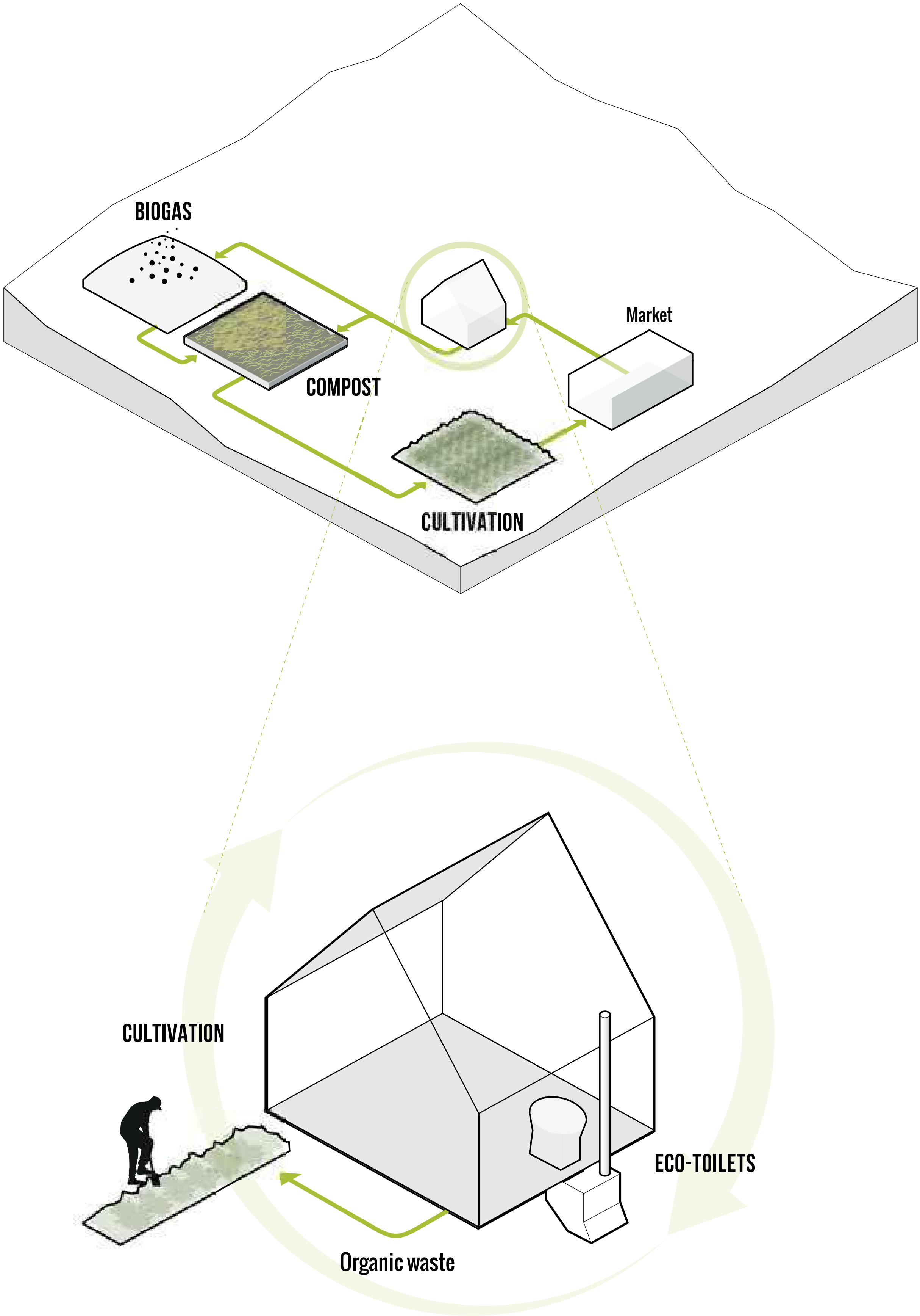
ORGANIC RESOURCES

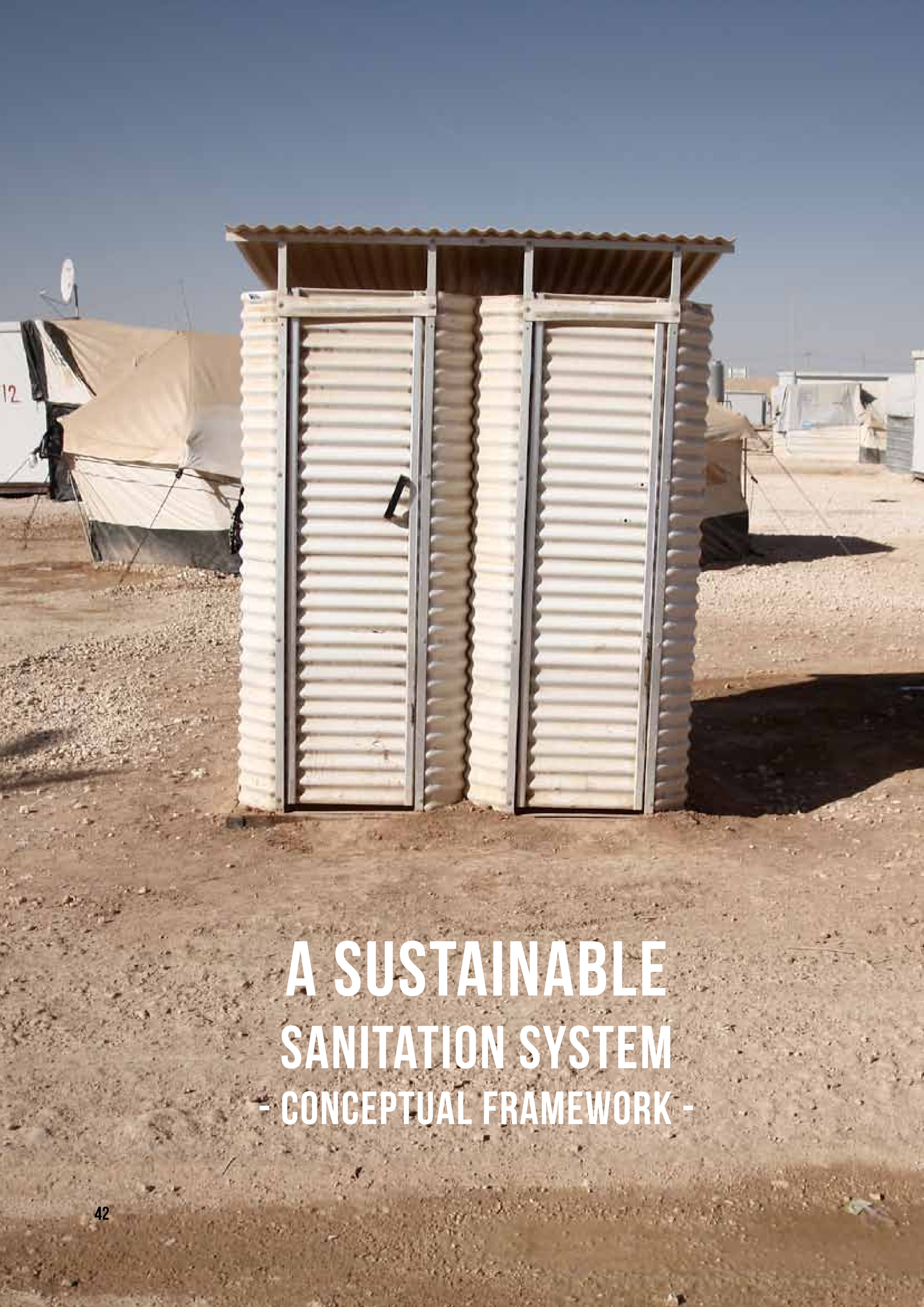
FOOD FROM WASTE

Within the context of a sustainable settlement it is essential to consider organic flows in relation to sanitation. Health, safety and access to functional services are key in any displacement setting and are often addressed with minimal consideration of the potential value of organic nutrients. Separating water and solids is essential in most cases, as mixing the resources often prevent their optimal reuse and increases risks.

In considering organic waste a local resource, values can be created such as local produce, improved micro economic activities and capacity building as well as minimizing costs associated with handling waste.

For Organic resources, contacts and case studies, see **page 89**


BIOGAS
COMPOST
Market
CULTIVATION
CULTIVATION
ECO-TOILETS
Organic waste



A SUSTAINABLE SANITATION SYSTEM
- CONCEPTUAL FRAMEWORK -

40% of the earth's population has no access to sanitation facilities, whilst another 40% use systems that do not adequately treat waste prior to its disposal. This has significant impacts on health, the economy and the environment as well as wasting valuable resources - good sanitation is estimated to bring $5 in social and economic benefits for every $1 invested through increased productivity and the prevention of illness and early death.

The primary role of a sanitation system should be the protection of health by reducing the risk of exposure to pathogens and hazardous substances that may be within human waste and could affect public health at all points from the toilet via the collection and treatment system to the point of reuse or disposal. Human health is generally protected by sanitation technologies breaking the cycles by which disease can move through a population by isolating, containing or killing pathogens entirely.

MANY APPROACHES TO SANITATION FAIL TO APPRECIATE THE INTRINSIC VALUE OF ALL ORGANIC MATTER

However, many approaches to sanitation fail to appreciate the intrinsic value of all organic matter and further increase the volume of material requiring treatment by using water as a disposal medium. In settings where treatment is an issue these large volumes of water mixing with human waste provides an active medium for the spread of life threatening diseases such as cholera and typhoid. The proper isolation, collection, treatment and disposal of human waste can be expensive and costly in terms of time, energy, water and finance. However a well designed system, if used properly, can operate in significantly more sustainable ways by;

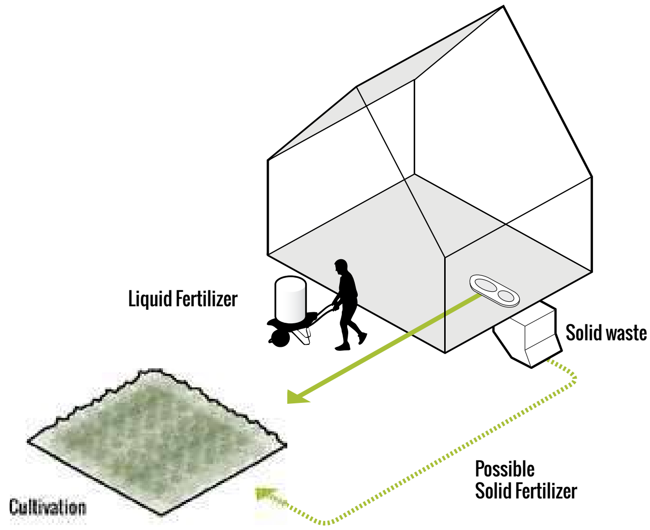
- Reducing water usage within sanitation prevents previously potable water becoming exposed to pathogens and reduces the volume of material for treatment.
- Urine is generally sterile and does not transmit disease. Separating urine and faeces reduces smells, the volume of material for treatment, provides a safe form of liquid fertiliser and also facilitates the rapid dehydration and biological processing of faeces.
- Any pathogens within faecal matter are more easily contained in the absence of fluids and are exposed to a significantly more hostile biological environment. The addition of additional organic matter or other sources of carbon further improve the environment for bacterial and chemical processes which will over time destroy all harmful pathogens.
- These treatment processes produce useful and potentially valuable by-products in the form of organically rich substrates that can be used to improve soil fertility and gases that can be used to produce energy.

RECOMMENDATION:

Elements of a sanitation system whereby liquids are separated, faeces isolated and at least partially processed could be implemented through all phases of a humanitarian disaster or displacement; One use isolation solutions such as Peepoo bags could be used in the first phase of an emergency along with a basic collection and disposal system which can then be developed to link into a broader waste processing system. Urine separation is an essential component of most Eco-sanitation processes and this can be combined with dehydration, composting or other form of toilets that isolate faeces and begin the treatment process. These types of latrines can be built using incremental designs that allow improvement over time such as the addition of secondary chambers so waste can be treated over long time frames onsite into usable soil improvers or alternatively can be added to a bio digester for secondary treatment and the production of gas for energy.

NRC sees comprehensive septic sludge and waste management within displacement settlements as a clear area of opportunity for more detailed engagement as part of this project and would propose more detailed engagement with the Sustainable Sanitation Alliance, among others to link the opportunities of this project to the exciting ongoing developments in this sector. Significant investments of time for engaging with users on aspects of design, usage and acceptance is essential for the success of all sanitation interventions.

For Sanitation resources, contacts and case studies, see **page 89**



ECO-SANITATION: UDDT

Ready to use fertilizer

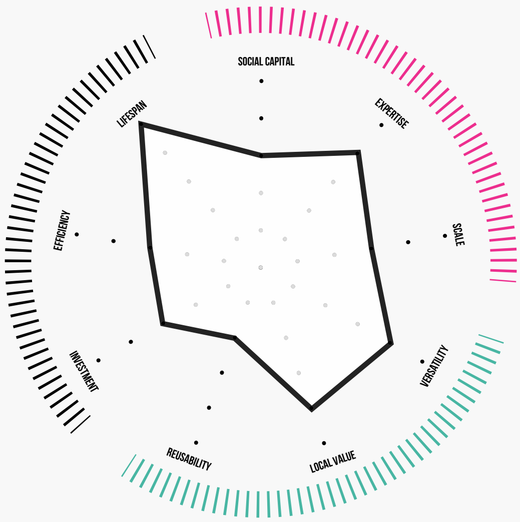
Ecological sanitation or EcoSan is an approach to sanitation that seeks to reduce health risks whilst simultaneously making use of the nutrients and energy contained within human wastes and preventing the pollution of surface or ground water. Within this broader philosophy the methods and design of ecosan systems can take on a variety of approaches depending on the culture and context.

A Urine Diverting Dry Toilet (UDDT) is a toilet that operates without water and is built so that urine is collected and drained from the front area of the toilet, while faeces fall through a large chute (hole) in the back. To prevent odours from coming back up the pipe, an odour seal is ideally installed within the urine drain and drying material such as lime, ash or earth are added to the larger hole after defecating.

