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Framework for capacity based sustainable design & development; towards resilient communities

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Abstract: The most fundamental struggle for realizing a sustainable built environment still lies in the use of non-renewable resources in its articulation. Although effort has been taken to increase the use of sustainable materials (bio based, C2C, etc.) the vast majority of the building sector still relies heavily on steel and concrete. This article debates that the most fundamental contributors to sustainable development are the evaluation and incorporation of inhabitant capacities. Evaluating the proximity of available natural materials, inhabitant skills and tools could play a fundamental role in creating (social) sustainable societies and environments. However, inhabitant capacity models insufficiently cover the various capacities into one model (both inhabitant and community). Therefore, this article describes: a framework for evaluating inhabitant capacities; how to map available resource capacities; how these capacities can be incorporated into sustainable housing development and planning. The framework was developed as a part of a support tool, which helps designers and engineers to evaluate inhabitant capacities. To describe the framework and support tool a rural Sub-Saharan community is used- their capacities are relatively less complex compared to a 'western' or urban context. Moreover the articulated built environment is relatively uncomplicated. The article concludes that the framework shows great potential in reducing the use of unsustainable materials. Moreover, that it could enable social sustainability by creating self-reliant and resilient communities.

Keywords: inhabitant capacities; resource capacities; social sustainability; resilient communities; self-reliance

Introduction

Although sustainable design has been debated for an extensive time (Page, 2014), its interpretations are sometimes contradicting and confusing (Lélé, 1991). In the literal sense sustainability describes the ability to which something can be maintained at a certain level or rate, over a certain amount of time. From an environmental point of view, sustainability describes goods and services that do not use materials that cannot be replaced or that in any way damage the environment (Cambridge Dictionary, 2017). Its definition is thus clear, unlike the interpretation of damage (depleting resources, carbon emissions, social inequality, etc.).

Sustainable design is often less strict and clear. In most cases it refers to reducing environmental impact through design (Vargas Hernandez, Okudan Kremer, Schmidt, & Herrera, 2012), which implies that in the building industry the definition seems less strict. Although sustainable design has good intent: using local, natural and renewable resources, ensuring future generations can sustain a 'good' quality of life (Felce & Perry, 1995), talks about reducing bad impact instead of using sustainable solutions as departure point. With the building industry still as one of the heaviest polluting industries (Bribián, Capilla, & Usón, 2011) and main contributor to carbon emissions and resource depletion (steel, concrete, etc.), this might not be that surprising.

The 'formal' built environment might have a bad reputation, the 'informal' built environment shows quite the opposite. The ecological footprint (Wackernagel & Rees, 1998) of rural inhabitants in Third World countries is many times smaller than urban inhabitants in First World countries (Van Vuuren & Bouwman, 2005). The informal building production contributes to an extensive part of the entire global housing production (UN-Habitat, 2015).

However, with a rapid urbanization especially of developing countries these inhabitants will likely increase their ecological footprint. Therefore, sustainable design and development might emphasize more on preventing impoverished communities following the unsustainable example, offering a sustainable design and development alternative for 'developing' communities in the Global South.

In the Global South most rural inhabitants build houses primarily by themselves based on available materials, tools and skills. All contributors to self-building practices in this article are called: *inhabitant self-building capacities*[1]. This self-build practice is often supported by materials, tools and skills offered by relatives, friends or close community members, which in this article is called: *proximal self-building capacities*. Furthermore the gap in inhabitant self-build capacities and proximal capacities is often filled by capacities available in the periphery of their community, which in this article are called: *peripheral self-building capacities*.

This way of building is sustainable in terms of the ecological footprint of used materials, little transport being involved in a process (materials, labourers, etc.). What is more the building production generates an extremely high socially sustainable (resilient) development of the built environment. However, the vast majority of the informal built environment (vernacular, slums, camps, etc.) has a low Quality of Life (Felce & Perry, 1995) compared to the formal built environment. Indicating that even though the articulated built environment is highly sustainable in terms of design and development, it has not been able to substantially improve the inhabitants Quality of Life (QoL). It does show a potentially crucial model, framework and methodology for the articulation of a sustainable built environment.

