A DESIGN TOOL FOR RISK REDUCTION IN LEARNING FACILITIES:

Diseases prone areas

A DESIGN TOOL FOR RISK REDUCTION IN LEARNING FACILITIES *Diseases prone areas*

POLITECNICO DI TORINO

MSc degree program in
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Master Thesis

TUTHOR
Francesca de Filippi

CO-TUTHOR
Valeria Federighi
Roberto Pennacchio,
Michele Di Marco

AUTHOR
Juan Pablo Benavides Soto

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And inally, I would like to thank my family and friends who always believed in me and supported me in the development of this thesis.

Thank you all .

PREFACE

This thesis is part of a collaboration between 4 students: Andrea Matevska, Jana Tosheva, and Erika Cerra, Juan Pablo Benavides as a mather of both indiviual and colective work.

The development of this thesis is thanks to EAHR (Emergency Architecture and Human Rights), a non-profit organisation based in Copenhagen, Denmark. The team of EAHR provide consultancy around the world, as well as creating educating frameworks, conducting research and hosting a range of workshops on architecture in humanitarian emergencies in universities around the world. “EAHR believe that Architecture is a Human Right.”

The research is focused on the development of a holistic design tool: “the matrix tool”. This will gather information on resilient construction against different types of disasters: floods, epidemics, earthquakes, and storms, based on scientific research applied to educational buildings. Therefore, allowing a better design decision process in contexts of scarcity and helping to development of safer projects for education, in areas of high risk and vulnerability to natural hazards.

METHODOLOGY

The primary aim of this thesis was to examine the nature of schools in hazard prone areas and to explore hazards and the factors which impacted upon the construction performance as well as interaction with the communities.

While we entered the research context with a clear framework for investigation based on a global level, the research was not focused on testing of any hypothesis or theory in terms of efficiency of different guidelines for hazard resilient buildings which were used as a starting point for the development of our tool – The matrix.

The initial purpose of this tool was to reveal and describe the possible solutions for a hazard safe classroom, in order to gain greater understanding for the site characteristics, local materials as well as building techniques which can be used by the communities.

INDEX

1. THE PROBLEM

1.1 EDUCATION

Going to school and learn is a right which all children have, regardless socio-economic aspects such as who they are, where they live or how much money their parents have.

Education is fundamental to development. A good education can open the door to jobs opportunities, and skills that a family needs to survive and progress. Access to high-quality primary education is a globally-recognized solution to the cycle of poverty. (Concern, 2020).**(1)**
It is imperative to highlight that some poverty scaping solutions, are related to education, in that order of ideas, putting efforts on a higher and stronger education it is possible to reduce:

- Economic growth
- Reduced income inequality
- Reduced infant and maternal deaths
- Reduced stunting
- Reduced vulnerability to HIV and AIDS
- Reduced violence at home and in society**(1)**

Several studies have shown that education is fundamental to develop and improve the population´s life. As an example: the new analysis by UNESCO's Global Education Monitoring (GEM) Report team, shows that nearly 60 million people could escape poverty if all adults had just two more years of schooling. **(2)**

However, worldwide there is still a huge education gap. Accessibility to classrooms is not possible for most of the population in the world, specially in developing countries.

References:
(1) CONCERNUNSA(2020) Olivia Giovetti, HOW DOES EDUCATION AFFECT POVERTY? IT CAN HELP END IT, 2020
(2) UNESCO(2017), UNESCO's Global Education Monitoring (GEM) report, 2017.

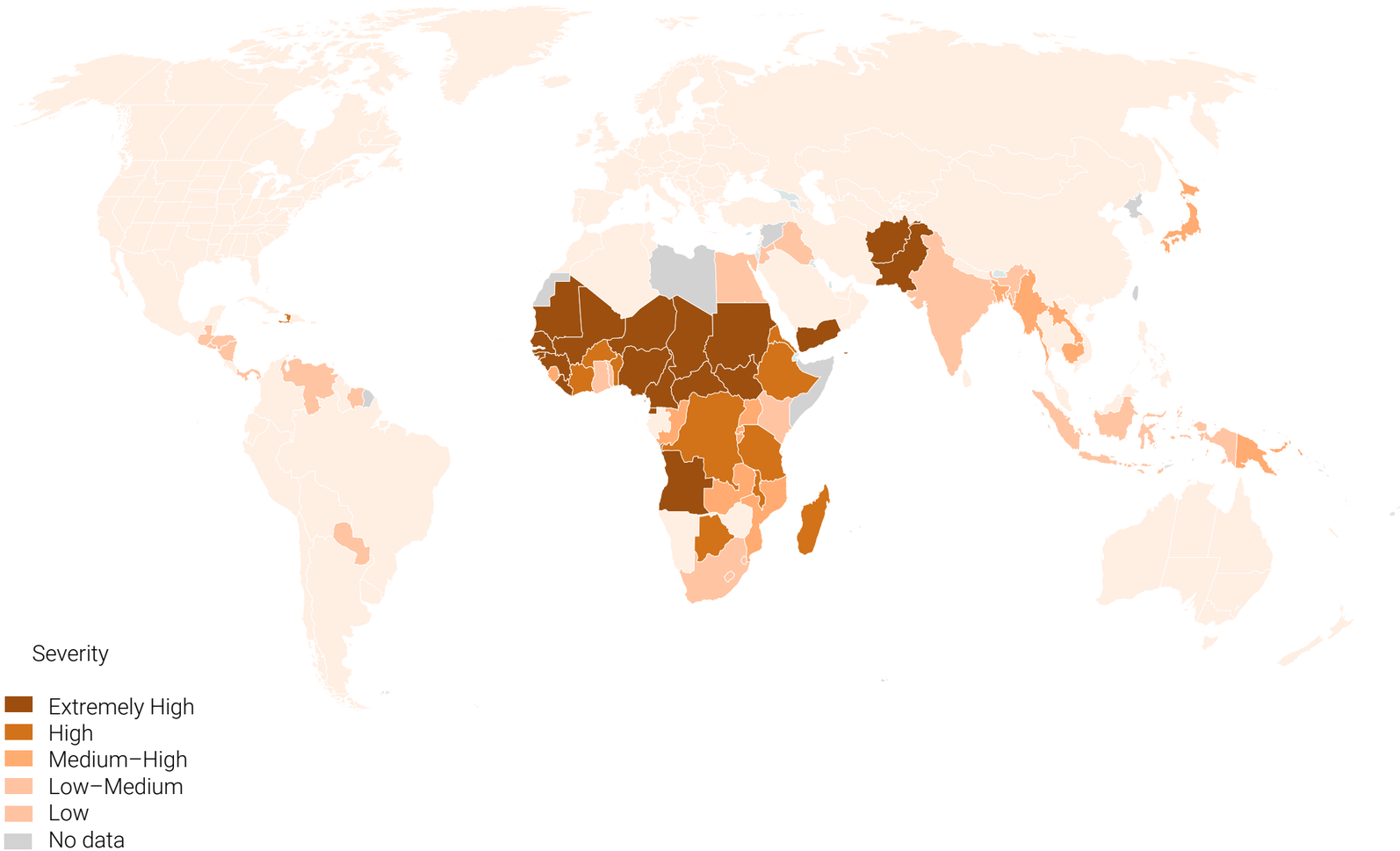
According to the United Nations, about 260 million children were still out of school in 2018, And more than half of all children and adolescents worldwide are not meeting minimum proficiency standards in reading and mathematics.(UN, 2018) **(3)**. Illiteracy children are a treat for developing countries.