Urine diversion design is also an essential component of dehydrating and ideally composting toilets and has a variety of other benefits in that it reduces odours in all forms of pit latrine and provides a ready to use liquid fertiliser.

Affected themes:

Wash | Environment | Livelihoods | Health / Nutr.



RECOMMENDATION

Urine diversion is an essential component of almost all current forms of Eco-sanitation, and the techniques and technology as applied in UDDT's are equally important for these processes. Acceptance of some of the technologies used in urine diversion is a key issue in many settings but the reduction in odour attributed to urine diversion toilets has proved to be a key point in the marketing of these latrines.

SUSTAINABILITY SCORE

Gains:

- Does not require a constant source of water
- No real problems with odours and vectors (flies) if used and maintained correctly (i.e. kept dry)
- Can be built and repaired with locally available materials
- Low capital and operating costs
- Good for areas with high water table, collapsing/rocky soils
- Large scale nutrient recovery is a realistic possibility.
- Suitable for all types of users (sitters, squatters, washers, wipers)

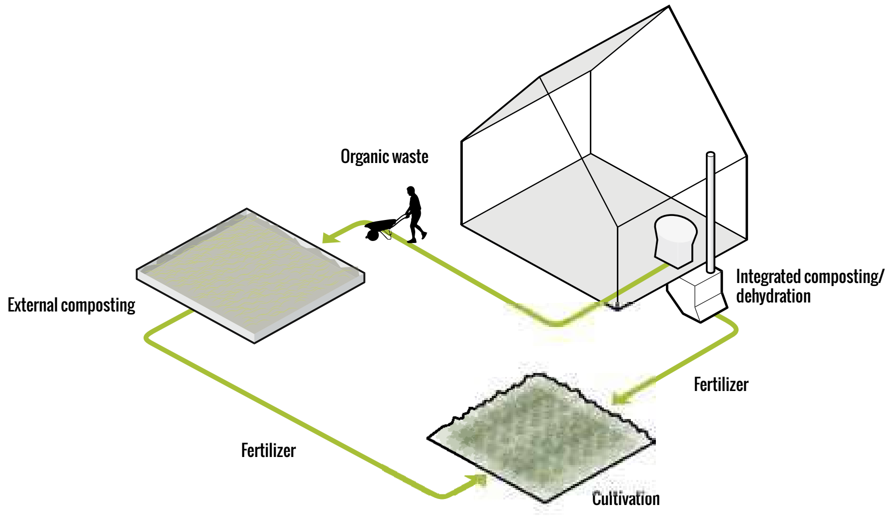
Challenges:

- UDDT's are not intuitive or immediately obvious to some users
- Prefabricated models not available everywhere
- No design will work for everyone
- Requires significant training and acceptance to be used correctly
- Is prone to misuse and clogging with faeces
- The excreta pile is visible
- More expensive that low-cost latrine options
- Men usually require a separate Urinal for optimum collection of urine
- Special child seats have to be provided to keep their urine and faeces separate
- Difficult to keep clean compared to other toilets because of both the lack of water

UDDT, NAIROBI

The low-cost "Fresh Life Toilet" for urban informal settlements is pre-fabricated at a local workshop and run by a network of local residents who purchase and operate them.

Read more **here**



ECO-SANITATION: DEHYDRATION/COMPOSTING

Produce fertilizer while reducing waste

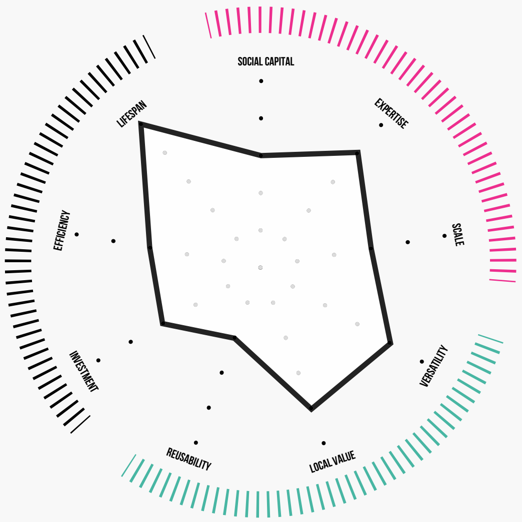
When faeces are separated from urine and other liquids, they dry quickly and in the absence of moisture, organisms cannot grow, pathogens are destroyed and smell minimized. Dehydration toilets generally consist of two well ventilated, watertight chambers used in conjunction with some form of urine diversion system to collect, store and dehydrate faeces. The use of two alternating chambers allows the faeces to dehydrate and decrease in volume in one chamber while the other vault fills. When the second chamber is full, the first one is emptied and put back into service. To prevent flies, minimize odours and encourage drying, a small amount of ash, lime, dry soil or sawdust is used to cover faeces after each use.

Within a dehydrating latrine the absence of moisture prevents organisms growing and destroys pathogens, whilst a composting latrine is designed to biologically decompose the pathogens in excreta along with other organic waste. In both cases after each use of the latrine organic bulking material such as wood chips, sawdust or ash are added to the excreta to provide additional carbon, absorb excess liquid and improve the aeration essential for the decomposition or drying processes and also to prevent flies, and minimise odours.

Assuming proper usage and maintenance the excreta and other waste will either desiccate or compost into soil conditioner safe to handle within 1-2 years. To facilitate this process many ecosan designs include 2 separate chambers so one can be left to breakdown or dehydrate whilst the other is filled. As excessive ammonia from urine inhibits the microbial processes in the chamber the use of urine diversion will improve the process.

Affected themes:

Wash Environment Livelihoods Health / Nutr.



RECOMMENDATION

Dehydrating latrines show great potential to change the way sanitation is dealt with but will require significant investment in engaging communities to adjust their sanitation habits. The suitability of dehydrating latrines would need to be decided according to careful analysis and understanding of the context, culture and target group.

SUSTAINABILITY SCORE

Gains:

- Significant reduction in pathogens
- Can be built and repaired with local materials
- Because double pits are used alternately, lifespan is virtually unlimited
- Takes up minimal space
- Potential for use of dried faeces as soil conditioner
- Appropriate for water-scarce areas
- Good in rocky and/or flooded areas
- Excavation of dried faeces is easier than faecal sludge
- No real problems with flies or odours if used correctly (i.e., kept dry)
- Suitable for all types of user (sitters, squatters, washers and wipers)
- Low (but variable) capital costs depending on materials; no or low operating costs

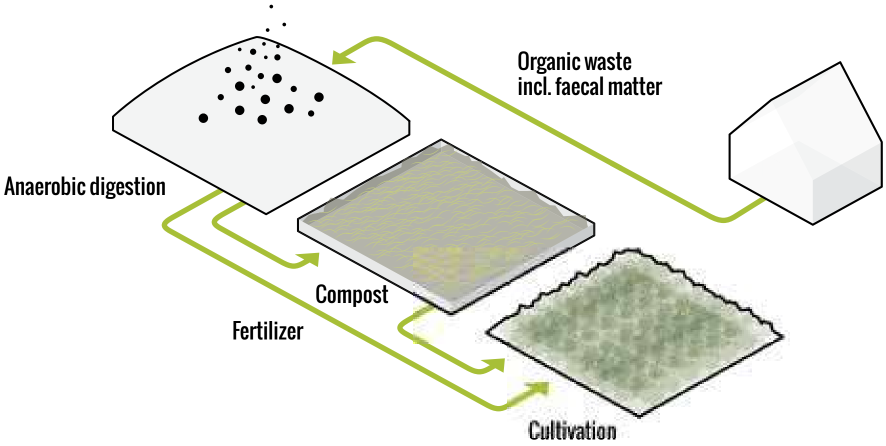
Challenges:

- Requires training and acceptance to be used correctly
- Users must be trained to understand how the technology works and appreciate its benefits
- Requires constant source of cover material, e.g. ash, sand or lime
- Dry cleansing materials will not decompose in the chambers
- Manual removal of dried faeces is required
- Special child seats have to be provided to keep their urine and faeces separate
- Difficult to keep clean compared to other toilets because of both the lack of water

SUSANA, PHILIPPINES

EcoSan project aiming is to provide improved sanitation facilities for households and public institutions in rural areas, in order to improve public health, in particular reduce intestinal worm infestation of children as well as to provide fertilizer for vegetable growers and small-scale farmers.

Read more **here**



ANAEROBIC DIGESTION

Produce gas and fertilizer while reducing waste

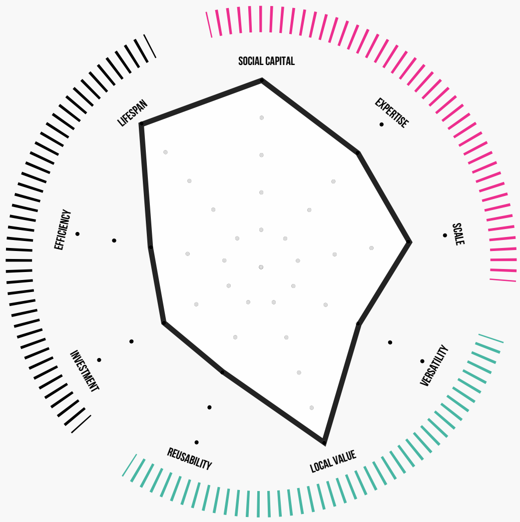
Bio-digesters are airtight chambers where biological processes are used to treat and break down all forms of organic material including human black water, food, market and animal waste. They are sometimes used as an alternative to a septic tank but have the added benefit that the anaerobic digestion of organic waste produces concentrated slurry useful as a fertilizer and biogas that can be used for energy production (discussed in the energy section page 64).

Although this technology is perhaps better known for the production of gas for energy purposes the application of this technology in waste treatment is of particular importance given that the processing of large volumes of human waste is in many humanitarian settings an underserved area of the WASH sector despite the clear health implications. Bio-digesters when combined with other technologies such as constructed wetlands are a low cost and viable means to process waste at scale.

Although this technology can be used for the treatment of human waste at scales varying from individual household to processes waste for whole suburbs and camps, the highest levels of biogas production occurs when regular and predictable inputs of a range of concentrated organic materials is possible.

Although perfectly safe the use of biogas gas for cooking has proved unpopular in some cultures and the digested slurry may still carries a risk of infection so may need further treatment prior to use as fertiliser.

Affected themes:



SUSTAINABILITY SCORE

Gains:

- Generation of renewable energy
- Small land area required (most of the structure can be built underground)
- Conservation of nutrients
- Long service life
- Low operating costs
- Reduces waste volumes

Challenges:

- Requires expert design and skilled construction
- Variable pathogen removal, further treatment of sludge and waste water may be required prior to safe handling
- Unpredictable gas production may hinder the marketing of the value of bio-digesters within a community.

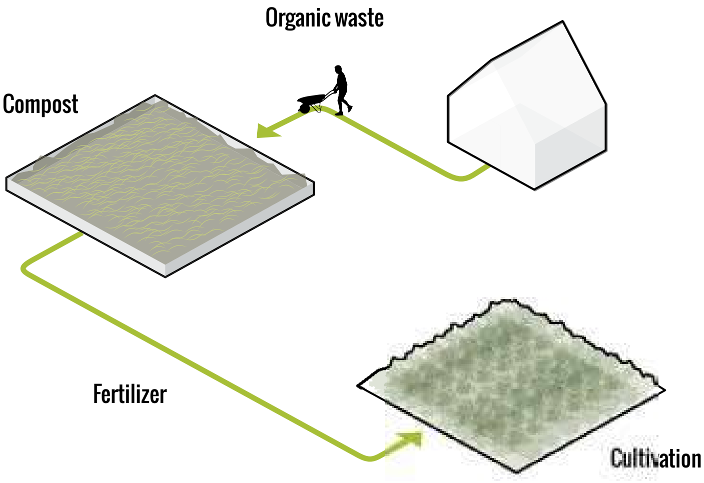
RECOMMENDATION

Although gas production is often seen as the primary function of bio-digesters the potential of this technology for destroying harmful pathogens should not be underestimated. Given that safe waste treatment is an issue in many countries bio-digestion should be considered as one potential opportunity to help address this deficit.

NRC, ETHIOPIA

Households have been provided with 'backpack' biogas systems to produce gas to supplement household fuel wood consumption and produce soil improving sludge for cultivation.

Read more **here**



COMPOSTING

Reduce organic waste and produce fertilizer

In most humanitarian settlements there are usually inadequate facilities for dealing with organic household waste so much of it is either left to rot or is collected and dumped on open land or in landfills. Little effort is made to reclaim the valuable nutrients content in the waste, and when decomposing in large volumes it can produce a liquid ‘leachate’ which presents a hazard if it reaches a watercourse or enters the water table.

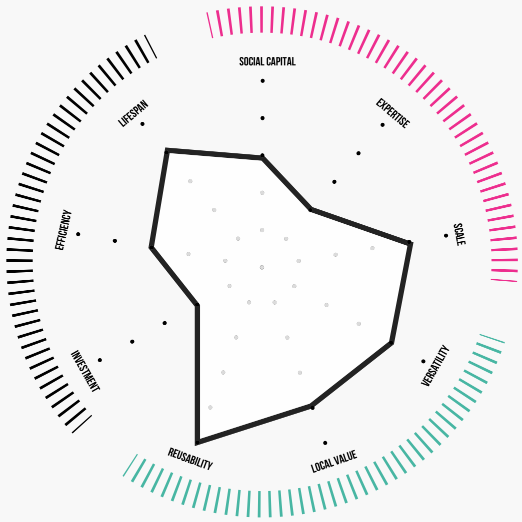
If household or institutional (schools, markets, restaurants etc) food waste, either cooked or uncooked can be separated from the plastics and other non-organic materials it is often mixed with then it can be processed and used in three main ways: soil improvement (composting), animal raising (as a replacement or supplement to expensive commercially produced feed) or biogas production.

During composting the natural processes of decay are accelerated and in these conditions, bacteria and fungi feed and multiply, giving off a great deal of heat which is sufficient to kill organisms that cause disease in plants and animals. Once the temperature drops, invertebrates enter the compost from the surrounding soil and complete the process of decomposition.