This article argues that one of the most important factors for the success of the sustainable informal built environment can be explained by "self-building capacities". This means that all capacities a rural inhabitant needs to build a dwelling are available in their direct surrounding. Although inhabitant self-building capacities could be highly valuable for sustainable design and development, a framework to assess inhabitant self-building capacities does not yet exists. Therefore, the article firstly articulates a framework for inhabitant self-building capacity evaluation. To enable designers to use such framework in situ, a design support is described consecutively.

The developed framework and design support use a mixed method approach, combining: mapping, context analysis, interview and observation methods. Secondly, the framework and design tool describe how to assess capacities (inhabitant, proximal and peripheral) weigh them against alternative building solutions. Lastly, it allows planning of building activities according to all the capacities (inhabitant, proximal and peripheral), combining the capacities of the families with those of their neighbours, family and other community members. The framework is an essential part of the sustainable design support tool formulated within a larger PhD research. This article uses a rural Sub-Saharan family and its community to explain how the framework can be used. Rural Sub-Saharan community's capacities are relatively less complicated compared to a 'western' urban context and therefore easier to analyse.

[1] Inhabitant capacities: all factors that enable the inhabitants to produce a dwelling by themselves, which include: tools, resources, knowledge, skills and income

Methodology

This investigation seeks to determine if a specific treatment influences inhabitant self-reliance towards their built environment and is therefore an experimental research (Creswell, 2013). Within this article the framework of the support as a part of this 'treatment" is explained. The main goal of the support is to evaluate, include and plan inhabitant capacities. Inhabitant capacities are complex and can be measured in both the quantitative (income, tools, resources, etc.) as the qualitative spectrum (skills, knowledge, etc.). Therefore the proposed framework for the support in this article uses mixed methods.

Framework for inhabitant, proximal and peripheral capacity evaluation

In this section a framework is described to evaluate inhabitant capacities in relation to their built environment. Some of these capacities are easy to identify for both inhabitant and designer. Tools such as a hammer or saw can easily be found within the household and are directly related to the production of the house. The same counts for income or available resources such as: thatch, soil or wood. However, there are many capacities that are less obvious. Some capacities like tools, skills and resources are not directly related to the production of housing. This section will describe the steps required for the evaluation of inhabitant self-building, proximal and peripheral capacity evaluation. Each section starts with a summary (in italic) of what the chapter of the support tool entails. The support book is currently being published and will be available by 2018.

Preparatory house and context mapping

"To better understand how the family currently lives and how they use their space, this section of the support explains how you can map, measure and draw: individual structures, interior, family compound and community area. Most of the rural families have more than one structure on the compound but still a multitude of functions are taking place outdoors. Some functions can be clearly identified (such as cooking) some are more difficult due to their temporal nature (studying). To be able to mark actions in the field (eating, washing, studying, etc.) you need detailed floor plans, section, façade views, interior (functions and furniture) of all the houses within the family compound and their surroundings. In this way during the observations (next section) you have the lines in which the activities take place. Most activities take place in and around the house, however, many of them also in the surroundings. To better understand important places in the surrounding (water points, school, church, etc.) and how they relate in terms of infrastructure, you will need to map the surroundings (max 0,5-1 km radius). The outcome of this section will offer a departure point for the design."

Before any capacity analysis can commence the general context of the location needs to be understood. This article will not debate the importance of mapping (de Jong & van der Voordt, 2002), various types or compare the benefits of mapping. It accepts that making an inventory of the existing context is common practice in design. However, it does state the importance for designers to start with a preparatory inventory to evaluate and localize inhabitant capacities. Therefore a general context inventory of the houses and family plot/compound needs to be made. This inventory can then be used to locate and contextualize inhabitant capacities gathered in observations and interviews (explained in the upcoming subsections). The in Appendix A described inventory starts with analysing the house(s) of the family within the context of their plot: measuring the individual structures to

produce facades, floor plans and sections sketches Figure 1; indicating the position of furniture, objects (containers, shoes, clothing, etc.) and openings (doors, windows and roof); gathering all information by drawing the plot with all individual structures.