A prove of this is the education CCRI component score shows the severity of education vulnerability worldwide taking in consideration three relevant index: children out of school, youth literacy and education expenditure. It exhibits that the most affected countries by this situations are in the regions of Asia-pacific and sub-Sahara Africa (UNICEF, 2021). **(4)**

In order to expand the illustration on how the situation of education affects the life of kids around the glove, this section is going to explain why children are out of school, taking in account some of the most important reasons reflecting school absence:

1. Conflict
2. Natural Disasters
3. The Lack of WASH Services
4. Infectious diseases

Education CCRI Component Score **(4)**



References:
(3) UNITED NATION. (2020, 01 01). OBJETIVO DE DESAROLLO SOSTENIBLE. Tratto da https://www.un.org/sustainabledevelopment/es/inequality/
(4) The Climate Crisis is a Child Rights Crisis:: Introducing the Children's Climate Risk Index. New York: United Nations Children's Fund (UNICEF), 2021.

1.1.1 CONFLICT

Conflict affects children in different aspects of their life, but one of the most important is education. In conflict zones, 27 million children are out of school, putting their educational processes at risk. (UNICEF, 2017)**(5).**

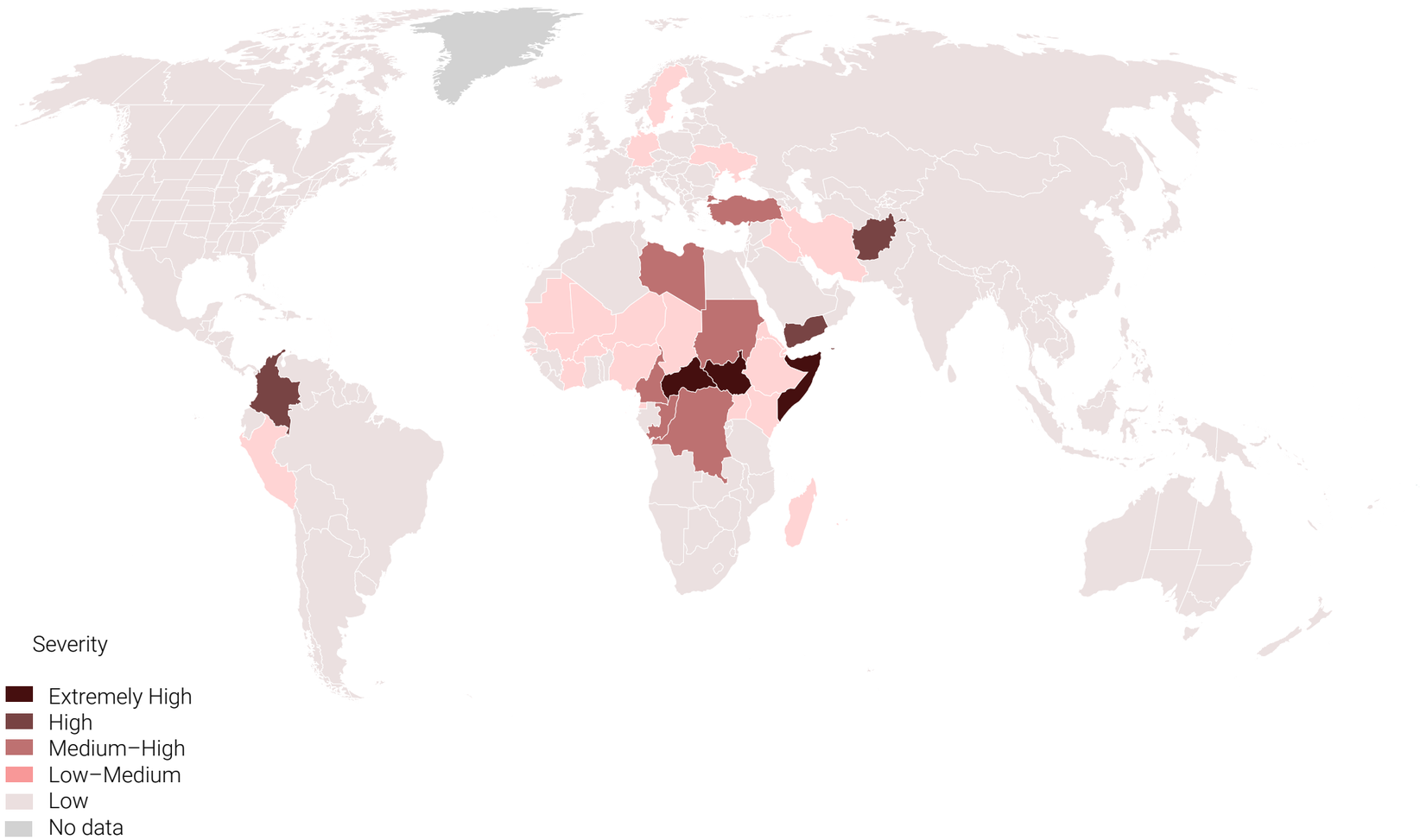
Unfortunately, during armed conflict, the security of thousands of children and teachers is affected. The most frequent consequences of war are death, kidnappings, recruitment and forced displacement. An example of this is the Rwandan genocide in 1994, in which more than two-thirds of teachers in primary and secondary schools were killed or displaced.**(6)**

On the other hand, in these war contexts, children are forced to stay home and interrupt their education process. Usually, schools tend to be taken as war targets or military bases by armed groups, which can lead them to be attacked, damaged, or destroyed. As reported by UNICEF, in 2020, there were 535 verified attacks on schools, leaving thousands of children without accessibility to education.**(7)**

Many other examples can be found such as the Mozambique civil war in which 58% of primary schools were destroyed or the Iraq war conflict where 85% of learning facilities were totally affected. **(8)**

These situations force many children to not be able to access educational services, putting their learning process in high risk and exposing them to other types of hazards, such as child marriage, recruitment, sexual exploitation, and child labour.

Uprooted people **(4)**



References:
(5) United Nations. (2017, september 18). United nations. Conflict keeps 27 million children out of school, with girls at high risk of abuse – UN report
(6) In the context of this study, conflict refers to violent conflict, including civil and interstate wars and armed rebellions. This definition is used in the World Bank publication by Buckland (2005)
(7) UNICEF. (2020). UNICEF. Tratto da Education under attack: https://www.unicef.org/education-under-attack#:~:text=For%20children%20living%20in%20conflict,per%20cent%20compared%20to%202019.

References:
(8) UNESCO, Institute of stadistics. (2010). The quantitative impact of conflict on education

1.1.2 NATURAL DISASTERS

Other children's threats related to school absence are natural disasters. Globally, approximately 1 billion children – nearly half of the world's children – live in countries that are at an 'extremely high-risk' from the impacts of climate change, according to the CCRI **(4)**. This exposes them to many hazard, health, environmental and social risks.