Composting at the household level requires suitable organic waste to be placed in a pit and left to decompose for 2 - 3 months. For larger scale neighbourhood composting long rows called ‘windrows’ are laid out and turned occasionally or placed in aerated rotating bins.

Affected themes:

Wash Environment Livelihoods Health / Nutr.



DECENTRALISED COMMUNITY COMPOSTING

Composting schemes using a variety of business models have been run successfully in a number of Indian cities.

Read more **here**

SUSTAINABILITY SCORE

Gains:

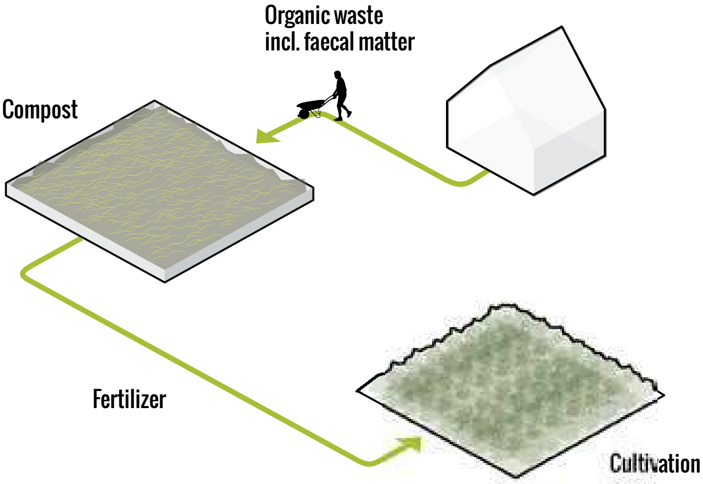
- It provides a useful way of reclaiming nutrients from organic refuse
- Prevents localised dumping and unpleasant local environment
- Saves valuable landfill space and possible contamination of land and water due to landfill 'leachate'
- Can be used as fertiliser on farmland or in the garden
- Improves the condition of soils
- Provides potential income generation

Challenges:

- Vermin can be attracted by improperly stored household waste.
- Some odours will be associated with the processing of organic matter - but these should be minimal if composting is carried out correctly
- Organic waste needs to be separated from in-organic - ideally at household level.
- Manual separation can be unpleasant and may attract social stigma

RECOMMENDATION

The separation of organic waste is best undertaken at household level and if means can be identified to achieve this then a number of opportunities present themselves to help keep settlements cleaner and produce useful resources. As part of a broader organic waste management plan composting at both household and settlement level is a good way to reduce the volume of waste requiring disposal, or the organic matter could be used for use in ECOSAN latrines, for co-composting with faecal sludge or used to feed bio-digesters.



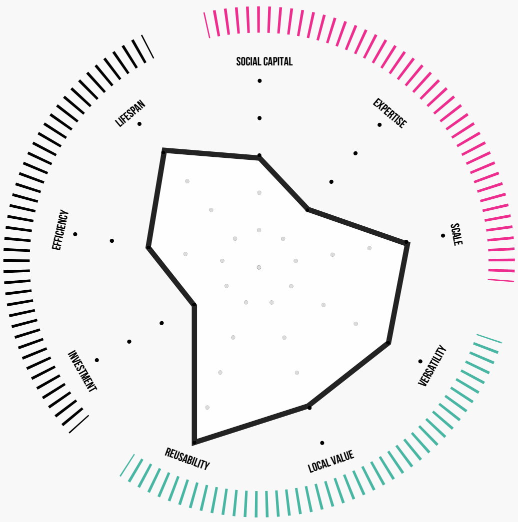
CO- COMPOSTING

Reduce organic waste and produce fertilizer

Co-composting is the controlled decomposition of a mixture of faecal sludge and other forms of organic solid waste. Faecal sludge has a high moisture and nitrogen content, whilst organic solid waste is high in carbon and facilitates the circulation of air. During co-composting, the mixed material is piled into long heaps and periodically turned to provide oxygen and ensure that all parts of the pile are subjected to the same treatments. By combining the two, an ideal environment is formed to allow for chemical and biological processes to destroy pathogens and break down the waste into useful fertiliser.

Although the composting process is a simple, passive technology, a well-functioning facility requires careful planning, design, routines and management to ensure efficient processing of waste and compost production.

Affected themes:



SUSTAINABILITY SCORE

Gains:

- Relatively straightforward to set up and maintain with appropriate training
- Uses almost all organic waste to produce large volumes of compost that can improve local agriculture and food production
- A high removal of helminth eggs is possible
- Can be built and repaired with locally available materials
- Low capital and operating costs
- Provides livelihoods

Challenges:

- Requires a lot of space in a well located area close to sources of both kinds of waste but away from communities due to smells etc.
- Sludge must be handled during the process
- Very wet or dry climates may require covering to prevent sun/rain impacting the decomposition
- Requires large volumes of well sorted and prepared/shredded organic waste
- Long storage times
- Temperatures in waste piles must be kept high to reduce pathogen load
- Requires expert design and operation by skilled personnel
- Labour intensive
- Market for large volumes of compost is required to ensure viability

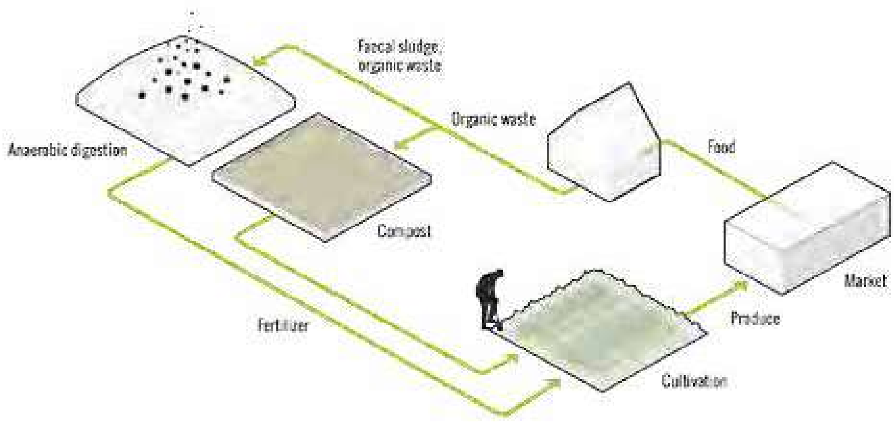
RECOMMENDATION

Co-composting could prove to be a viable strategy of sludge disposal where existing composting of organic matter is occurring at scale. Alternatively setting up a co-composting site as part of a holistic approach to dealing with organic waste at settlement level could be a way to both process sludge and other waste as well as provide potential livelihoods linked to the market for large volumes of organic soil improver and fertiliser. Co-composting would work well combined with other forms of eco-sanitation proposed in this document.

SOIL, HAITI

EcoSan as a social business model for providing access to safe santiation and converting human waste into compost.

Read more **here**



CULTIVATION

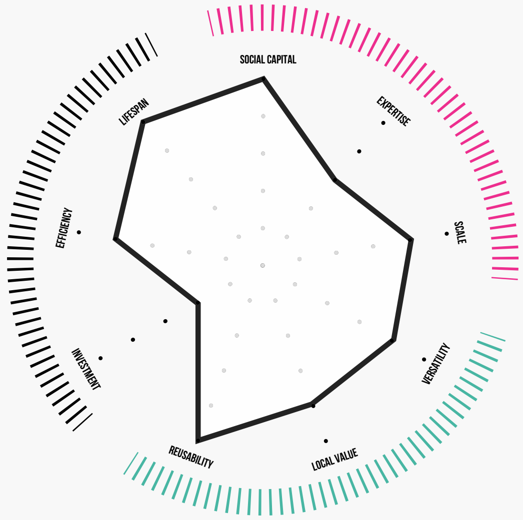
Familiar and alternative agricultural initiatives

In many displacement settings competition for space is fierce and there is often uncertainty as to how long families may be able to remain in a particular place. Both of these factors alongside local restrictions may make the growing of plants or raising of small livestock to supplement other sources of nutrition complicated. However the growing of plants can be done at almost any scale and there is significant evidence to suggest that such activities have benefits outside of the value of the crops produced. Gardening activities provide purpose and allow families some degree of independence and personalisation of their shelter and plot.

The use of containers or recycled bottles as pots, small cultivated areas within household plots and vertical garden systems as well as more formal communal gardens or greenhouses are all seen in camps and settlements as people adjust to longer periods of displacement. Often these are initiatives of individuals, but more formalized approaches can help utilise household grey water whilst also significantly improving the local environment for residents and offering additional nutrition and saving household finance.

Affected themes:

Wash | Environment | Built env. | Education | Protection | Livelihoods | Health / Nutr.



SUSTAINABILITY SCORE

Gains:

- Provides families with low cost additional nutrition
- Reduces household food costs
- Productively utilises grey water
- Psychological benefits of improved environment and productive activity
- Increased ownership of household plots

Challenges:

- Cultivation may be discouraged by local authorities
- Small scale cultivation produces low yields
- Seasonal production in most parts of the world
- Training required to ensure potable water not used for watering purposes
- More complex and productive systems require more space and set up investment

RECOMMENDATION

In any setting the promotion of small scale cultivation presents benefits in advance of the investment required and is of particular value where efforts are being made to encourage people to compost. The use of soil improvers derived from a populations waste is where the benefits of such activities fully illustrate their usefulness and potential.

URBAN AGRICULTURE, GAZA

The UN's Food and Agriculture Organisation (FAO) has set up aquaculture and vertical garden systems for families in Gaza City to supplement nutrition and incomes.

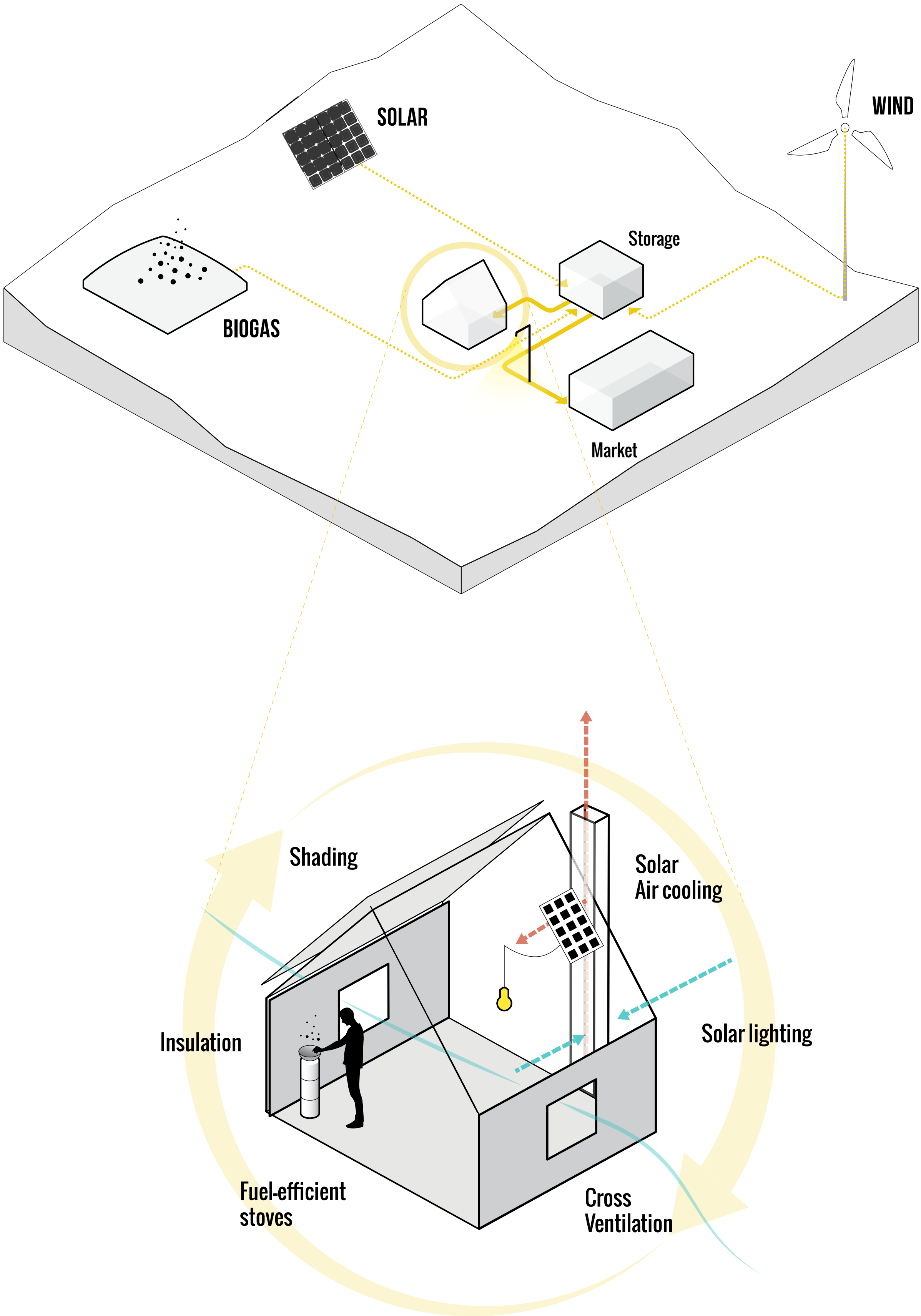
Read more **here**

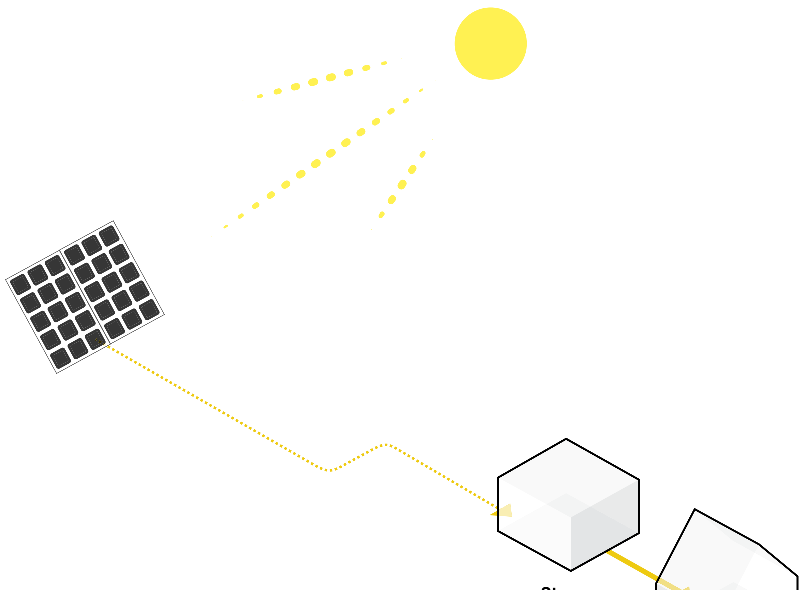
ENERGY

PRODUCE AND REDUCE

Meeting energy demands and needs of displaced communities is rapidly growing in importance and has significant additional value across many sectors. Relevant energy priorities are to maximise local energy production through non carbon technologies where possible, and to reduce energy needs through smart, low-tech design solutions. Choosing interventions appropriate to scaling strategies - concerning scales of size, distribution and time is essential, in order to create meaningful solutions. Small, short-term solutions are relevant in all displacement situations, but should be planned in relation to larger community scale systems, which might provide more cost efficient solutions and eventually contribute positively towards host community relations. All community energy solutions will also have an educational value in that many require a certain amount of training to operate and maintain, but this can stimulate livelihoods and should be considered a valuable way to improve community ownership.