Figure 1. Example inventory of a family on Mt. Elgon

Many of the inhabitant's capacities are peripheral: they do not own the resources and the resources are not located on their plot. They rely for substantially on the support of others to produce their built environment. Especially, skills and tools used in building the existing house are made available by neighbours, family, friends and community members (Smits, 2017). Therefore, it is essential to continue to make an inventory of the surrounding area. The next part of the described support (Community Area) emphasizes on an area in a 500-1000 meter radius around the family plot (see Figure 2). This 'initial' proximal and peripheral inventory helps to locate borders, water, infrastructure, trees, water points and general places of interest. It is aiming at helping the designer/engineer to get a general notion of the direct surroundings of the family. Based on the combined inventories (plot, proximal and peripheral) now both the family capacities and community capacities can be registered and located

Figure 2. Target area for context analysis on Mt. Elgon (500 meter radius) of approx. 50 families

Observing inhabitants on their own and proximal capacities

"One of the most essential steps to design a new house is to better understand the existing

house. Besides the physical elements and their function (what you mapped in the previous section), there are many behavioural elements. We need to understand both in depth to grasp what preferences the family has and how they prefer to perform them. In this way you gain very detailed understanding what they prefer to do, where, when and how (for example where they wash, prepare food, fetch water, dry clothing, etc.). Obviously also what they do not prefer and would like to change in the future house. Before we can do so we will need to observe family members to understand their routine. The most important are the activities directly related to the house, compound and direct surrounding. The preferred method to perform such analysis is observation. Here an individual observes the behaviour (actions, movements, gestures, etc.) of an actor in its environment. This section explains how observations can be performed, what the difficulties are and how we advise you to perform your observation."

In the previous subsection the area in which the capacities are being evaluated was explained. This subsection will elaborate how the first inventory of the capacities of the family in the everyday life can be made. This means looking at when, where and how capacities (resources, tools and skills) are used, stored or shared. It is important to understand that the presence of a visiting designer in such context has a tremendous effect on the inhabitant's behaviour. This might influence behaviour and ultimately the designer might misplace or misread the inhabitant's capacities. Therefore, to get an in-depth understanding, it is important to evaluate the inhabitants before *actively engaging*[2]. Observation is a suitable methodology to systematically record people's behaviour, actions and interactions (Hennink, Hutter, & Bailey, 2010). The level of engagement of the observer can normally range between participating fully in everyday activities (participant observation) and not participating at all in any activities (non-participant) observation. Although, it is commonly argued that not participating in practice does not exists, as the presence of an observer (person/camera/recorder) requires a level of participating.

Non-participant observation might theoretically give the most objective results, however the presence of the observer might suppress regular every day activities of the inhabitant (Hennink et al., 2010). On the other hand full participation in everyday activities (helping, asking, sharing, etc.) changes the behaviour as well. The support uses a partially engaged participant observation. Here, the observer can help in everyday activities, however, is requested to only engage in a supporting role (not sharing ideas, perspectives, etc.). To get a broad understanding on the capacities of the family as a whole, every family member will need to be observed for one whole weekday and one weekend day. Based on the previously made maps (inventory) the observer is able to mark where each capacity is registered (Figure 4).

[2] To actively engage: any other methodology or action that requires direct interaction between designer and inhabitant.

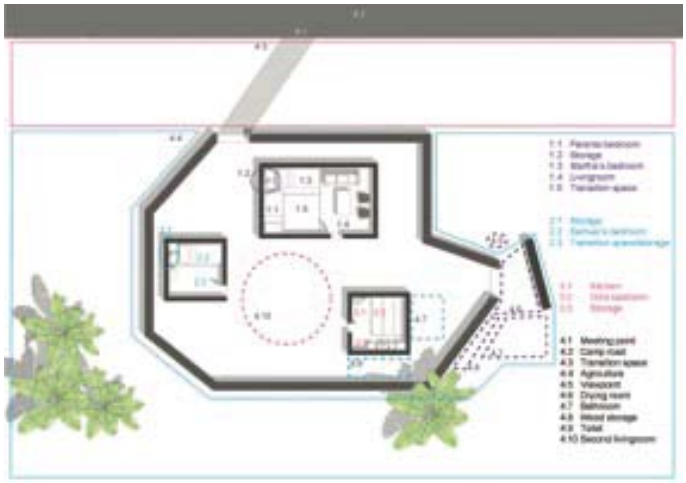

Figure 3. Example of a family compound on Mt Elgon

To help the observer note the various capacities a registration sheet was made to track the activities and related capacities during observations. Everyday activities such as cooking, cleaning, washing, water fetching, etc. show the inhabitants physical capacities (resources and tools) and how they are used in activities (skills). Although an observed capacity might not directly connect to the built environment the observer is able to register it and later decide on its possible use. At the end of the observation the observer is asked to add a picture, sketch or plan that explains, locates or proofs the described activity and capacities. Another important finding of the observation is to get a first notion of the social structures of the family (which shared activities do they have). These structures play a vital role in evaluating proximal capacities to the family. On a later moment identified families can be interviewed and their capacities evaluated.