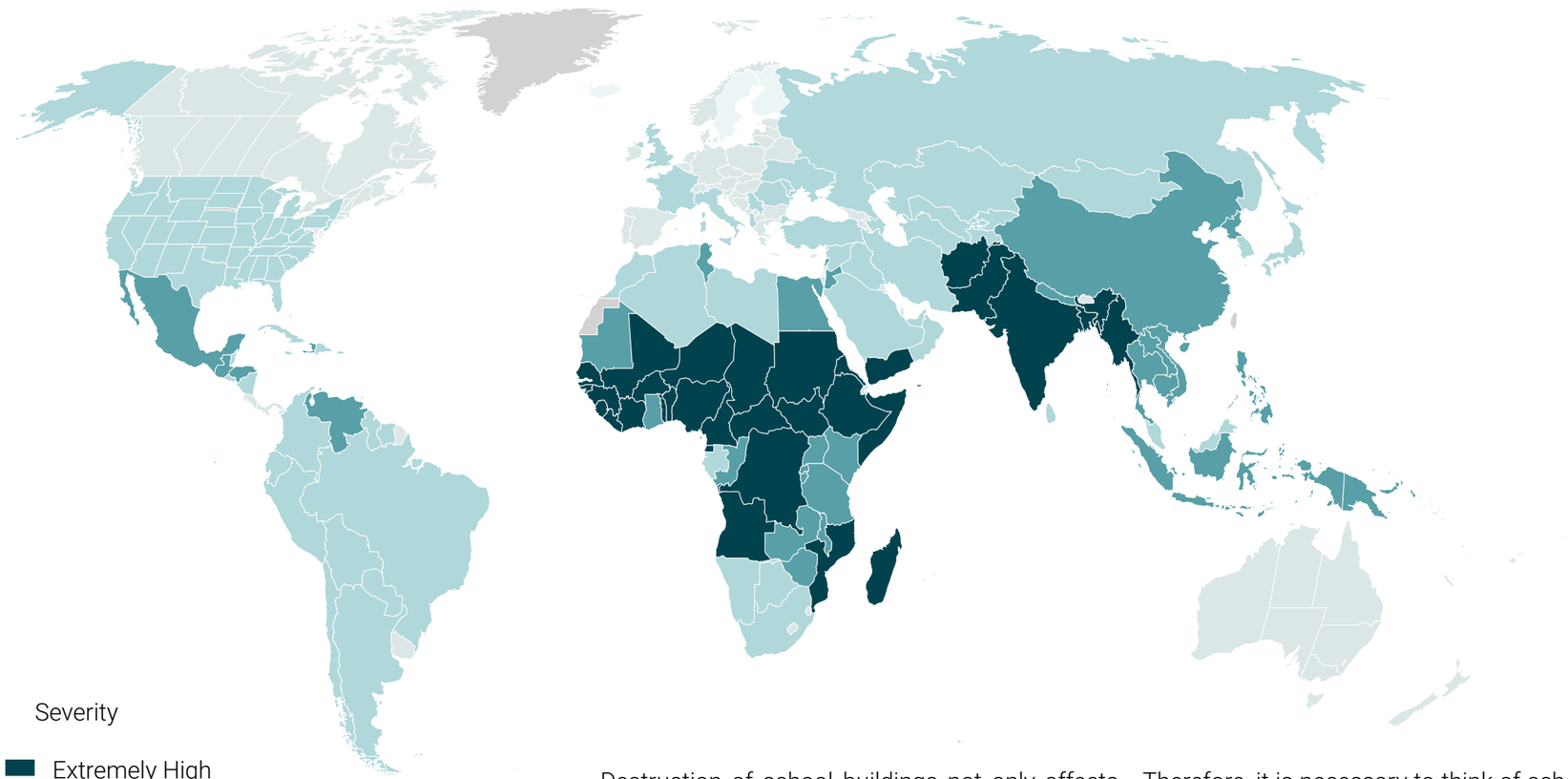
The Children's Climate Risk Index ranks countries based on how exposed children are to climate and environmental shocks, like cyclones and heatwaves. It also looks at the access young people have to essential services, such as water, sanitation, healthcare, and education (UNICEF, 2021). **(4)**

Every year education faces the impact of natural disasters. Natural hazards such as Cyclones, floods, earthquakes, and landslides can delay education process for millions of children. Several damages to infrastructure and destruction are the main causes of absence to school after these events.

Also, even if the schools survive, it can take months or even years for them to be repaired and for education to return to normal. Families whose livelihoods have been destroyed may no longer be able to afford to send their children to school. (Theirworld, 2020).

For example, In the Asia Pacific region, it is estimated that climate change will lead to around 200 million children a year will have their lives severely disrupted by natural disasters over the coming decades. **(9)**

The Children's Climate Risk Index (CCRI) **(4)**



Destruction of school buildings not only affects children but entire communities, these facilities might serve other critical functions within communities. A School building often serve as centers for social interaction, and as a place for community and cultural life. In crisis context, schools are often designated as shelters for displaced families.

Therefore, it is necessary to think of schools as resilient and safe structures to guarantee the education and protection of hundreds of people. Natural disasters not only affect the integrity of children but also the infrastructure that supports their needs.

References:
(9) . Their world. (07, 02, 2020). theirworld. 20 reasons why, in 2020, there are still 260m children out of school: https://theirworld.org/news/20-reasons-why-260m-children-are-out-of-school-in-2020.

1.1.3 WASH ACCESIBILITY

The lack of adequate wash and sanitation services in school is another reason of school absence. As reported by the WHO, 818 million children must contend with a lack of basic hygiene facilities during their education, exposing their health at risk and meaning some have to miss school. **(10)**

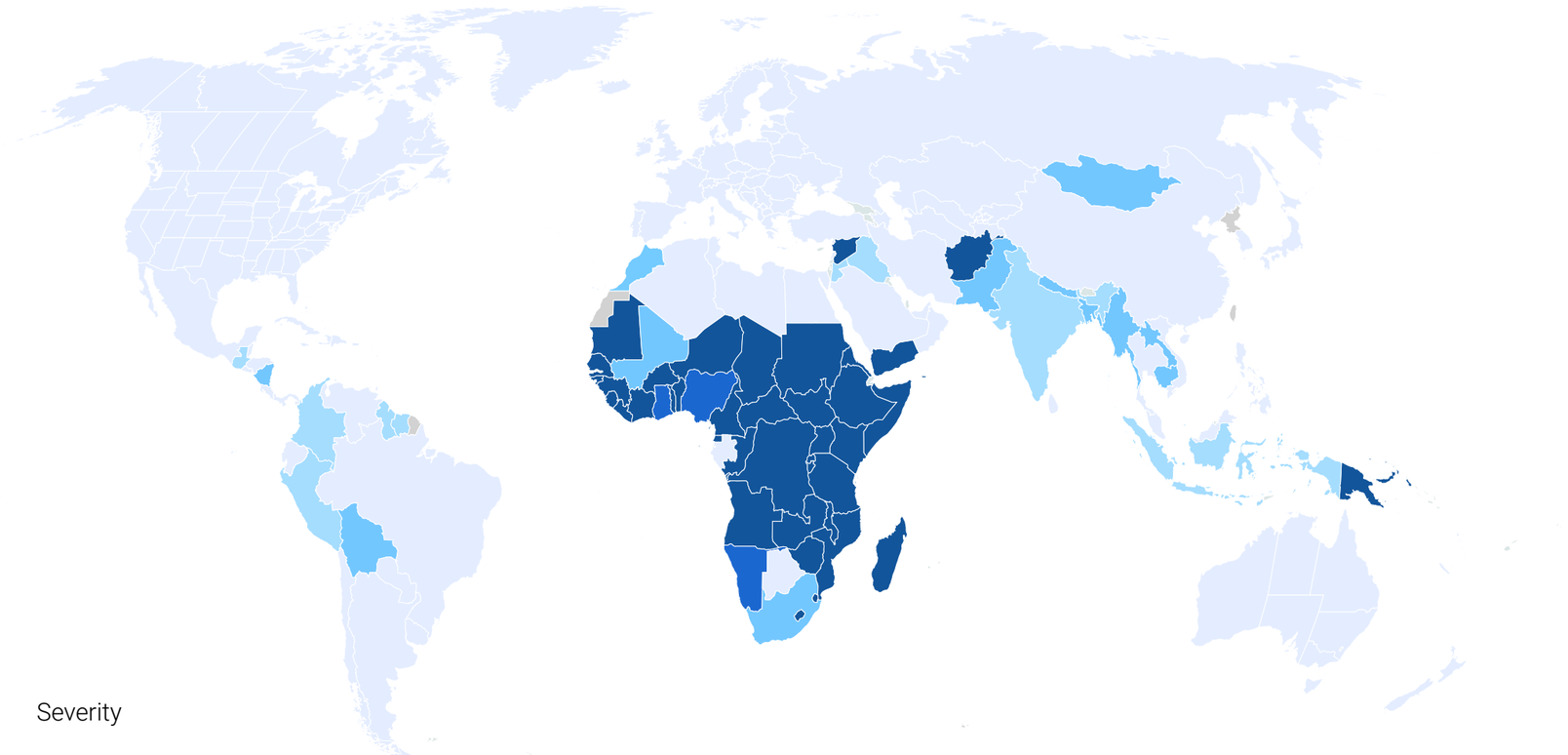
Schools without WASH services put children in vulnerability to illness and diseases. Children without access to adequate WASH provisions have a reduced capacity to respond to, and treat, climate-related diseases. (UNICEF,2021)
The WASH CCRI component score shows the severity of WASH vulnerability worldwide taking in consideration three relevant index: water supply, sanitation and hygiene expenditure. **(4)**