For Energy resources, contacts and case studies, see **page 93**


SOLAR
WIND
Storage
BIOGAS
Market
Shading
Solar
Air cooling
Insulation
Solar lighting
Fuel-efficient
stoves
Cross
Ventilation



SOLAR ENERGY

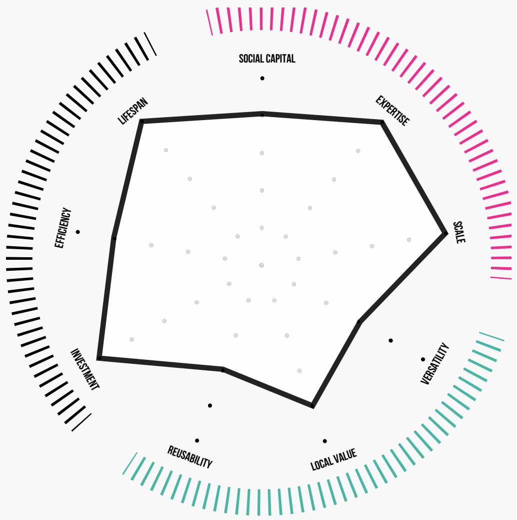
Affordable and reliable

The costs associated with using photovoltaic panels for electricity generation meant that until recently they were not seen as viable in humanitarian settings, other than small scale off grid power generation to power for example refrigerators containing vaccines in rural clinics. However advances in technology related to the production and efficiency of photovoltaic panels and batteries has seen their costs tumble in recent years. Setting up a solar system with significant generation capacity is still an expensive undertaking, but the ever increasing costs of fuels and fuel delivery along with the ever improving performance of solar technologies are helping to decrease pay back times for the required initial capital investment. Given that a solar system once operating has negligible operating costs and can run requiring no input other than sunlight they are rightly being seen as entirely suitable for use within humanitarian settings.

The main hindrance to wholesale adoption of solar systems in humanitarian settings is the high start up costs of the system itself and especially the batteries required to ensure availability of power 24 hours a day. Many donors are reluctant to invest significant sums at the beginning of a response. However, such investment could result in significant cost savings over time and additionally provide a valuable commodity that could be used in negotiations with host governments or indeed be removed for use elsewhere. Combining solar systems with wind generation capacity could help reduce the risks and the number of expensive batteries needed to ensure a constant supply of power. In less remote settings where there is an existing power grid it should be possible to use solar systems to offset at least some of the energy used by humanitarian activities.

Affected themes:

Environment Built env. Education Protection Livelihoods Health / Nutr.



SUSTAINABILITY SCORE

Gains:

- After initial investment provides 'free' electricity
- Payback for most systems if properly managed and set up is approximately 3 years
- Unattended operation and low maintenance requirements
- Technology is improving rapidly and costs decreasing so increasing the viability and performance of solar related technologies

Challenges:

- Reliant on sun to work so only works during the day
- High capacity batteries are very expensive and have relatively short life spans
- Electrical systems require specific technical skill sets for set up and maintenance

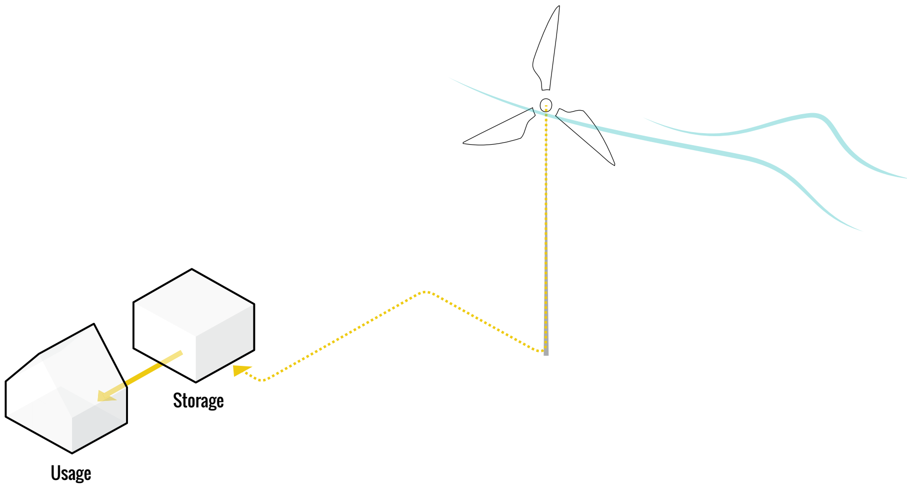
RECOMMENDATION

The management of the design and construction of multimillion dollar solar systems to provide power to entire settlements is currently outside of the capacity of NRC. However NRC has been involved in a number of projects where solar systems power entire compounds and large scale water systems as well as schools and other communal infrastructure. The promotion of such approaches and capacity in this area should be expanded and dialogue started with donors over ways to prioritise and increase funding of solar energy in NRC activities.

OFF GRID SOLAR, RWANDA

Interdiciplinary study of off grid solar systems in Rwandan schools and clinics

Read more **here**



WIND

Dependable technology ready for smaller scale interventions

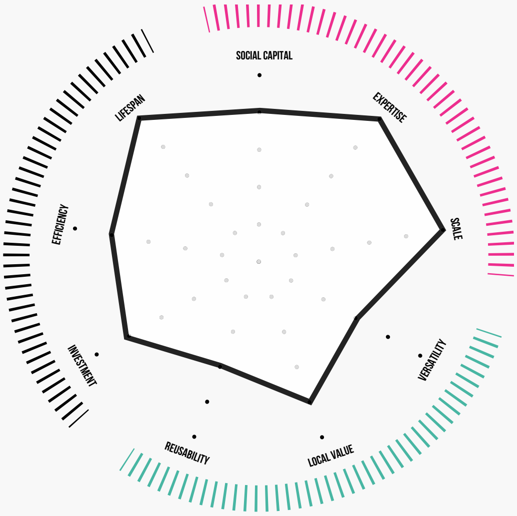
Generating electricity using wind turbines is one of the most established forms of producing energy from renewable sources and is based on centuries of wind being used to power a range of energy intensive activities. Given this history and the fact that reliable wind speeds are found across most parts of the world, wind power is becoming increasingly commonplace with global power production from wind generation trebling between 2007 and 2013.

This growth has been sustained by ever improving efficiencies and reducing costs of wind generation technologies. However the costs related to the set up of a wind turbine with capacity to power a settlement is still very high. This combined with the needs for backup systems for periods of no wind or connection to a reliable grid have meant that the adoption of such technology by the humanitarian sector has been slow. Increasing costs of diesel generated power along with the ever decreasing life cycle costs of wind power technologies now makes wind a much more attractive and viable option for consideration.

Wind powered generation systems rely on continuous wind at certain velocities, so combining wind generation capacity with photovoltaic solar systems could help ensure a constant supply of power. In less remote settings where there is an existing power grid it should be possible to connect any wind generation capacity so that any excess powered generated is sold into the grid which would help cover costs for periods of no wind. Such off setting is a highly economical way to ensure reliable power supply and the asset could then be donated to the local authorities or host government at the end of the humanitarian intervention.

Affected themes:

Environment | Built env. | Education | Protection | Livelihoods | Health / Nutr.



SUSTAINABILITY SCORE

Gains:

- After initial investment provides 'free' electricity - maintenance costs are generally very low.
- Payback of set up costs is estimated at around 5 years - although this is highly dependent on the size and location.
- Unattended operation and low maintenance requirements once in place
- Technology is improving rapidly and costs decreasing so increasing the viability and performance of wind generation technologies
- Large availability of different sized systems on the market
- Subsidies may be available

Challenges:

- Reliant on specific wind speeds to work and won't produce power without this
- Detailed planning requirement - wind speed data is not available for many parts of the world
- Electrical systems require specific technical skill sets for set up and maintenance.
- Large generator windmills are very expensive increasing need for large capital investment.
- High capacity batteries for periods of no wind are very expensive and have relatively short life spans

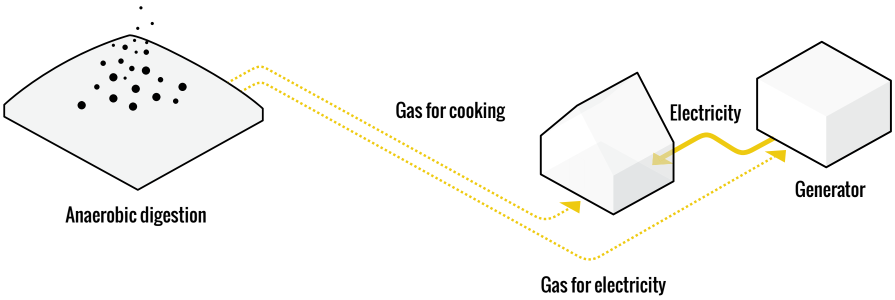
RECOMMENDATION

The management of the design and construction of multimillion dollar wind generation systems to provide power to entire settlements is currently outside of the capacity of NRC. However wind powered electricity generation can be conducted at a range of scales (household to settlement) and the promotion of such approaches and capacity in this area should be expanded and dialogue started with donors over ways to prioritise and increase funding of wind powered power energy generation in NRC activities.

ALLIANCE FOR RURAL ELECTRIFICATION

Medium and small scale turbines provide rural areas with electricity over an estimated life time of 20 years

Read more **here**



BIOGAS ENERGY

Generating energy from organic waste

Biogas reactors or anaerobic digesters are a form of treatment technology that utilise biological processes within an airtight chamber to treat all forms of organic material including human black water, food, market and animal waste. The anaerobic digestion of these materials produces an almost odourless slurry rich in nutrients that is highly suitable for use as a fertilizer, and biogas that can be burned in the same ways as conventional gas for cooking or heating or can be converted to electricity.

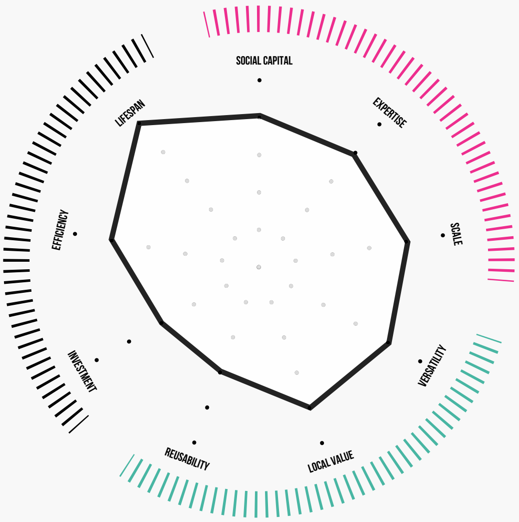
Although this technology can be used for the treatment of human waste at scales varying from individual household to processes waste for whole suburbs and camps, the highest levels of biogas production occurs when regular and predictable inputs of a range of concentrated organic materials is possible.

Digesters can be built at almost any scale but the volumes of energy a system can produce is entirely dependent on the material feeding the digester and as such there must be clarity around whether the desired amounts of gas are achievable with the volumes of material to be treated.

Although perfectly safe the use of biogas gas for cooking has proved unpopular in some cultures and the digested slurry may still carries a risk of infection so may need further treatment prior to use as fertiliser.

Affected themes:

Wash Environment Built env. Education Protection Livelihoods Health / Nutr.



SUSTAINABILITY SCORE

Gains:

- Generation of renewable energy
- Small land area required (most of the structure can be built underground)
- Conservation of nutrients
- Long service life
- Low operating costs
- Reduces waste volumes

Challenges:

- Requires expert design and skilled construction
- Reliable gas production dependant on predictable waste and water input
- Pressured gas can be extremely dangerous
- Variable pathogen removal, further treatment may be required
- Limited gas production at lower temperatures
- Cultural issues: using “waste gas” for cooking

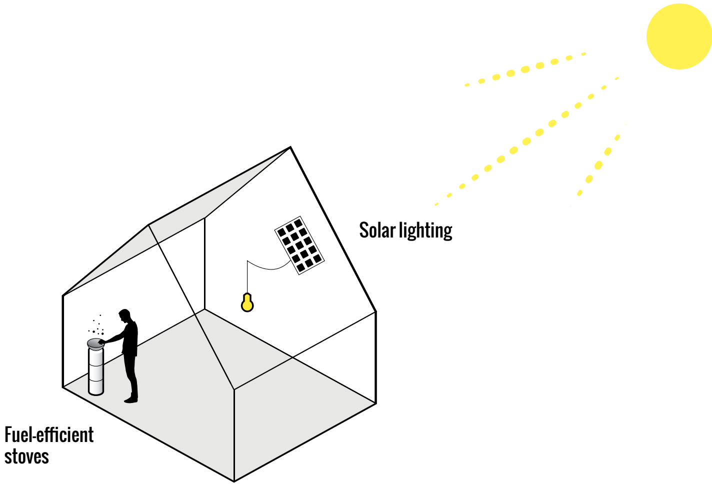
RECOMMENDATION

Expectations around energy production are often the reason for the perceived failure of bio digesters, and as such it is recommended that NRC engage in this technology with the clear understanding of the two equally important purposes - the processing of organic waste as well as the production of biogas for energy. To achieve both of these objectives at a meaningful level then systems processing the organic waste of a facility such as a school/clinic, or with the capacity to treat the waste of >1000 people are recommended.