TEAM: 1
OBSERVATION: MOTHER
DATE: 21-08-2017

Time	Activity	Duration	Where	With Whom	Skills, Tools, materials	Problems/chances/ solutions	Comments	Map/Plan/Sketch/Picture
05:00	Arrival							[redacted]

Figure 4. Example empty observation sheet

Context depth analysis

"To prepare for the design phase it is important to start analysing the context of your project in a more conventional approach. The mapping in chapter 7 helped to understand the surrounding, here the registered elements followed mainly on your own observations while walking in the area. Here places of importance, usage and behaviour are perceived with the least influence from local opinions (family, relatives and community members). After observing the family members in their daily activities your insights in the area changed substantially, hopefully in a more objective way. Now you can weigh your own initial observation with those of the family. In most cases this means you are able to analyse in a more detailed matter. Some of the analysis will focus on the direct surrounding of the family (compound & structures, ground) some on the community scale (garden, public areas, etc.) and some on the regional scale (available materials & climate)."

After making the first context analysis of the house and spending substantial amount of time observing the activities of the family, the findings have to be located in a broader context of the community - starting by adding the identified capacities in the observation to the inventory shown in the first subsection, making a rich complete inventory of the family house and compound, registering; functions, orientation, usage, public/private relations, etc. Next steps in the support (see Appendix C) describe how to map: proximal capacities (locating identified capacities from the observation), building typologies (how capacities are articulated into a built form), available materials in the area (locate used building resources/capacities in the area: wood, soil, thatch, etc.), infrastructural capacities (water, firewood & electricity points, farmlands) and public areas.

Figure 5. Water points and electricity points

The results of this subsection enable the designer to articulate a comprehensive overview of the existing capacities of the family. Without an extensive conversation with the family, the designer observed most of this information in the families every day activities. The next subsection elaborates on which proximal and peripheral capacities the family and their community have.

Interview inhabitants & community members on proximal and peripheral capacities

"In the previous chapter you assessed everything you could find in and around the family compound. All these elements together enable you to make valuable decisions, however the ownership and usefulness of the objects (resources) remain abstract. In order to clarify them in this chapter we will try to transform all available elements into capacities. Capacities are all things that possibly enable us to do or make certain things. In the realm of the built environment they can be described in 4 different categories: Resources (wood, grass, soil, etc.), Tools (hammer, saw, machete, needle, brush, etc.), Skills/knowledge (weaving, digging, thatching, cooking, washing, etc.) & Income/labour (farmer, carpenter, cook, etc.). As engineers we need look in detail onto the capacities, which enable the family to build/maintain, a house. Specifically – to understand the difference between the house they have and the one they desire. Although the reasons might be complex and interrelated, at the end they all come down to the capacities they currently have and ones they do not have.

When you compare the desired capacities with the existing capacities most likely you will conclude that there is simply no way that they could build the desired house. In order to prevent insensitive decisions that are harmful to the inhabitants we have to better understand what the current capacities are and how we can use them/improve them to articulate solutions. This is what Michiel Smits has coined as capacity based decision-making. This decision-making process is based on three steps: Assess existing capacities of the family, Assess desired capacities of the family & Making decisions on improvements based as much as possible on existing capacities. In rural communities not only the individual but also the community's capacities are important to the realized house. Family relations, friends and

neighbours are essential in most parts of realizing a house. For this purpose the interview in this section will help you to evaluate all capacities of both family and parts of the community they live in."

After mapping and observing the family and their community the designer has a large inventory of capacities. This subsection intends to explore them in detail (ownership, costs, reward, quantity, etc.) by interviewing the inhabitants and their community. Therefore the support tool (Appendix D) helps the designer to setup a semi-structured interview. An informal or unstructured interview would give too much room for free interpretations and might cause blind spots in the capacity analysis. A structured interview would be too formal and might limit the inhabitants sharing on their capacities. An in-depth interview would allow too much detailed information about the capacities. Although very valuable, in this phase concisely described or quantified resource, tool and skill capacities are needed.