In poorer countries only 53% of upper secondary schools have drinking water. Globally, only 66% of primary schools have handwashing facilities but the average across the poorest countries is 43% - and much lower in some nations. (theirworld, 2020). **(9)**

As stated by UNICEF and WHO, In 2019, 584 million children lacked a basic drinking water, 698 million children lacked a basic sanitation service and 818 million children lacked a basic hygiene service. **(11)**

Also, it is well known that climate change will

WASH CCRI Component Score **(4)**



References:
(10) World Health Organization. (13, 08, 2020). WHO. 2 in 5 schools around the world lacked basic handwashing facilities prior to COVID-19 pandemic — UNICEF, WHO: https://www.who.int/news/item/13-08-2020-2-in-5-schools-around-the-world-lacked-basic-handwashing-facilities-prior-to-covid-19-pandemic-unicef-who.
(11) Progress on drinking water, sanitation and hygiene in schools: Special focus on COVID-19. New York: United Nations Children's Fund (UNICEF) and World Health Organization (WHO), 2020.

impact the spread not only of vector-borne diseases but also water-borne ones, such as diarrhoea, the second leading cause of death among children under the age of 5. (WHO, 2020). **(12)**

It is important to highlight that access to sanitation services support fighting illness outbreaks and epidemics.
As evident from the COVID-19 pandemic, practice of effective sanitation and hygiene behaviours such as frequent handwashing with soap are crucial to prevent disease transmission at the individual and wider community. (UNICEF, 2020). **(4)**

References:
(12) World Health Organization. (28, 01, 2022). WHO. Child mortality (under 5 years): https://www.who.int/news-room/fact-sheets/detail/levels-and-trends-in-child-under-5-mortality-in-2020

REFERENCES

(1) CONCERNUNSA(2020) Olivia Giovetti, HOW DOES EDUCATION AFFECT POVERTY? IT CAN HELP END IT, 2020

(2) UNESCO(2017), UNESCO's Global Education Monitoring (GEM) report, 2017.

(3) UNITED NATION. (2020, 01 01). OBJETIVO DE DESAROLLO SOSTENIBLE. Tratto da https://www.un.org/sustainabledevelopment/es/inequality/

(4) The Climate Crisis is a Child Rights Crisis:: Introducing the Children's Climate Risk Index. New York: United Nations Children's Fund (UNICEF), 2021.

(5) United Nations. (2017, september 18). United nations. Conflict keeps 27 million children out of school, with girls at high risk of abuse – UN report

(6) In the context of this study, conflict refers to violent conflict, including civil and interstate wars and armed rebellions. This definition is used in the World Bank publication by Buckland (2005)

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(8) UNESCO, Institute of stadistics. (2010). The quantitative impact of conflict on education

(9) . Their world. (07, 02, 2020). theirworld. 20 reasons why, in 2020, there are still 260m children out of school: https://theirworld.org/news/20-reasons-why-260m-children-are-out-of-school-in-2020.

(10) World Health Organization. (13, 08, 2020). WHO. 2 in 5 schools around the world lacked basic handwashing facilities prior to COVID-19 pandemic — UNICEF, WHO: https://www.who.int/news/item/13-08-2020-2-in-5-schools-around-the-world-lacked-basic-handwashing-facilities-prior-to-covid-19-pandemic-unicef-who.

(11) Progress on drinking water, sanitation and hygiene in schools: Special focus on COVID-19. New York: United Nations Children's Fund (UNICEF) and World Health Organization (WHO), 2020.

(12) World Health Organization. (28, 01, 2022). WHO. Child mortality (under 5 years): https://www.who.int/news-room/fact-sheets/detail/levels-and-trends-in-child-under-5-mortality-in-2020

2. INFECTIOUS DISEASES

2.1 INFECTIOUS DISEASES

In unsafe learning environments, children are exposed to many infectious diseases such as measles, cholera, diarrhea, typhoid fever, going to school can putting their health at high risk.

There are three types of infectious diseases, these can be classified by the way of spreading: Water borne diseases, Vector borne diseases and Airborne diseases.

2.1.1VECTOR - BORNE DISEASES

Defined by WHO, Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors such as mosquitos, bugs, fleas, and other insects.
Some of the most frequent diseases are malaria, dengue, leishmaniasis, Chagas disease, yellow fever, Japanese encephalitis, and onchocerciasis. **(1)**

As reported by the World health organization, every year there are more than 700,000 deaths from vector borne diseases and the burden of these diseases is highest in tropical and subtropical areas (WHO, 2020). **(1)**

The climate crisis that the world is facing is increasing the risk of malaria transmission in many countries, exposing more people to this threat. Changes in temperature, precipitation patterns and humidity have a direct effect on the reproduction and survival of the mosquitoes that transmit diseases (UNICEF, 2021). **(2)**

Warmer temperatures from climate change increase bite rates and transmission. It also reduces the mosquito virus incubation period, leading to higher mosquito proliferation.

Additionally, the increase of natural disasters such as cyclones, floods and storms, lead to environmental and social changes which can expose communities to diseases.

Common situations after disasters are infrastructure destruction, contaminated drinking water (leading to makeshift water storage), people sleeping in temporary outdoor shelters, and others. They can also influence the spread of other deadly diseases such as cholera and meningococcal meningitis and other food-borne diseases. (WHO, 2020).**(2)**

References:
(1) World Health Organization. (02, 03, 2020). Vector-borne diseases: https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases
(2) The Climate Crisis is a Child Rights Crisis:: Introducing the Children's Climate Risk Index.New York: United Nations Children's Fund (UNICEF), 2021.