LOOWATT SYSTEM

Portable biodigesters generate gas and energy from a mixture of faeces and urine, demonstrated in festivals.

www.loowatt.com



HOUSEHOLD ENERGY DEVICES

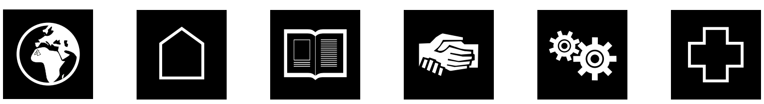
Small- scale energy improvements makes life easier for households

Initiatives within humanitarian response to address household energy issues have increased dramatically over the past 4 or 5 years as appreciation for the importance of energy and access to affordable technology have both increased. Solar lamps are increasingly becoming a standard item distributed alongside buckets and blankets whilst fuel efficient stoves in various forms are finally being promoted more aggressively.

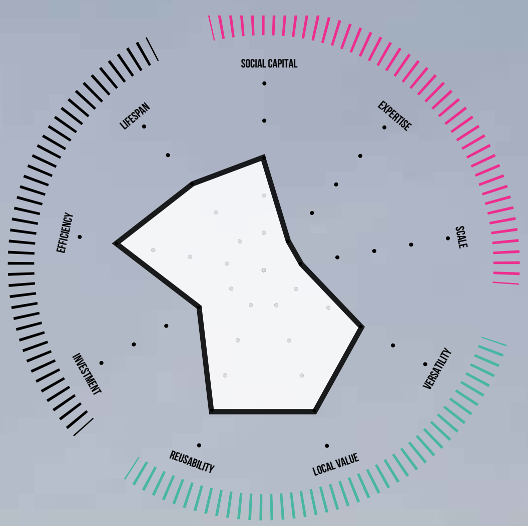
The benefit of technologies to meet household energy needs goes far beyond their primary purpose. Solar lighting allows children to study or for people to move around safely after dark, and in many instances charge mobile phones to facilitate communication. Fuel efficient stoves reduce the incidence of respiratory disease and the volumes of wood that may need to be collected and carried long distances where women may be at risk of harm. All of these approaches additionally save resources by reducing the need to buy or be provided external sources of energy.

The majority of these interventions are comparatively cheap to deliver and the savings made are very quickly seen. In addition some can be improved upon incrementally over time to meet the needs of individual families. For example certain solar lighting systems can be upgraded with further panels and batteries so that all household electrical needs can eventually be met. Rolling out of these kinds of assistance at scale is the key issue as energy is not yet seen as a life saving activity and the costs associated with providing such assistance to large numbers of families remains substantial when considered as a standalone activity and broader benefits not considered.

Affected themes:



Environment Built env. Education Protection Livelihoods Health / Nutr.



SUSTAINABILITY SCORE

Gains:

- After initial investment provides energy at significantly reduced costs
- Technology is improving rapidly and costs decreasing, increasing the viability of household systems
- Increasing acceptance of energy as an essential service

Challenges:

- Some larger household energy systems require specific technical skill sets for set up and maintenance
- Some approaches may need sensitisation to encourage changes in usage patterns
- Providing energy support to all displaced households can be expensive
- Energy requirements are not always acknowledged as a primary need in all displacements

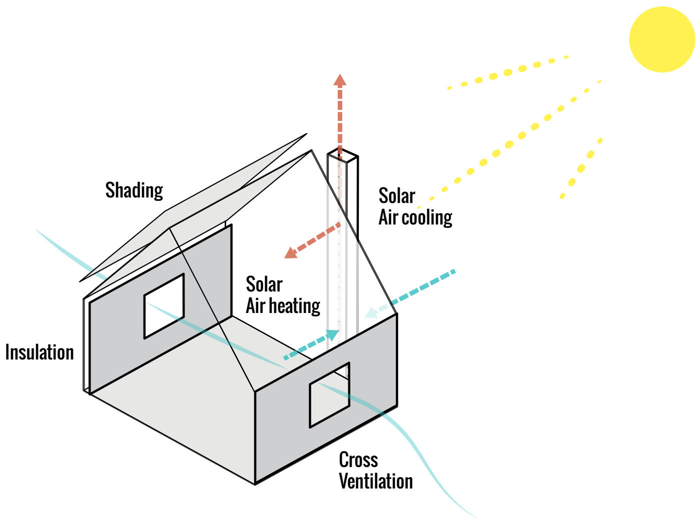
PAY-AS-YOU-GO SOLAR

Inexpensive solar panels, gradual payment options and an incremental development plan allows eight 19 to deliver energy to rural areas in Kenya.

Read more **here**

RECOMMENDATION

NRC is implementing projects in a number of settings providing household solar lighting, solar water heating, and fuel efficient stoves. The primary issue however is the ability to sources funds to deliver such assistance at scale. Energy access is a significant issue for billions of people across the globe and it is only through the application of such approaches as an automatic and engrained part of humanitarian assistance will the true benefits across the whole range of humanitarian sectors be realised.



HOUSEHOLD ENERGY EFFICIENCY

Using passive techniques to reduce costs and energy demands

Away from light and cooking, the energy needs for keeping warm or cool in extreme temperatures has also received increased attention from the humanitarian community as the crisis in the Syria region has dragged on and the numbers displaced in a highly variable climate has increased.

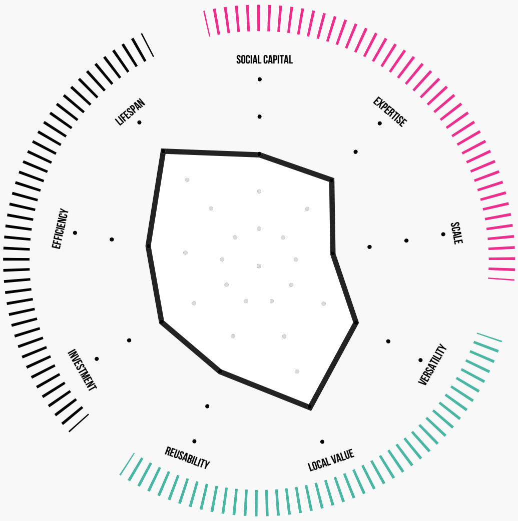
Finding immediate shelter solutions is always a primary concern in such settings and this is usually done in the timeliest and most cost efficient way. However these solutions are often not designed with variable climatic conditions as a priority and leave occupants to find alternative ways to ensure comfort. Options often require significant inputs of energy and so may expose people to increased risk through fire or fumes. To mitigate these future costs and risks, energy efficient design needs to be promoted throughout the humanitarian community and to partners. Passive approaches to heating or cooling should be included into the design of shelter and other infrastructure, and can usually be retrofitted or improved upon incrementally over time.

Insulation and passive air heating and cooling techniques will keep families warm in cold weather and cool in hot, whilst thermal solar heaters can provide hot water. All of these interventions are comparatively cheap to deliver and the savings made are very quickly seen as they reduce the need to buy or be provided external sources of energy.

Rolling out of these kinds of assistance at scale is the key issue as energy is not yet seen as a life saving activity and the costs associated with providing such assistance to large numbers of families remains substantial.

Affected themes:

Environment | Built env. | Education | Protection | Health / Nutr.



SUSTAINABILITY SCORE

Gains:

- After initial investment such interventions provide cost savings overtime
- Energy efficient design improves living conditions and therefore the health of occupants
- Can be retrofitted

Challenges:

- Increases initial costs of shelter
- Not considered a priority when large numbers need immediate assistance

RECOMMENDATION

Energy efficiency should be seen as an important part of the design process in all NRC shelter and construction programmes. Given the increasing energy costs and demands in most settings the consideration of longer term savings and efficiencies that can be made through more sensitive design or higher quality buildings should become part of NRC advocacy to humanitarian partners and donors as well as embedded in programmes where relevant.

PAPER LOG HOUSE, KOBE

Shading system made from canvas and a simple opening system for natural ventilation designed by Shigeru Ban Architects.

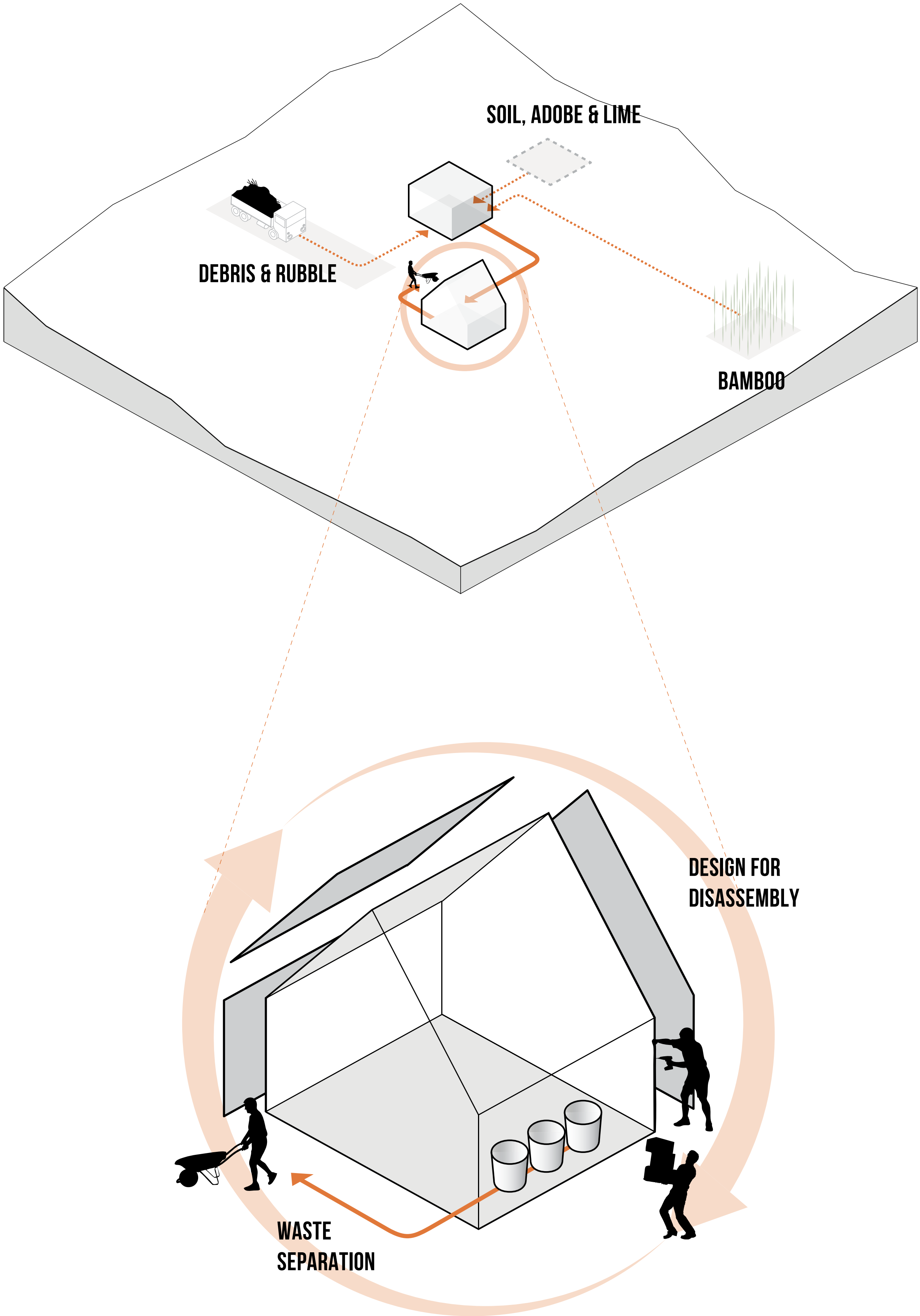
Read more **here**

MATERIALS

LOCAL, REPURPOSED AND HEALTHY

Vernacular architecture around the world consists of various locally adapted typologies evolved from the use of local materials, climatic conditions and cultural preference. The humanitarian community should make use of whatever locally available and non carbon intensive materials are available. Social mobility is often a driver for communities to reject 'old fashioned' materials or approaches despite obvious merits, but with minor adaptations it is often possible to improve the performance of these materials to better suit modern ways of living - and by doing so increase efficiency and reduce the carbon heavy logistical and production demands of a growing settlement.

For Material resources, contacts and case studies, see **page 98**


SOIL, ADOBE & LIME
DEBRIS & RUBBLE
BAMBOO
DESIGN FOR
DISASSEMBLY
WASTE
SEPARATION

SOLID WASTE COLLECTION AND MANAGEMENT

Solid waste management (SWM) involves the collection, storage, transportation, processing, treatment, recycling and final disposal of waste. SWM can be complex, but the systems themselves need to be simple and affordable and should improve the environment, protect health, support economic productivity, and provide safe employment.

The main constituents of solid waste in most humanitarian settings are organic kitchen waste, plastics, paper, glass, and metals. Reliable baseline information about the quantities and types of waste being generated is essential when developing management plans and devising means to inform reduction and recycling programmes.

Primarily it is important to know;

- What are the constituent components of a settlements waste?
- How much waste is produced?
- Where and when is it produced?
- Are there any potential hazards within the waste (e.g. batteries or chemicals)?