Materials/resources									
nr	item	amount	unit	comments	owership	name of the owner	payment	if payed:specify	distance
1	clay soil	unlimited		soil for makng walls	family		free		none
2	timber	5	st	d=15cm, l=3m	family		free		1km
3	wood: post	11	st	150mm in diameter, l=3-4m	family		free		2km
4	dried grass	150	bundle	s (suitable for roofing)	family		free		1km
5	window	2	st	windows with iron bars 50x60cm	family		free		none
6	door+frame	1	st	ironsheet door with wooden frame door 1,80x0,8	family		free		none
7	water	unlimited	bucket	waterpoint	community	common	free		500m
8	clay soil	unlimited			community	Francis Kibue	free	free: fill up the whole with other soil	500m
9	rocks	unlimited		rocks for the foundation	community	common	free		1km
10	timber	15	st		community	Francis Kibue	paid	500 Ksh or give back the same within a year	2km
11	wood: post	5	st		community	Francis Kibue	paid	1000 Ksh or give back the same within a year	2km
12	dried grass	50	bundle		community	Francis Kibue	paid	100 KsH per bundle or vegetables in comparable sum	2km
13	cement	unlimited	bag		other	shop	paid		5km

Figure 6. Example, overview capacities- materials

The designers are asked to prepare an interview instruction (based on a given example), which helps them to organize the interview. The instruction section assures that the interviewee is at ease (location, sitting, etc.) and understands the purpose of the interview (aim, topics, etc.). The interview guide section helps the designer to transform the capacities into logical questions for the interview. The questions of the interview guide are organized in four sections: resources, tools, skills/knowledge and income/labour. The support explains how interviews should be transcribed afterwards. This helps the designer to go through the answers afterwards and fill in a complete overview of all the capacities. After interviewing the family the designer is requested to repeat the process with the identified friends, family and community members that have certain capacities. Now have observed, mapped, located and quantified the capacities, we can use them to make decisions on future housing.

Capacity informed decision-making

"In the previous chapter you assessed the capacities of the family, their neighbours, friends, family and other community members. Most likely you now have an elaborate list of resources, tools, skills and many other things. The overview will be tremendous and to calculate and plan how to use it is difficult and a precision job. That's why this section describes the main support tool that was developed as a part of the PhD research of Michiel Smits. It will help you to weigh the options and identify the most suitable solution according to the available and desired capacities. Before we can start the comparison we will need to set some limitations. With too many variables you will be unable to properly compare

options. Therefore, we begin by setting the three main limitations to the (framing) analysis; first of all, the finance. The family you are helping stated the amount of savings they have for building a new house. Secondly, is to set the time limitation.

The third import limitation is the estimated quantities used in the project. Without an existing design this is extremely difficult to set. For this purpose we ask you and the family to identify the minimal house measurements for the family to have an "improved" house. Most likely the dimensions will be comparable to the house they currently live in (as they are able to sustain life there) or you already set the dimensions during the dream house game. Based on the set floor plan you can make a sketch design of the new house. This model you will use in order to estimate possible capacities like: materials, transportation, tools, labour and to weigh various different options to see if they are more suitable according to the existing capacities of the family."

The core argument of this article is that the main contributor to sustainable design is the use of available, proximal and peripheral capacities in articulating the built environment. As argued before capacities are complex and difficult to evaluate. Therefore, this article described the steps of a support tool that could be used by designers to evaluate those capacities via a mixed method approach. This section elaborates on the most important steps in the support that describes how these capacities can be used in what the author calls: *capacity informed decision-making* (see Appendix E). Here, the departure point for the design process is not defined by the functions, size or aesthetics, but by the available capacities of the family and their community.

In earlier sections of the support (not mentioned in this article) the designers organised 'sessions' with the family evaluating their desired house. The outcomes of this chapter describe: house typology, building methodology and materials. They are used to help the designer to compare the desired capacities (by the family) with their actual existing capacities. In the example below (Figure 8) the desired foundation phase was chosen of a family with extremely low financial capacities (less than 20.000 KsH to build an entire house; representative for the area on Mt. Elgon). Figure 8 indicates in red the problematic desired materials (costly materials and/or transportation). In the right columns the designer is able to list possible alternative materials found in the capacity analysis that are within the inhabitants reach, enabling the designer to openly discuss alternative materials with the family, exchanging ideas and elaborating why certain desired materials might be less suitable (considering families capacities) and why the alternatives are.