MALARIA

Malaria is one of the most important vector-borne diseases affecting people and children worldwide. As reported by the BMS, mortality is greatest among young children. The major causes of childhood death are cerebral malaria, severe malaria anemia and respiratory distress. **(3)**

Young children who survive cerebral malaria may be left with debilitating neurological impairments. . **(4)**

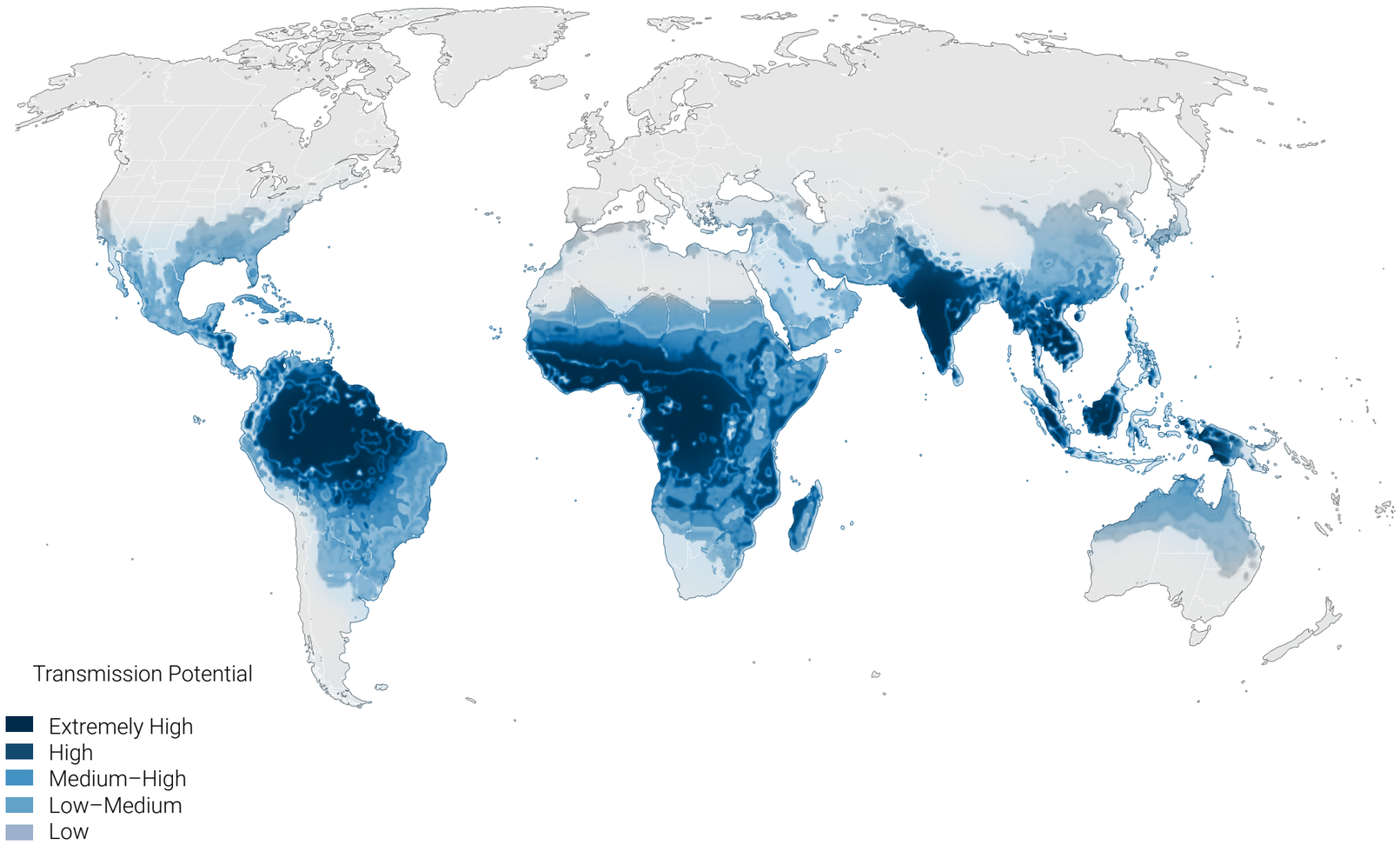
The “world malaria report” shows that, in 2019, there were an estimated 229 million malaria cases worldwide, with over 409,000 fatalities. Children under the age of five accounted for 67 per cent of global malaria deaths in 2019. **(5)**

Malaria is estimated to contribute between 5% to 8% of all-cause absenteeism among African schoolchildren, equivalent to 50% of all preventable absenteeism. **(4)**

Between the malaria prevention tools and strategies, recommended by WHO we can find vector control and the use of preventive antimalarial drugs. However, malaria is a disease affecting poorest populations, which might not be able to affort these increasing the vulnerability to it.

Therefore, Access to water and sanitation is a very important factor in disease control and elimination. Adequate Water storage, sanitation and waste management would reduce the risk to malaria and vector borne diseases in general.

Disease vector exposure worldwide **(2)**



References:
(3) Conroy, A.L., Datta, D. & John, C.C. What causes severe malaria and its complications in children? Lessons learned over the past 15 years. BMC Med 17, 52 (2019). https://doi.org/10.1186/s12916-019-1291-z
(4) Malaria control in schools.: Partnership for Child Development, London School of Hygiene and Tropical Medicine, Kenya Medical Research Institute-Wellcome Trust Research Programme, The World Bank; 2009
(5) World malaria report 2020: 20 years of global progress and challenges. Geneva: World Health Organization; 2020. Licence: CC BY-NC-SA 3.0 IGO

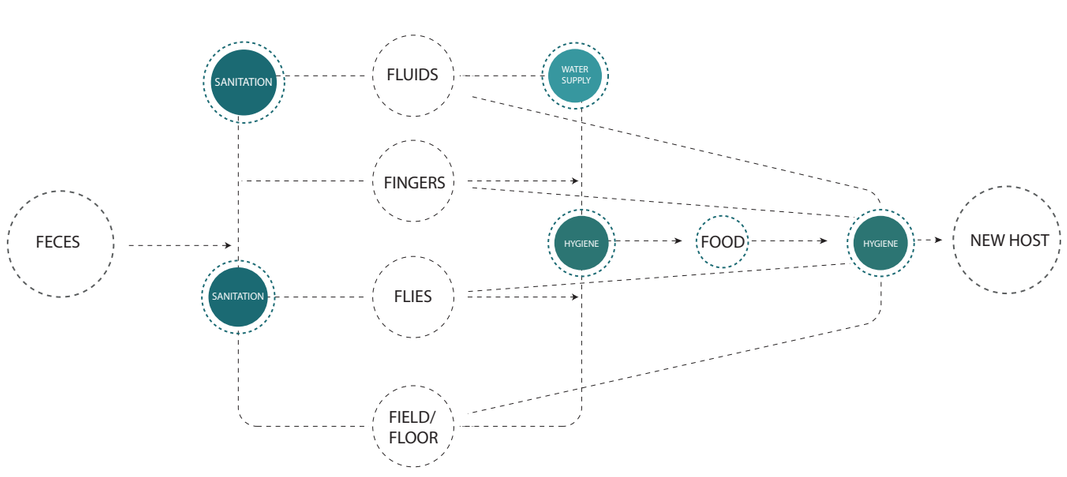
2.1.2 WATER - BORNE DISEASES

Waterborne diseases are illnesses caused by microscopic organisms, like viruses and bacteria, that are ingested through contaminated water or by encountering feces. Difficulties to access WASH services in developing countries, expose thousands of children to waterborne diseases.

According to the WHO, every year there are nearly 1.7 billion cases of childhood diarrhoeal disease and about 525.000 deaths. **(6)**
Diarrhoea is a major public health concern and a leading cause of disease and death among children under five years of age in low and middle-income countries. It can last several days and can leave the body without the water and salts that are necessary for survival.

As explained before, accessibility to WASH services are barriers which prevent the spread of water borne diseases. The importance of water, sanitation and higiene can be explained by the F diagram, developed by Wagner and Lanoix in 1985. It shows pathways of fecal–oral disease transmission. **(7)**

The blue circles show barriers: toilets, safe water, hygiene, and handwashing.