To effectively manage this waste we need to understand;

- What are the present behaviours, perceptions and attitudes to waste?
- Are people willing to segregate waste?
- How is waste stored prior to disposal?

Primary collection

Primary collection is the process of waste generators (e.g. householders) moving waste to a transfer or collection point where waste is deposited and accumulated before being transported to the final disposal site. Households or businesses may do this themselves or use some form of collection service for which they might pay. Primary collection can be labour-intensive and as such provides opportunities for income generation through waste transportation and resource-recovery when recyclable and organic waste is separated. By understanding how primary collection is undertaken it is possible to review how existing waste collection activities be increased and new SWM initiatives considered.

Recycling

Recyclable materials can be extracted from the waste stream from the points of generation, transfer or disposal. In many countries, the informal sector makes a significant contribution to solid waste management and recycling through the collection of marketable commodities within the waste either through door-to-door waste collection or searching for recyclable materials at disposal grounds. Further details can be found on page x

Organic waste makes up a significant components of solid waste generated in a settlement and can be composted as described on page x

'Secondary collection'

Waste is collected from transfer points by municipal or private entities and transported to the final disposal site where waste is disposed of according to available resources and knowledge. Supporting secondary collection could involve providing guidance or additional capacity to municipalities or through promoting small enterprise.

Landfill and incineration

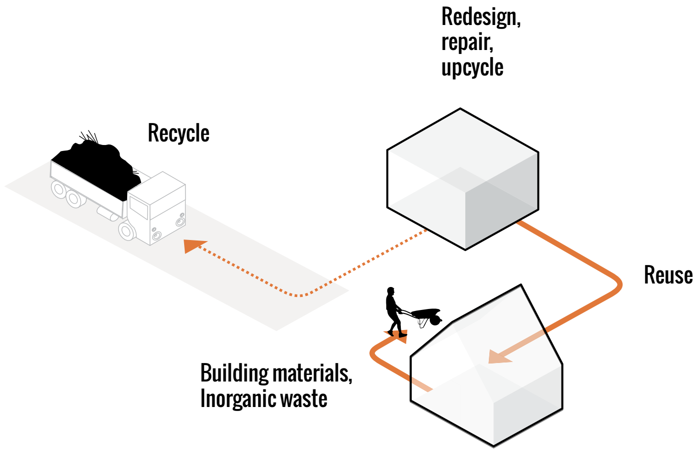
Disposal is one of the most problematic aspects of solid waste management and should ideally only be undertaken in controlled and specially engineered landfill site or through incineration at high temperature.

RECOMMENDATION

In many cases a carefully managed basic landfill site is the most achievable option – however if a system of waste separation can be set up that removes organic matter from the waste stream as well as recyclable plastic, paper, glass and metal then remaining waste could be suitable for controlled incineration – assuming capacity exists to operate this at sufficiently high standards.

All these activities present opportunities to link with a range of other broader waste management initiatives.

For Waste Collection and Management resources, contacts and case studies, see **page 97**



WASTE SEPARATION / RECYCLING

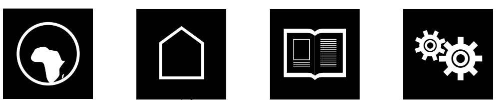
Theoretically it is possible to recycle almost all forms of solid waste found in most humanitarian settings. Organic kitchen waste can be composted whilst the majority of plastics, paper, glass, and metals can be recycled in some way assuming the technology and markets for the raw commodity exist and are economically viable.

Recyclable materials need to be extracted from the waste stream which is often easy to encourage when the high prices of virgin materials such as aluminium makes recycling attractive. For some other materials this is less easy but in many settings the collection, sorting and sale of recyclable materials is profitable enough to offer multiple opportunities for income generation.

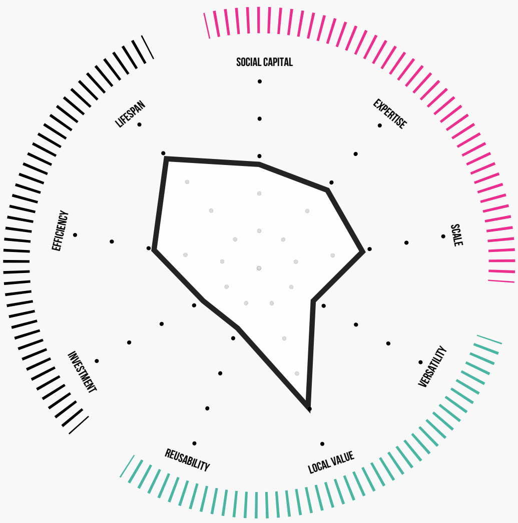
Supporting recycling in humanitarian settings and settlements as part of a more systematic solid waste management strategy depends on cultural attitudes to the handling of waste, and the proximity of businesses willing to purchase the separated materials either from individual collectors or from a centralised handling point. Any funds from the sale of the raw commodity can either be used to pay the individual collectors or to support the costs of the overall waste management system.

As well as the recycling of traditional materials like glass, metal and paper humanitarian setting also provide opportunities for the inventive reuse of materials such as the canvas from old tents. The innovative re-use of commodities should be encouraged to reduce the volumes of waste requiring disposal and also to provide additional economic opportunity.

Affected themes:



Environment Built env Education Livelihoods



NRC TENT RECYCLING, JORDAN

Unused tents are reconditioned for re-use saving over $3 million dollars, whilst damaged tents are recreated into range of innovative and useful products

Read more **here**

SUSTAINABILITY SCORE

Gains:

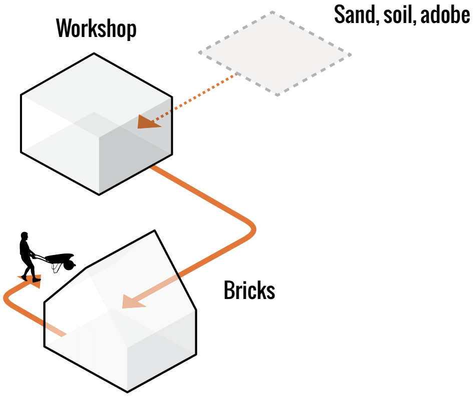
- Reduces the volume of waste needing disposal
- Generates income
- Waste collection can employ large numbers of people either on formal or informal basis
- Promotes more sustainable attitudes towards disposal

Challenges:

- Reliant on local markets for raw materials or recycled products
- Volumes and prices of particular materials dictate viability
- Income from materials may not cover all costs of running a solid waste management system
- Cultural attitudes to waste may dictate the ease of promoting waste separation and recycling
- Handling of waste exposes staff to potential risk

RECOMMENDATION

Recycling should be a significant component of any solid waste management system given the opportunities it presents to generate income either to help offset costs or provide an income to people employed within the system. Removing recyclable commodities also reduces the volume of waste requiring disposal therefore further reducing costs. NRC has only minor experience of managing solid waste systems but should consider building this expertise given the lack of capacity across the humanitarian sector.



SOIL AND ADOBE

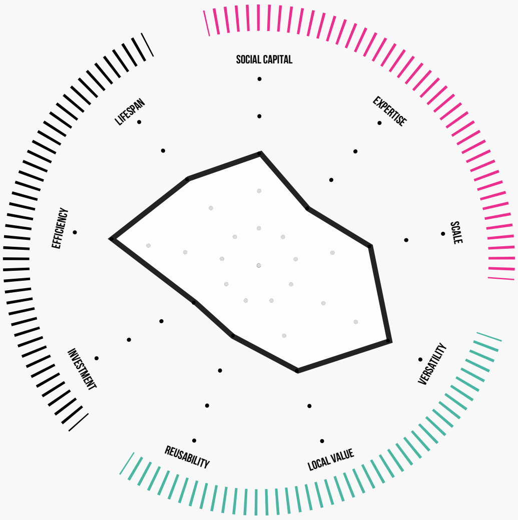
Traditional and durable

Soil and mud have been used as construction materials for millennia. It is an extremely adaptable material with excellent thermal properties and can be used for basic construction with very low levels of training. The availability of appropriate soils for use in construction can be variable and it is often necessary to source more than one kind to mix together to get the most appropriate combination of clays and sand for construction.

In recent years there has been a growing interest in learning more from vernacular soil architecture and approaches, and there has been some progress in improving and adapting these traditional materials and methods towards modern construction practises. The addition of stabilising agents such as cement or lime have increased strength and durability whilst interlocking blocks reduce the need for mortar in construction and mechanised block machines are available on the market.

Whether using Rammed Earth, Adobe, or Stabilised Soil Blocks, earth construction presents significant opportunities to make use of a commonly available resource to construct comfortable and durable buildings and infrastructure with significantly lower impacts than with conventional construction techniques.

Affected themes:



RECOMMENDATION

NRC has extensive field experience in using mud based construction from across its Shelter programmes. This includes rammed earth structures in Afghanistan and the use of compressed and stabilised soil blocks for school and housing construction across east Africa. The use of improved soil construction practises should be considered in all NRC responses given the multiple benefits of using this material.

SUSTAINABILITY SCORE

Gains:

- Soil is easy to work with for simple structures
- Suitable soils are available in most countries and settings - or can be mixed to become appropriate
- Low transportation costs when is available
- Excellent livelihoods opportunities producing soil blocks
- Soil constructions have excellent thermal properties, regulating inside temperatures
- Improved soil approaches such as stabilised blocks have comparative strengths to conventional fired bricks
- Soil construction is extremely economical
- Soil blocks can be integrated into many 'modern' forms of construction

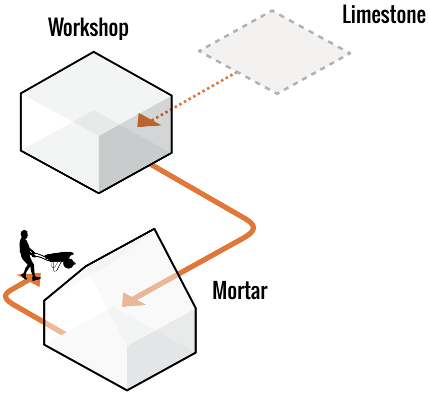
Challenges:

- Appropriate soil availability is dependent on local geography - not all soils are appropriate
- Often requires large volumes of water
- Producing blocks takes time and space not required when purchasing materials
- Unmanaged soil quarrying soil can cause localised environmental damage
- Specialist knowledge is needed for more complex structures
- Construction may be relatively slow
- Local acceptance may be difficult - cultural and social attitudes to soil as a 'poor' material
- Maintenance demands can be higher for unprotected soil constructions in some climates

NRC SHELTER

Shelter programmes in Afghanistan, South Sudan, Uganda and Kenya among others have used mud and soil in a variety of forms for the construction of housing and schools

Read more **here**



LIME AND OTHER CEMENT ALTERNATIVES

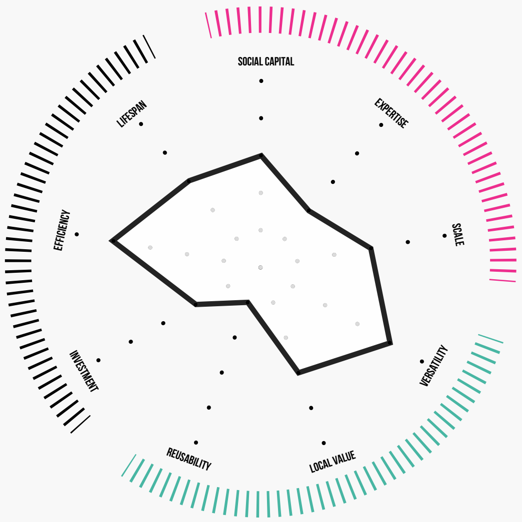
Lime is a derivative of calcium carbonate based rocks such as Limestone that has been used in a variety of forms for construction for thousands of years, and in particular was used by the Romans for early concretes. Different kinds of lime with differing properties can be formed by treating with heat or the addition of water at varying stages in the processing or preparation cycle.

The production of Lime products uses significantly less energy than producing cement which results in the production of less carbon dioxide, and whilst curing during usage it actually absorbs CO2 from the atmosphere. Although not as strong as cement lime products have a number of other properties and flexibilities that make them equally useful and in some instances preferable.

Lime products are most useful in a humanitarian context when used as an alternative to cement for use in mortar, plasters, renders or a strengthening addition to soil blocks. Lime based renders in particular will greatly improve the durability of soil constructions and reduce maintenance requirements.

Affected themes:

Environment Built env. Livelihoods



SUSTAINABILITY SCORE

Gains:

- Less environmentally damaging and often cheaper than cement
- Excellent for breathable renders that let moisture out and prevent cracking
- Works very well with soil based construction techniques
- Easy to use

Challenges:

- Unfamiliar to many builders despite its long history - so training may be required
- Not suitable for replacing cement use in conventional concrete reinforcement

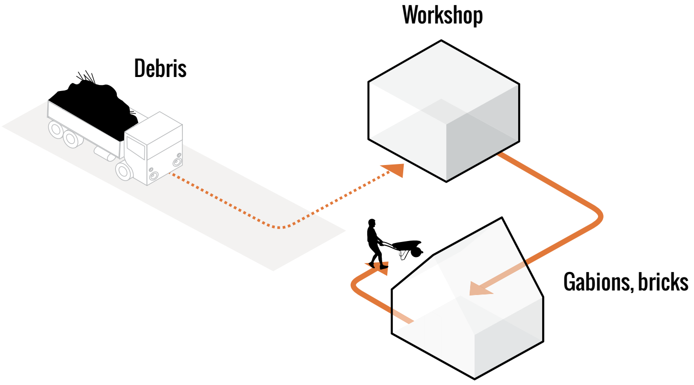
RECOMMENDATION

The use of Lime as an alternative to cement should be considered for use in construction by NRC operations given its lower carbon footprint and its compatibility with soil based construction techniques.

ACTED & IOM, LIME IN PAKISTAN

The use of lime was promoted as part of post flood reconstruction efforts to improve traditional mud construction to make houses significantly more durable and resistant to future floods

Read more **here**



REUSE OF DEBRIS AND RUBBLE

Following a large earthquake or conflict in urban areas there are often enormous volumes of debris and rubble - in Haiti there was estimated to be 20 million cubic meters of debris. This debris needs to be removed before reconstruction can begin presenting huge logistical challenges in transporting and disposing of it.