Materials (Required)	Quantities		Availability	Transport	Materials (Alternative)	Quantities		Availability	Transport
Branches	15	m1	yes	0	Branches	15	m1	yes	0
Marram Soil	1,32	m3	yes	500	Marram Soil	1,32	m3	yes	0
Cement	1396	kg	no	500	Clay soil	1,5	m3	yes	0
Riversand	2,828	m3	no	1000	Soil	2,828	m3	yes	0
Brick	600		no	1000	Stones	300		yes	0
Small Ballast (1/4 inch)	0,6996	m3	no	400	Marram Soil	0,6996	m3	yes	0
Transparant hose	8	m	no	0	Transparant hos	8	m	no	0
Mixed Soil	3	m3	yes	0	Mixed Soil	3	m3	yes	0
String	22	m	no	0	Sisal rope	22	m	yes	0

Figure 7. Weighing alternatives – materials

To make sure sufficient alternative materials for the new house are being considered, the designers are advised to make at least 2 alternatives. However, with alternative building materials come alternative tools, labour and skills. Therefore, the support explains how to generate an overview of the alternatives on all the capacities: resources, tools, skills/knowledge and income/labour. In Figure 9 an example of the alternative building tools is listed to show the differences in required capacities. The financial capacity is solely given to indicate how much the capacity would cost in case in it is not available.

Tools (Needed)	h	Available	Costs/Reward	Sum
Measure (ruler, tape: 1m1=0,5h)	11	no	1100	
Shovel (1m3= 8h)	130,42	yes		
Compacter (1m2= 0,5h)	12,1	yes	200	
Measure volume unit(container, wh	2	yes		
Trovel & flatboard	54	no	3500	
			4800	4800
Tools (Alternative)	**h**	**Available**	**Costs/Reward**	**Sum**
Measure (ruler, tape: 1m1=0,5h)	6	no	1100	
Shovel (1m3= 8h)	130,42	yes		
Compacter (1m2= 0,5h)	12,1	yes	200	
Measure volume unit(container, wheelb	2	yes		
Stone Hammer	26	no	2000	
			3300	3300
Tools (Alternative 2.0)	**h**	**Available**	**Costs/Rewar**	**Sum**
Measure (with feet: 1m1=0,5h)	6	no	0	
Shovel (1m3= 8h)	130,42	yes		
Compacter (1m2= 0,5h)	12,1	yes	200	
Measure volume unit(container, wheelb	2	yes		
Break with stones	26	yes	0	
			200	200

Figure 8. Weighing alternatives – tools cost

After formulating at least two alternative solutions besides, the designers are asked to prepare a presentation for the family (Figure 10). Here, the designers present a sketch design solely based on capacities: resources, tools, skills/knowledge and income/labour. The typology, program and aesthetics of the sketch house are not considered in this presentation, solely the capacities. Per sketch design the designers are asked to clearly show what the needed capacities are and to what extend they suit the existing capacities of the family.

Figure 9. Presentation of the sketch design

After the presentation, there is an informal unstructured interview where the family can address all their questions and remarks about the presented designs, most likely indicating which elements they like about the individual designs and which they would like to include in their future house. The last part of the support advises the designer to gather all the results from the presentation and interview session and combine them into a final recommendation for the design phase. It contains all the resources, tools, skills/knowledge and labour that should be used in making the design. The support does not elaborate how the capacities should be used in articulating a design. It is firmly believed that by analysing the context, making an inventory of the capacities and weighing them against material alternatives gives a solid departure point for the design process. However, designing and building based on available proximal and peripheral capacities is complex and extremely difficult to organize. Tools have to be borrowed, materials exchanged and labour planned (what activity planned when and who will help with it). Therefore, in the last section of the support and also this article, the planning methodology is explained.

Planning with (available, proximal and peripheral) capacities

"In the previous chapters you were able to identify the capacities of the family and their community, formulate alternative desired houses (based on the capacities), make sketch designs, discuss the different chosen options by the family and finally use these in a final design proposal for their new house. Weeks of analysis, talking, observing and much more have come to an end. All you decided upon with the family has to be built by them, their family, friends, neighbours and other community members. All with your help, expertise and skills.