References:
(6) World Health Organization. (02, 05, 2017). Diarrhoeal disease: https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease.
(7) Brian Reed, Brian Skinner and Rod Shaw, WEDC.. The F diagram: https://wedc-knowledge.lboro.ac.uk/resources/posters/P004_The_F_Diagram.pdf

However, the absence of access to sanitation services in school forces hundreds of people (students and teachers) to have harmful habits such as open defecation. In environments where this is common, surface, and shallow groundwater sources are often contaminated.

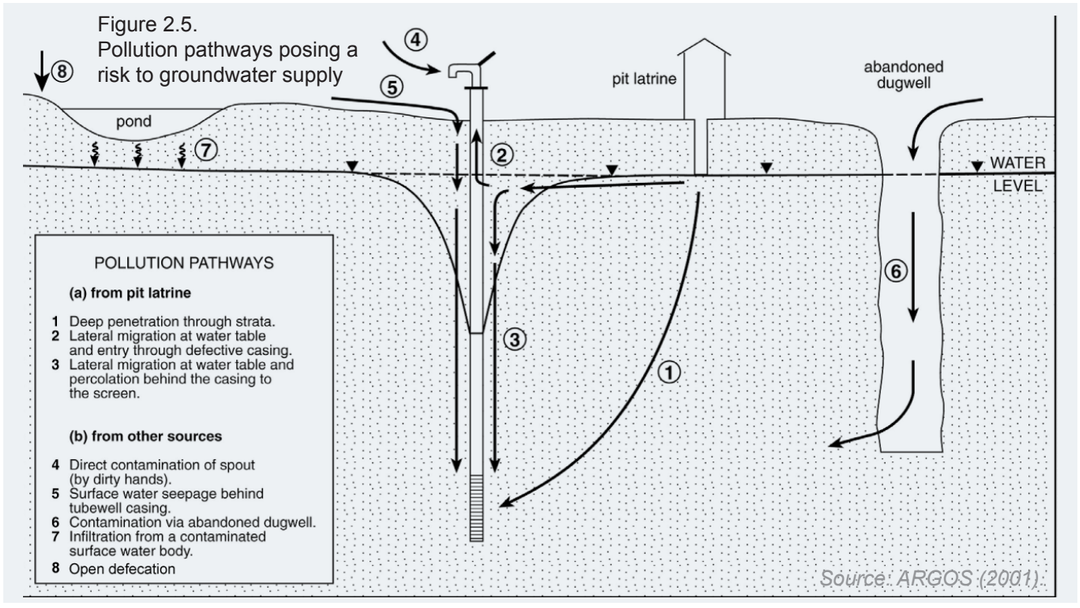
According to UNICEF, one gram of feces can contain 10 million viruses, one million bacteria and one thousand parasite cysts. (UNICEF, 2000) **(8)**

This practice is very dangerous for health and affects entire communities and families, it increases the risk of contracting diseases such as diarrhea, cholera, dysentery, and typhoid since it contaminates water supplied sources for drinking, and cooking.

in some places, where open defecation is common, large areas are converted into feacal fields. these potentially put the village and consequently water sources at risk of flooding with feacal material form surrounding areas. **(9)**

This situation, explains why sanitary and higiene systems are so important for people's heath.

Figure 2.5.
Pollution pathways posing a risk to groundwater supply



Source: UNICEF, GWP (2017), WASH Climate Resilient Development.

References:
(8) State of the World's Toilets, WaterAid, 2007, based on data from WHO/UNICEF Joint Monitoring Programme.
(9) Okullo, J. O., Moturi, W. N., & Ogendi, G. M. (2017). Open Defaecation and Its Effects on the Bacteriological Quality of Drinking Water Sources in Isiolo County, Kenya. Environmental health insights, 11, 1178630217735539. https://doi.org/10.1177/1178630217735539

2.1.3 AIR - BORNE DISEASES

The third type of diseases affecting children are Airborne. This kind of disease can spread when people with certain infections cough, sneeze, or talk, spewing nasal and throat secretions into the air. Some viruses or bacteria take flight and hang in the air or land on other people or surfaces, the most common are influenza, tuberculosis, measles, mumps, and chicken pox.

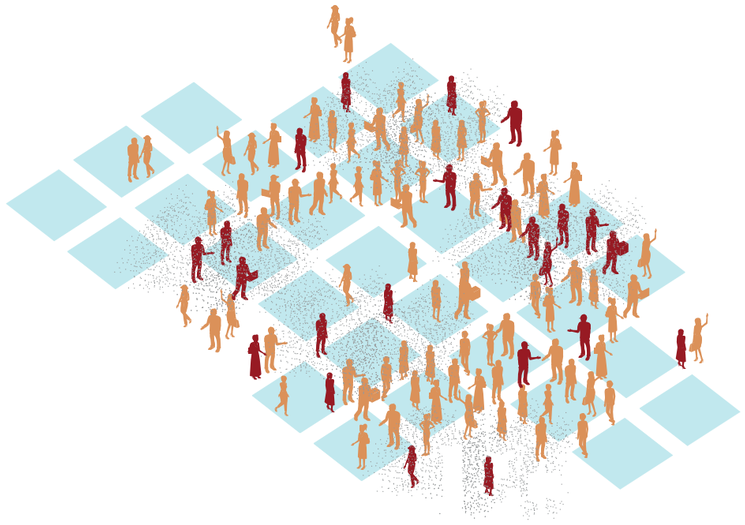
Despite being entirely preventable and treatable, common infectious diseases are still killing or affecting young children in large numbers:

- in 2019, Pneumonia killed 740 180 children under the age of 5, accounting for 14% of all deaths of children under five years old but 22% of all deaths in children aged 1 to 5. (WHO, 2020). **(10)**

- Influenza annual epidemics result in about 3 to 5 million cases of severe illness, and about 290 000 to 650 000 respiratory deaths, children aged between 6 months to 5 years are at high risk. (WHO, 2018) **(11)**

- In 2020, 1.5 million people died from TB and 1.1 million children fell ill with TB globally. it is the 13th leading cause of death and the second leading infectious killer after COVID-19 (above HIV/AIDS). (WHO, 2021) **(12)**.

- In 2018, 353,236 people was infected by measles and more than 140 000 people died, mostly children under the age of 5 years, despite the availability of a safe and effective vaccine. In 2019, measles cases worldwide increased to 869 770 and in 2020 the total was 7.5 million globally. (WHO, 2020). **(13)**



References:
(10) World Health Organization. (2020). Pneumonia: https://www.who.int/health-topics/pneumonia#tab=tab_1
(11) World Health Organization. (02, 11, 2018). Influenza seasonal: https://www.who.int/news-room/fact-sheets/detail/influenza-(seasonal)
(12) World Health Organization. (14, 10, 2021). Tuberculosis: https://www.who.int/news-room/fact-sheets/detail/tuberculosis
(13) World Health Organization. (12, 11, 2021). Worldwide measles deaths climb 50% from 2016 to 2019 claiming over 207 500 lives in 2019: https://www.who.int/news/item/12-11-2020-worldwide-measles-deaths-climb-50-from-2016-to-2019-claiming-over-207-500-lives-in-2019

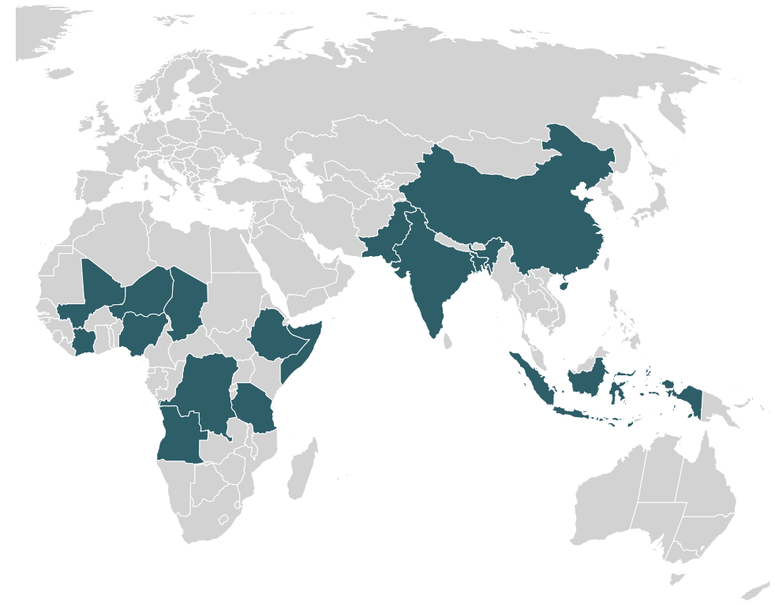
Children education is affected by the spread of these air-borne diseases. The lack of infrastructure and health services in many countries makes more difficult medical care of these diseases and ill children are obligated to stay far from education while healing.