This debris however if dealt with correctly can have huge value as a base product for the varied materials that will be needed in huge volumes for the reconstruction process. Once sorted and crushed into varying sizes and depending on the quality of the original materials rubble can be used as aggregate in the forming of blocks when cement is added or used as bulk base material of floors, roads and pathways. Alternatively rubble can placed into steel mesh cages to form 'gabions' which can then be stacked and used much like large bricks to form the lining for drainage channels or as retaining walls.

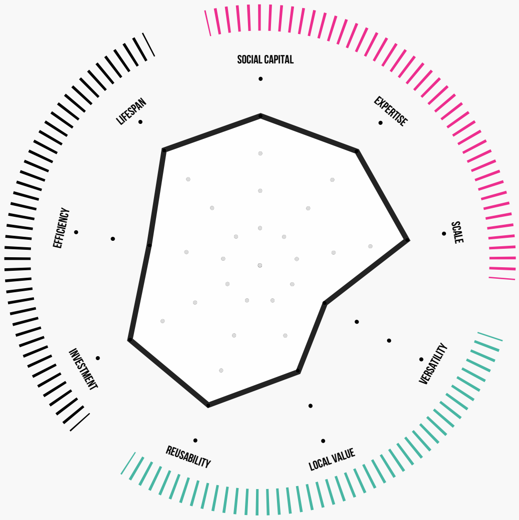
Processing large volumes of rubble requires heavy machinery and ideally specialist processing crushing, sorting and grading machines to achieve results quickly. Where such machinery isn't available then it is possible to do this by hand and presents significant income generating opportunities.

Affected themes:

Environment

Built env.

Livelihoods



SUSTAINABILITY SCORE

Gains:
- Makes use of a plentiful resource post disaster as a base material for new construction commodities
- Rubble can be processed into valuable construction commodities
- Assists in constructive clearance of debris
- Creates employment opportunities
- Reduces need for and impacts of dumping

Challenges:
- High processing demand to separate into constituent parts
- Ownership of rubble and waste can be contentious
- Requires heavy machinery to do at scale

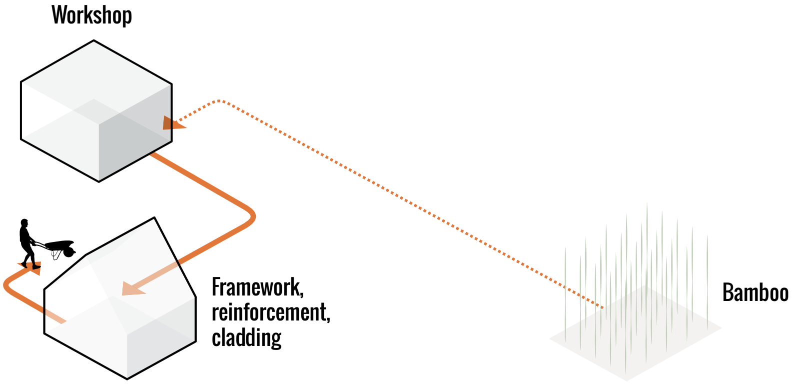
RECOMMENDATION

If operating in a post disaster or conflict setting where there are large volumes of rubble waste NRC operations should consider the potential of setting up small or medium scale processing operations as part of livelihood or income generating schemes to supply shelter programmes with aggregates and other base construction materials.

GABION HOUSES, HAITI

Rubble from the earthquake reused in the construction of shelters by filling wire cages or 'gabions' stacked to form stable and strong walls

Read more **here**



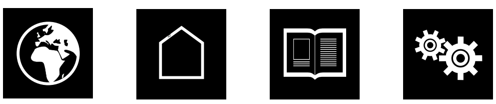
BAMBOO

Bamboo is an extremely useful material, and as a product has a higher compressive strength than wood, brick or concrete and a tensile strength that rivals steel. Bamboo is a well known construction material with a huge range of uses, and with the addition of modern technologies for treatment and processing the potential uses for this extremely adaptable material is only set to increase. Although bamboo is best known for use in construction in Asia it is increasingly cultivated and used across the world with rapidly expanding industries developing in east Africa.

Bamboo species are members of the grass family and are among the fastest growing plants known. Because of their rapid growth and means of replication Bamboo is an extremely sustainable material reaching maturity in only 3 years, and the plant will continue to regenerate new shoots allowing for a continual process of harvesting if properly managed.

Although Bamboo can be used for construction in its raw green form it is susceptible to attack from insects and other forms of degradation unless treated. The simplest treatments aim to remove starch from the stems whilst more complex treatments replace this with chemical compounds which offer more protection from insect attack. As well as being used to replace timber construction components, bamboo if used correctly can also be used to reinforce concrete or be processed into laminate board products and other products.

Affected themes:



Environment Built env. Education Livelihoods

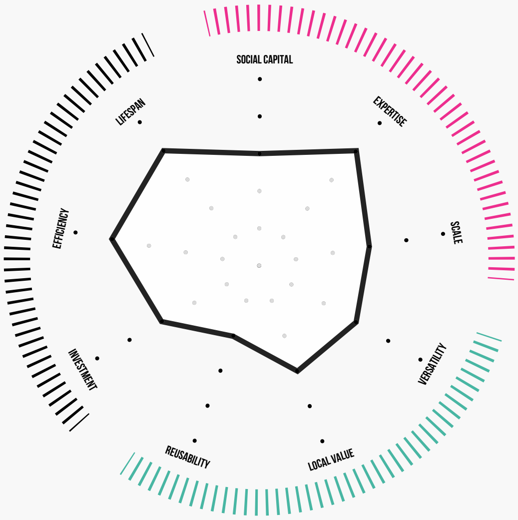
SUSTAINABILITY SCORE

Gains:

- Bamboo is an extremely sustainable material if harvested responsibly
- It is an extremely strong and adaptable material
- Basic treatment processes are relatively easy to set up at a small scale

Challenges:

- Bamboo construction techniques are not well know out of Asia
- If untreated, bamboo is vulnerable to attack from insects and rotting
- It can be difficult to make strong connections if untrained
- Like all natural resources responsible sourcing can be difficult in times of high demand.



RECOMMENDATION

NRC shelter programmes in a number of countries already have some experience of using bamboo in a range of constructions so the material is not new to the organisation. However its use should be considered more formally in all countries where it is commonly available - and beyond construction the cultivation of bamboo could present a range of livelihood opportunities as well as being a good plant to consider for making use of grey and other waste water.

SHELTERS, ETHIOPIA

NRC promoted the use of bamboo for use in the construction of shelters in Dollo Ado refugee camp, Ethiopia. Bamboo is a common and sustainable material in Ethiopia

Read more **here**

KEY RESOURCES
KEY CONTACTS
AND CASE STUDIES

WATER

Water section: page 28

SANITATION

Key resources:

SUSANA Forum
http://forum.susana.org/forum/categories/33-sanitation-systems

Practical Action
http://answers.practicalaction.org/our-resources/collection/sanitation-6

SSWIM: Sustainable Sanitation & Water Management Toolkit
http://www.sswm.info/

Appropedia
http://www.appropedia.org/Category:Sanitation

Eawag: Swiss Federal Institute of Aquatic Science and Technology: "Compendium of Sanitation Systems and Technologies"
http://www.eawag.ch/forschung/sandec/publikationen/sesp/dl/Compendium_2nd_Ed_Lowres_1p.pdf

Key contacts:

Sustainable Sanitation Alliance
http://www.susana.org/en/

World Toilet Organisation
http://worldtoilet.org/

SUSAN Design
http://susan-design.org/

SOLAR AND WIND POWERED WATER PUMPING

Key resources:

Practical Action
http://answers.practicalaction.org/our-resources/collection/water-pumping-and-lifting-1

SSWM
http://www.sswm.info/content/mechanised-pumping

Key contacts:

Lorentz
https://www.lorentz.de/

NRC has an existing working relationship with Lorentz but there are many other private companies specialising in aspects of water pumping using solar and wind power that could be engaged with.

Case Studies:

NRC managed Solar pumping in Dadaab
http://www.lorentz.de/pdf/lorentz_casestudy_dadaab_kenya_en-en.pdf & http://wedc.lboro.ac.uk/resources/conference/37/Runo-1991.pdf

Other Lorenz case studies
https://www.lorentz.de/en/applications/case-studies.html

Wind pumping for communities
http://bergey.com/wind-school/articles/wind-electric-pumping-systems-for-communities-2

Mechanical wind pumping in Bangladesh & Pakistan
http://answers.practicalaction.org/our-resources/item/wind-energy-in-bangladesh
&
http://answers.practicalaction.org/our-resources/item/wind-energy-technologies-in-pakistan

DEW COLLECTION

Key resources:

Unep
http://www.unep.or.jp/ietc/publications/techpublications/techpub-8e/fog.asp

Fogharvesting
http://www.fogharvesting.com/

Case studies:

FogQuest in Chile
http://www.fogquest.org/
&
http://www.dailymail.co.uk/news/article-2301226/Fog-catchers-attempt-harvest-moisture-huge-nets-Chilean-desert.html

RAINWATER HARVESTING

Key resources:

Practical Action
http://answers.practicalaction.org/our-resources/collection/rainwater-harvesting-1

Water Harvesting - guidelines for good practise
https://www.wocat.net/fileadmin/user_upload/documents/Books/WaterHarvesting_lowresolution.pdf

Key contacts:

International Rainwater Harvesting Alliance
http://www.irha-h2o.org/

Rainwater Harvesting Implementation Network
http://www.rainfoundation.org/

Case Studies:

WEDC/Tear fund
http://tilz.tearfund.org/~/media/Files/TILZ/Topics/watsan/Case%20Studies/Simple%20but%20effective%20rainwater%20harvesting.pdf

The Water Channel
http://www.thewaterchannel.tv/media-gallery/1002-rainwater-harvesting-food-security-part-1?category_id=773

GREYWATER REUSE GARDENS

Key resources:

WHO
http://www.susana.org/_resources/documents/default/2-1004-summary-of-whoguidelines-for-the-safe-use-of-wastewater-excreta-and-greywater-vol4-part1.pdf

EAWAG
http://www.eawag.ch/forschung/sandec/publikationen/ewm/dl/GW_management.pdf

Key contacts:

Grey Water Action
http://greywateraction.org/

SUSANA

EAWAG

Case Studies:

IRC in Ethiopia
http://humanitarianlibrary.org/sites/default/files/2014/01/Greywater%20reuse_keyhole%20gardens.pdf

CONSTRUCTED WETLANDS

Key resources:

SUSANA/GIZ
http://www.susana.org/en/resources/library/details/930

Constructedwetlands
http://www.constructedwetlands.net/

Key contacts:

SUSANA

Carlos Arias @ Aarhus University, Department of Bioscience

http://pure.au.dk/portal/en/carlos.arias@bios.au.dk

Case studies:

Wetlands in Albania
http://www.susana.org/_resources/documents/default/2-806-en-susana-cs-albania-tirana-constructed-wetland-20120628.pdf

Institutional scale wetlands in Tanzania
http://www.constructedwetlands.net/IR2-Factors%20for%20Success%20and%20Failure_FIN.pdf

ORGANICS

Organic section: page 40

SANITATION

Key resources:

SUSANA Forum
http://forum.susana.org/forum/categories/33-sanitation-systems

Practical Action
http://answers.practicalaction.org/our-resources/collection/sanitation-6

SSWIM: Sustainable Sanitation & Water Management Toolkit
http://www.sswm.info/

Appropedia
http://www.appropedia.org/Category:Sanitation

Eawag: Swiss Federal Institute of Aquatic Science and Technology: "Compendium of Sanitation Systems and Technologies"
http://www.eawag.ch/forschung/sandec/publikationen/sesp/dl/Compendium_2nd_Ed_Lowres_1p.pdf

Key contacts:

Sustainable Sanitation Alliance
http://www.susana.org/en/

World Toilet Organisation
http://worldtoilet.org/

SUSAN Design
http://susan-design.org/

ECOLOGICAL SANITATION

Key resources:

Sustainable Sanitation Alliance
http://www.susana.org/en/
&
http://postconflict.unep.ch/humanitarianaction/documents/02_11-07.pdf

Practical Action
http://answers.practicalaction.org/our-resources/item/bio-latrines

WHO
http://www.who.int/water_sanitation_health/hygiene/emergencies/fs3_7.pdf

Eawag: "Compendium of Sanitation Systems and Technologies"
http://www.eawag.ch/forschung/sandec/publikationen/sesp/dl/Compendium_2nd_Ed_Lowres_1p.pdf

Sustainable sanitation and water management (SSWM)
http://www.sswm.info/category/implementation-tools/water-use/hardware/toilet-systems/uddt

GTZ
http://www.wsscc.org/sites/default/files/publications/gtz_technology_review_udd_toilets_2009.pdf

Video of UDDT
https://www.youtube.com/watch?v=pYJE2X7s3rs

Key contacts:

Hamish Skermer / Natural Event
http://www.naturalevent.com.au/

Paul Calvert / Eco-Solutions
http://www.eco-solutions.org/index.html

Karsten Gjefle / SUSAN Design
http://susan-design.org/

Case Studies:

GTZ Ecosan pilots in India
http://www2.gtz.de/Dokumente/oe44/ecosan/nl/en-ecosan-case-studies-draft-report-iesn-2006.pdf

UNEP Compilation of cases
http://www.unep.org/ietc/OurWork/OtherProjects/Ecologicalanddecentralizedsanitation/Compilationofcases/tabid/104217/Default.aspx

Dehydration latrines in Tanzania
http://www.ecosanres.org/icss/proceedings/presentations/01--AlfredShayo--SessionPresentation.pdf

Compilation of case studies
http://cgi.tu-harburg.de/~awwweb/susan/projects.htm

BIO-DIGESTION

Key resources:

SUSANA
http://www.susana.org/en/resources/library/details/877 http://www.susana.org/en/search?searchword=biogas