The key to a success realization for your project is in your grasp, however you will have to do one last preparation before you can start. Starting the foundation work without involving everyone that offered their resources, tools and skills might make them feel excluded from the project. This might cause them to redraw from the project leading to a lack of resources, tools and skills. Therefore this chapter will firstly advise you how to make a detailed planning. Secondly to prepare and present the future house of the family including a detailed planning when, who and what is needed of the community. Of course planning in rural areas is difficult and very complicated. With people struggling to meet ends every day. So although people really want to help they do not always remember what they agreed upon. Going through the planning regularly with the family and asking them to make sure the involved people are aware of what is expected two to three days in advance will majorly improve the success of the project."

With the design finalized and approved by the family, the designer is ready to start planning the building activities. The user/community capacity & participation planning section of the support describes how the designer can approach planning of the building activities. Here step by step the process is unravelled roughly into five phases: foundation, floor, walls, roof and finishes. Per building activity the designer states the capacities needed: materials, tools and labour. Indicating who (from the earlier made capacity analysis) has offered to help and for what reward. When the whole planning is finished the designer discusses the planning with the family and makes corrections if necessary (dates might not fit, resources might not be available, etc.).

When the planning is finalized it is time to present the planning to the community members that are listed in the planning. Per community member a small letter will be

handed out stating what is requested, by when and for what reward. The community members are asked to reply to the letter or ask any questions they might have. They are given time to discuss the requested capacities with their family members before they agree. As families struggle to generate the financial capacities to pay for help by the community, it is extremely important to enable the inhabitants to trade capacities instead of paying for them, offering each other a better habitation without the need of large savings and investments. This system of exchanging materials, labour and tools (capacities) need a thorough registration system. Most of the inhabitants on Mt. Elgon do not have the luxury to help each other without asking for something in return. Therefore, the last step of the support describes a registration system (logbook) where all borrowed capacities (tools, materials, labour) are registered in. At the end of each day a logbook is used to register the shared capacities. Per day, week or activity the inhabitant can write an "I owe you", clearly stating which capacity needs to be given back by when. This can be a certain amount of hours of digging, giving back six wooden posts by the end of the year, or a bag of maize by the end of the harvest season. This way is allowing a more flexible exchange system that follows the fluctuations in income, harvest and available time. Finally empowering the community to plan and realize a more self-reliant and improved built environment.

Conclusion

This article explained the importance of capacity evaluation for sustainable design and development, concluding that there is a lack of a suitable framework to evaluate available, proximal and peripheral inhabitant capacities. It elaborated on the possible positive effects of available rural inhabitant capacities, proximal community capacities and peripheral capacities on the ecological footprint of their built environment. Continued by describing a framework that employs mixed methods to identify, contextualize and evaluate capacities in a rural Sub-Saharan context. Furthermore, it showed how these capacities can be weighed and used to formulate a capacity based sketch design. Concluding by describing how the capacity based design can be planned with the involvement of the inhabitants with their family, friend and their community.

The framework was developed to help designers advise rural communities in developing counties how they can realize a sustainable alternative housing based on their existing capacities. Opposing trend can be seen in developing countries where the 'western' example of building methodologies and materials is being used increasingly more often. Here, the ecological footprint of the inhabitants' built environment is growing exponentially which is in many ways becoming comparable to the formal unsustainable built environment seen in the West. Advising rural communities on the negative effects of pursuing unsustainable solutions and offering them sustainable alternatives, can potentially have a tremendous effect on making the built environment as a whole more sustainable. More importantly, it possibly sustains communities' resilience and social cohesion. Advocating the use of local available (sustainable) over industrialized (unsustainable) non-local materials potentially reducing emissions caused by the transport of non-local materials and labour. Although the described framework is not yet tested in practice, it will most likely allow effective evaluation of inhabitant capacities. As the support tool was written to assess inhabitant capacities in rural developing countries it can't yet be used in another context. However, the framework itself could be used to evaluate available inhabitant, proximal and peripheral capacities in different contexts.

The support is currently tested in a quasi-experiment setting (Shadish, Cook, & Campbell, 2002) in Sub-Sahara Africa. In two consecutive articles the framework for the quasi-experiments and the results of the impact of the support will be described.

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