Children in the world's poorest regions are disproportionately affected, according to the UNICEF 2020, infectious diseases are particularly prevalent in sub-Saharan Africa. (UNICEF, 2020). **(14)** The map shows the top 15 countries presenting pneumonia death for children under the age of 5 in 2018.

15 high Burden Countries
Pneumonia

Severity

-Angola
-Bangladesh
-Chad
-China
-Cote d'ivoire
-DRC
-Ethiopia
-India
-Indonesia
-Mali
-Niger
-Nigeria
-Pakistan
-Somalia
-Tanzania



References:
(14) UNICEF. (12, 11, 2021). Childhood diseases: https://www.unicef.org/health/childhood-diseases

COVID-19 AND SCHOOL ABSENTISM

On the other hand, it is important to highlight that schools can be place of spreading diseases. Social activities in learning spaces such as playing, talking, and interacting for several hours can increase the risk of contracting viruses.

Besides, the risk gets higher specially in crowded spaces where WASH services are not available or in poor condition. Also, natural ventilation or mechanical is important to renewal the air in indoor spaces.

A safe learning environment can prevent the spread of infectious diseases protecting children, families, and communities.

The spread of viruses can cause epidemics and pandemics having strong impacts on countries and territories. Since March of 2020 when the COVID-19 pandemic was declared by WHO, education, health, economy sectors has been impacted. The situation forced governments to act with Lockdown and the closure of many public and private buildings, affecting people's daily life.

Some of the most vulnerable groups were children, by march of 2021, schools for more than 168 million children globally had been completely closed (UNICEF, 2021). **(15)**

References:
(15) UNICEF. (03, 03, 2021). COVID-19: Schools for more than 168 million children globally have been completely closed for almost a full year: https://www.unicef.org/rosa/press-releases/covid-19-schools-more-168-million-children-globally-have-been-completely-closed

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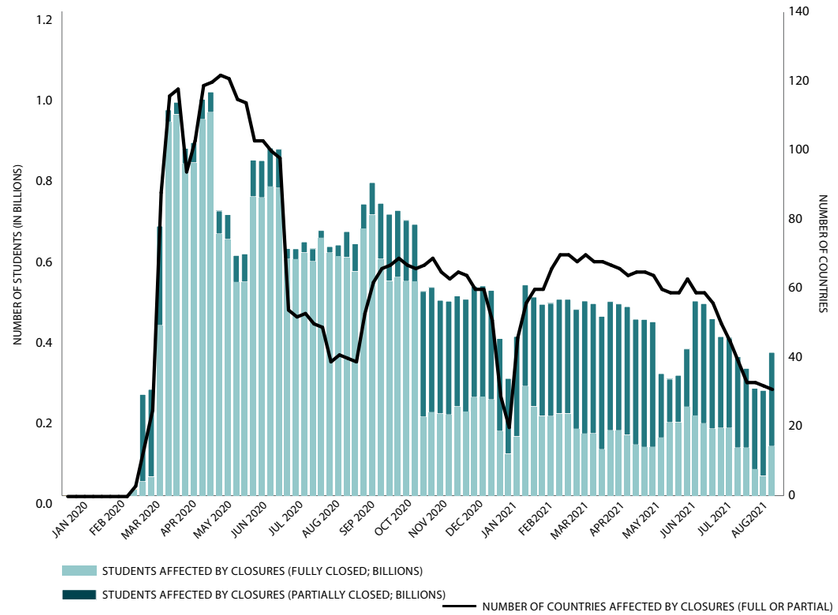
full and partial school closures since the start of the pandemic



Sourceauthors' calculations using UNESCO school closure database.

References:
(16) The World Bank, UNESCO and UNICEF (2021). The State of the Global Education Crisis: A Path to Recovery. Washington D.C., Paris, New York: The World Bank, UNESCO, and UNICEF

REFERENCES

References:
(1) World Health Organization. (02, 03, 2020). Vector-borne diseases: https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases
(2) The Climate Crisis is a Child Rights Crisis:: Introducing the Children's Climate Risk Index.New York: United Nations Children's Fund (UNICEF), 2021.

(3) Conroy, A.L., Datta, D. & John, C.C. What causes severe malaria and its complications in children? Lessons learned over the past 15 years. BMC Med 17, 52 (2019). https://doi.org/10.1186/s12916-019-1291-z.

(4) Malaria control in schools.: Partnership for Child Development, London School of Hygiene and Tropical Medicine, Kenya Medical Research Institute-Wellcome Trust Research Programme, The World Bank; 2009.

(5) World malaria report 2020: 20 years of global progress and challenges. Geneva:
World Health Organization; 2020. Licence: CC BY-NC-SA 3.0 IGO

(6) World Health Organization. (02, 05, 2017). Diarrhoeal disease: https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease.

(7) Brian Reed, Brian Skinner and Rod Shaw, WEDC.. The F diagram: https://wedc-knowledge.lboro.ac.uk/resources/posters/P004_The_F_Diagram.pdf.

(8) State of the World's Toilets, WaterAid, 2007, based on data from WHO/UNICEF Joint Monitoring Programme.

(9) Okullo, J. O., Moturi, W. N., & Ogendi, G. M. (2017). Open Defaecation and Its Effects on the Bacteriological Quality of Drinking Water Sources in Isiolo County, Kenya. Environmental health insights, 11, 1178630217735539. https://doi.org/10.1177/1178630217735539.

(10) World Health Organization. (2020). Pneumonia: https://www.who.int/health-topics/pneumonia#tab=tab_1

(11) World Health Organization. (02, 11, 2018). Influenza seasonal: https://www.who.int/news-room/fact-sheets/detail/influenza-(seasonal).

(12) World Health Organization. (14, 10, 2021). Tuberculosis: https://www.who.int/news-room/fact-sheets/detail/tuberculosis .

(13) World Health Organization. (12, 11, 2021). Worldwide measles deaths climb 50% from 2016 to 2019 claiming over 207 500 lives in 2019: https://www.who.int/news/item/12-11-2020-worldwide-measles-deaths-climb-50-from-2016-to-2019-claiming-over-207-500-lives-in-2019

(14) UNICEF. (12, 11, 2021). Childhood diseases: https://www.unicef.org/health/childhood-diseases

(15) UNICEF. (03, 03, 2021). COVID-19: Schools for more than 168 million children globally have been completely closed for almost a full year: https://www.unicef.org/rosa/press-releases/covid-19-schools-more-168-million-children-globally-have-been-completely-closed.

(16) The World Bank, UNESCO and UNICEF (2021). The State of the Global Education Crisis: A Path to Recovery. Washington D.C., Paris, New York: The World Bank, UNESCO, and UNICEF.