SSWM
http://www.sswm.info/category/implementation-tools/wastewater-treatment/hardware/site-storage-and-treatments/anaerobic-di

Department of Water and Sanitation in Developing Countries (Sandec)
http://www.eawag.ch/forschung/sandec/publikationen/swm/dl/biowaste.pdf

Ashden
http://www.ashden.org/biogas

Loowatt
www.loowatt.com

Key contacts:

Moving Energy Initiative – Chatham House/DfID
http://www.chathamhouse.org/about/structure/eer-department/moving-energy-initiative-project

Case Studies:

NRC in Ethiopia
http://www.nrc.no/?did=9186732

Biogas in Rwandan prisons
http://www.sswm.info/sites/default/files/reference_attachments/ASHDEN%202005%20Biogas%20plants%20providing%20sanitation%20and%20cooking%20fuel%20in%20Rwanda.pdf

COMPOSTING

Key resources:

Practical Action
http://answers.practicalaction.org/our-resources/item/managing-organic-municipal-waste & http://answers.practicalaction.org/our-resources/item/recycling-of-organic-waste

Key contacts:

WASTE
http://www.waste.nl/en

Martin Bjerregaard/Disaster Waste Recovery
http://www.disasterwaste.org/

Case studies:

WEDC - decentralised composting in India
http://wedc.lboro.ac.uk/resources/conference/28/Zurbrugg.pdf

CO-COMPOSTING

Key resources:

SSWM
http://www.sswm.info/content/co-composting-large-scale

EAWAG
http://www.eawag.ch/forschung/sandec/publikationen/ewm/dl/CCP_FS_orgWaste.pdf

Key contacts:

SOIL (Haiti)
http://www.oursoil.org/

SUSANA

Case studies:

Co-Composting in Ghana
http://www.pseau.org/epa/gdda/Actions/Action_A09/Rapport_final_A09.pdf

CULTIVATION

Key resources:

FAO - 'A vegetable garden for all'
http://www.fao.org/3/a-i3556e.pdf & 'Growing greener cities in Africa' http://www.fao.org/3/a-i3002e.pdf

ECHO Community Garden Toolkit
http://static1.squarespace.com/static/516da119e4b00686219e2473/t/52025abfe4b0aff3654a45dc/1375886015037/CGToolkit_web.pdf

How to make a bag garden
http://www.youtube.com/watch?v=GQrO5ktno3Y

Smallholder agriculture's contribution to better nutrition
http://eudevdays.eu/sites/default/files/8376.pdf

Key contacts:

FAO
http://www.fao.org/home/en/

ECHO Community
http://www.echocommunity.org/?page=About_Us

Manor House Agriculture Centre
http://www.mhacbiointensive.org/

Case studies:

Keyhole gardens in Ethiopia
http://humanitarianlibrary.org/sites/default/files/2014/01/Greywater%20reuse_keyhole%20gardens.pdf

Vertical Gardens in Gaza
http://www.fao.org/fileadmin/templates/FCIT/PDF/Fact_sheet_on_aquaponics_Final.pdf

Design of affordable greenhouses East Africa
http://www.et.psu.edu/humanitarian/papers/Pack2012a.pdf

Big Impact Smallholder agriculture's contribution to better nutrition
http://reliefweb.int/sites/reliefweb.int/files/resources/HA%20small%20scale%20big%20impact%2012pp_d5.pdf

ENERGY

Energy section: page 56

Key resources:

General energy resource – providing village level energy
http://www.easac.eu/fileadmin/PDF_s/reports_statements/Report_220113_PDF.pdf

Sustainable energy provision among displaced populations
http://www.chathamhouse.org/sites/files/chathamhouse/field/field_document/20141201EnergyDisplacedPopulationsPolicyPracticeBellanca.pdf

Key contacts:

Moving Energy Initiative – Chatham House/DfID
http://www.chathamhouse.org/about/structure/eer-department/moving-energy-initiative-project

Ashden
http://www.ashden.org/aboutus

UNHCR Energy & Environment Unit DPSM/OSTS

Energy without borders
http://energywithoutborders.com/

Alliance for rural electrification
http://www.ruralelec.org/245.0.html

SOLAR ENERGY GENERATION

Key resources:

Practical Action
http://answers.practicalaction.org/our-resources/collection/solar-energy-1

'The potential for small and medium scale wind energy in developing countries'
http://www.ruralelec.org/fileadmin/DATA/Pictures/07_Publications/ARE_Small_Wind_Position_Paper.pdf

Key contacts:

Moving Energy Initiative - Chatham House/ DfID
http://www.chathamhouse.org/about/structure/eer-department/moving-energy-initiative-project

Ashden
http://www.ashden.org/aboutus

UNHCR Energy & Environment Unit DPSM/ OSTS

Energy without borders
http://energywithoutborders.com/

There are a significant number of private sector businesses involved in the development of photovoltaic systems who would undoubtedly be interested in sharing their capacity and expertise within humanitarian settings. Due to the technical complexities of large scale systems formal engagement with these companies is best done on a site and energy need specific basis.

Case Studies:

Off grid solar systems in Rwandan schools and clinics
http://engineeringindevelopment.org/an-interdisciplinary-research-study-of-off-grid-solar-pv-systems-in-rwandan-health-centres-and-schools/

NRC managed Solar pumping in Dadaab
http://www.lorentz.de/pdf/lorentz_casestudy_dadaab_kenya_en-en.pdf & http://wedc.lboro.ac.uk/resources/conference/37/Runo-1991.pdf

WIND ENERGY

Key resources:

Practical Action
http://answers.practicalaction.org/our-resources/collection/wind-power-1

Ashden
http://www.ashden.org/wind

Wind Empowerment
http://windempowerment.org/

Case Studies:

The potential for small and medium scale wind energy in developing countries
http://www.ruralelec.org/fileadmin/DATA/Pictures/07_Publications/ARE_Small_Wind_Position_Paper.pdf

Sri Lanka
http://answers.practicalaction.org/our-resources/item/wind-energy-in-sri-lanka

Nepal
http://answers.practicalaction.org/our-resources/item/wind-energy-technologies-in-nepal

BIOGAS ENERGY

Key resources:

SUSANA
http://www.susana.org/en/resources/library/details/877 http://www.susana.org/en/search?searchword=biogas

SSWM
http://www.sswm.info/category/implementation-tools/wastewater-treatment/hardware/site-storage-and-treatments/anaerobic-di

Department of Water and Sanitation in Developing Countries (Sandec)
http://www.eawag.ch/forschung/sandec/publikationen/swm/dl/biowaste.pdf

Ashden
http://www.ashden.org/biogas

Loowatt
www.loowatt.com

Case Studies:

NRC in Ethiopia
http://www.nrc.no/?did=9186732

SULABH - tech info
http://www.sulabhinternational.org/content/biogas-technology

Community Biogas electrification in Guatemala
http://piet1.ucdavis.edu/projects/guatemala-haiti/Biogas-Guatemala-FinalReport2010DLabll

HOUSEHOLD ENERGY DEVICES

Key resources:

Global alliance for clean cook stoves
http://www.cleancookstoves.org/our-work/the-solutions/cookstove-fuels.html

Enlighten Initiative
http://www.enlighten-initiative.org/ResourcesTools.aspx

Safe access to fuel and energy
http://www.safefuelandenergy.org/resources/index.cfm

Practical Action
http://answers.practicalaction.org/our-resources/community/energy-6

Key contacts:

Moving Energy Initiative - Chatham House/DfID
http://www.chathamhouse.org/about/structure/eer-department/moving-energy-initiative-project

USAID Power Africa Initiative
http://www.usaid.gov/powerafrica

Enlighten Initiative
http://www.enlighten-initiative.org/ResourcesTools.aspx

UNHCR Energy & Environment Unit DPSM/OSTS

SAFE access to fuel and energy
http://www.safefuelandenergy.org/about/index.cfm

Global alliance for clean cook stoves
http://www.cleancookstoves.org/our-work/the-solutions/cookstove-fuels.html

Eight19 - Indigo pay as you go solar
http://www.eight19.com/overview/indigo-pay-you-go-solar

Case Studies:

Generating Opportunities Case Studies On Energy And Women
http://www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/sustainable-energy/generating-opportunities-case-studies-on-energy-and-women/GeneratingOpportunities_2001.pdf

Pay as you go solar in Rwanda
http://engineeringindevelopment.org/78pay-as-you-go-solar-lighting-in-rwanda/
&
http://www.eight19.com/overview/indigo-pay-you-go-solar

Wonderbag
http://www.nb-wonderbag.com/

HOUSEHOLD ENERGY EFFICIENCY

Key resources:

Passive heating and cooling techniques
http://sustainabilityworkshop.autodesk.com/buildings/stack-ventilation-and-bernoullis-principle

Case Studies:

Post Tsunami House, Sri Lanka
http://www.dezeen.com/2013/05/03/post-tsunami-housing-by-shigeru-ban/

Paper Log House, Kobe
http://www.shigerubanarchitects.com/works/1995_paper-log-house-kobe/index.html

MATERIALS & INORGANICS

Materials section: page 68

WASTE COLLECTION AND MANAGEMENT

Key resources:

Practical Action
http://answers.practicalaction.org/our-resources/community/waste-managemnet

UNOCHA
https://docs.unocha.org/sites/dms/Documents/DWMG.pdf

UNEP
http://postconflict.unep.ch/humanitarianaction/04_01.html

PROACT
http://www.proactnetwork.org/proactwebsite/media/download/BriefTecnicalGuides/Waste_Guide.pdf

Key contacts:

WASTE
http://www.waste.nl/en

Martin Bjerregaard @ Disaster Waste Recovery
http://www.disasterwaste.org/

Case Studies:

WASTE support BO in Sierra Leone with SWM planning
http://www.waste.nl/en/project/support-for-bo-city-in-setting-up-solid-waste-management-plan

Household waste management in Dhaka
http://tilz.tearfund.org/en/resources/publications/footsteps/footsteps_51-60/footsteps_59/household_waste_management_in_dhaka_bangladesh/

SOIL & ADOBE

Key resources:

Practical Action
http://answers.practicalaction.org/our-resources/collection/earth-construction-1

Good Earth Trust - stabilised soil blocks
http://www.goodearthtrust.org.uk/further_reading.html

CRAterre
http://craterre.org/accueil:ressources/

Key contacts:

CRAterre
http://craterre.org/?new_lang=en_GB

Auroville Earth Institute
http://www.earth-auroville.com/index.php

Case Studies:

Extensive list of earth built structures
http://www.earth-auroville.com/earth_in_auroville_introduction_en.php

Internal NRC practise from Afghanistan, South Sudan, Uganda and Kenya - among others.

Mud brick dome vaulted roof construction in Mali and Niger
http://sheltercentre.org/library/woodless-construction

Compressed soil blocks in Gujarat, India
http://www.crsprogramquality.org/storage/pubs/emergencies/india-resilient-shelters.pdf

Compressed earth blocks production manual
http://www.ecohabitar.org/wp-content/uploads/2012/01/04-57921.pdf

LIME

Key resources:

Practical Action
http://answers.practicalaction.org/our-resources/collection/cements-and-binders-1

CRAterre
http://craterre.org/accueil:ressources/

Key contacts:

Magnus Wolffe Murray @ X consultancy

Bill Flynn @ X consultancy

Case Studies:

ACTED & IOM use of Lime in Pakistan
http://www.acted.org/en/re-inventing-shelter-lime-safer-stronger-homes-flood-affected-people

http://sheltercentre.org/one-room-shelter-program-building-resilience-through-shelter-reconstruction

REUSE OF DEBRIS AND RUBBLE

Key resources:

Shelter Cluster
https://www.sheltercluster.org/Search/Pages/Results.aspx?k=rubble%20reuse&s=All%20Sites

PROACT
http://www.proactnetwork.org/proactwebsite/media/download/BriefTecnicalGuides/Waste_Guide.pdf

Key contacts:

Martin Bjerregaard @ Disaster Waste Recovery
http://www.disasterwaste.org/

WASTE
http://www.waste.nl/en

The Mobile Factory
http://www.demobielefabriek.nl/index_main_e.php

Case Studies:

Haiti overview
http://www.sheltercasestudies.org/shelterprojects2010/A04-A11-Haiti2010.pdf

Gabion houses in Haiti
http://www.iiirr.ucalgary.ca/files/iiirr/85.pdf

BAMBOO

Key resources:

Humanitarian Bamboo
http://humanitarianbamboo.org/bamboo-manual/downloads/
&
http://humanitarianbamboo.org/category/resources/

Building Green
http://www2.buildinggreen.com/article/bamboo-construction-grass-always-greener-0

Key contacts:

Dave Hodgkin @ Humanitarian Bamboo
http://humanitarianbamboo.org/

International Network for Bamboo and Rattan (INBAR)
http://www.inbar.int/

Case Studies:

Bamboo used in shelters in Dollo Ado Ethiopia
http://www.sheltercasestudies.org/shelterprojects2011-2012/A09-Ethiopia-DolloAdo-2011.pdf
&
http://www.nrc.no/?did=9154186

Bamboo shelter, Indonesia
http://www.sheltercasestudies.org/files/tshelter-8designs/assessments/S4%20Indonesia%20Java%20Structural%20Assessment_01.pdf

Paper log house, Phillipines
http://www.shigerubanarchitects.com/works/2014_PaperEmergencyShelter-Philippines/index.html

RECYCLING

Key resources:

Practical Action
http://answers.practicalaction.org/our-resources/collection/recycling-6

UNOCHA
https://docs.unocha.org/sites/dms/Documents/DWMG.pdf

Key contacts:

WASTE
http://www.waste.nl/en

Martin Bjerregaard @ Disaster Waste Recovery
http://www.disasterwaste.org/

Case Studies:

NRC tent recycling in Jordan
http://www.nrc.no/?did=9183996

http://www.sheltercasestudies.org/shelterprojects2013-2014/SP13-14_A12-Jordan-2014.pdf

Plastic recycling into 'timber' poles http://www.seedinit.org/images/documents/501/093.001_SEED_WinFly_Art_Plastics_Kenya_Stg1.pdf