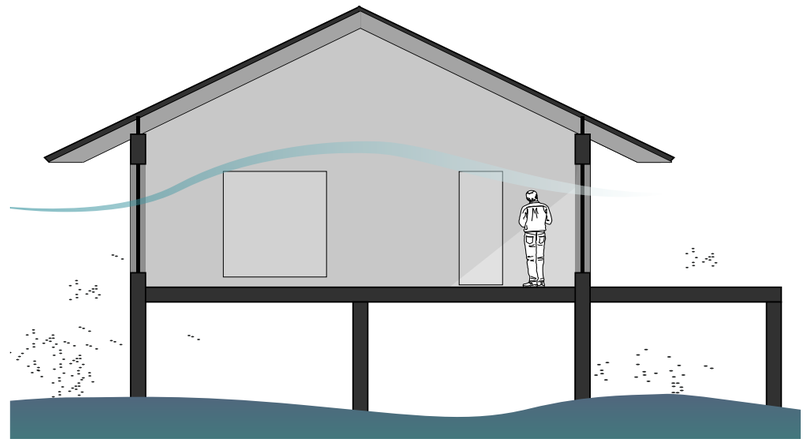
3. THE RESEARCH

In the next chapter, some of the best strategies to prevent the spread of infectious diseases from construction and architecture will be described. Most of these spects can be taken in consideration when designign safe learning facilities, in high risk zones.

3.1 VECTOR - BORNE

DELIVER **(1)**
Deliver is a document written by experts in vector-borne diseases and constructors. It provides recommendations for constructing mosquito proof buildings, specially houses in sub-Saharan Africa. However, it is possible to apply some of these recomendation to school buildings or classrooms, the main key points described in the document are:

-Lifting the building from the ground
-Doors should be screened and without gaps
-Closing or screening eaves
-Ventilation with large screened windows
-Roof should be solid



References:
(1) Lindsay SW, Davies M, Alabaster G, Altamirano H, Jatta E, Jawara M, Carrasco-Tenezaca M, von Seidlein L, Shenton FC, Tusting LS, Wilson AL, Knudsen J. Recommendations for building out mosquito-transmitted diseases in sub-Saharan Africa: the DELIVER mnemonic. Philos Trans R Soc Lond B Biol Sci. 2021 Feb 15;376(1818):20190814. doi: 10.1098/rstb.2019.0814. Epub 2020 Dec 28. PMID: 33357059; PMCID: PMC7776930.

3.1.1 DOORS

As reported in the document, most of the houses in rural Africa do not fit tighly. consequenlty, the little gaps on top and the bottom of not well fitting doors can be an entrance for mosquitos infected with Malaria, exposing families to this hazard. **(1)**

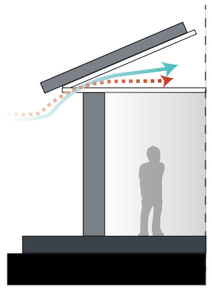
The “DELIVER” document recommend taking special care on this aspect, by improving or changing the doors. This would reduce singnificantly the mosquito insidence inside the house and prevent the spread of the disease.

3.1.2 CLOSING OR SCREENING EAVES

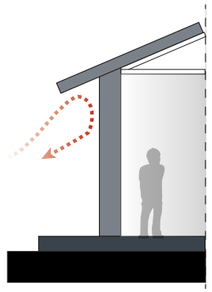
The number of mosquitos inside the houses is also associated with the presence of open eaves in the building. The Eaves (the gap between the wall and the over-haging roof) allow ventilation in houses but also let the entrance of An. Gambiae, increasing the risk of malaria.

Some studies from The Gambia and Uganda reported that houses with closed eaves had 65% fewer malaria mosquitoes. other study made in Tanzania, showed the benefit of screening eaves. this is a simple solution which can lead to prevent vector-borne diseases spread. **(1)**

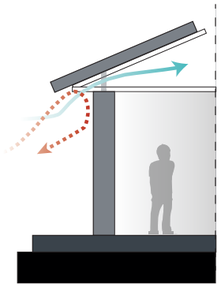
Mosquito entrance trought the eaves



Open eaves



closed eaves



screened eaves

References:
(2) Snow WF. 1987. Studies of house-entering habits of mosquitoes in The Gambia, West Africa: experiments with prefabricated huts with varied wall apertures. Med. Vet. Entomol. 1, 9-21. (10.1111/j.1365-2915.1987.tb00318.x)
(3)Lorenz von Seidlein, K. I. (08 de 2017). Affordable house designs to improve health in rural Africa: a field study from northeastern Tanzania:

3.1.3 LIFTING THE BUILDING

There is evidence that raising a house off the ground will reduce mosquito house entry.

A study made by SNOW in The Gambia demostrated that most mosquito species fly close to the ground, with 80% of the flying population found below 1 m in height. **(2)**

There is also evidence from a pilot study in Tanzania that fewer malaria mosquitoes enter bedrooms on the second storey, compared with those on the first storey. There is a reduction of 96% of mosquito entrance in those with the bedroom on top. **(3)**

3.1.4 VENTILATION AND SCREENING

Ventilation and screeninig are very important factors to take inaccount. Studies in Vietnam and Mexico have shown that the use of insecticide-treated screening in windows can reduce the mosquito entry by up to 60%. **(2)**

However, the use it will affect the airflow across the room increasing the temperature inside the house and making people not want to use mosquito bed-net. For this reason it is important to increase the natural ventilation.

In order to increase the airflow, large doors and windows should be used, with screening to restrict mosquito house entry.

3.1.5 ENVIRONMENTAL MANAGEMENT

Environmental management is of great importance to control the proliferation of disease-transmitting mosquitoes. Since mosquitoes usually reproduce in aquatic habitats, it is of necessary to prevent water accumulation in human waste during rainy periods.

On the other hand, according to the report, the water crisis forces many people to collect water in containers. It is advisable in such situations, water-storage containers should be covered and scrubbed weekly to remove any mosquito eggs. **(2)**

For this reason, environmental management and effective surveillance for the control of malaria and Aedes-transmitted diseases should be the foundation for disease control.

3.1.6 ROOF

Durable and clean alternatives to thatch roofs is recommended in sub-Saharan Africa to reduce disease transmission, as long as the house can remain well ventilated to keep the interior cool. Also, vector abudance inside the house is related to wall and roof material, a study made in Baringo County, Kenya , describes this situation. **(4)**

it was demonstreated that corrugated Iron sheet roof-Mud walled houses had a higher average number of malaria vectors per house per sample followed by Grass thatched roof-Mud walled houses. this is important evidence to take in consideration the roof and walls materials.

References:
(4) Ondiba IM, Oyieke FA, Ong’amo GO, Olumula MM, Nyamongo IK, Estambale BBA (2018) Malaria vector abundance is associated with house structures in Baringo County, Kenya. PLoS ONE 13(6): e0198970. https://doi.org/10.1371/journal.pone.0198970

Cumulative malaria vector abundance in different house structures in Baringo County during the 12-month sampling period.

N. houses	ROOF - WALL	An. funestus	An. gambiae	An. pharoensis	Total	Average/house/ sample
23	Grass thatched roof Mud wall	29	1788	4	1821	6.6
29	Corrugated Iron sheet roof- corrugated Iron sheet wall	0	662	1	663	1.9
16	Corrugated Iron sheet roof- Mud wall	33	1500	14	1547	8.1
3	Grass thatched roof Wooden wall	0	104	16	120	3.3
2	Corrugated Iron sheet roof- Stone wall	0	14	0	14	0.6

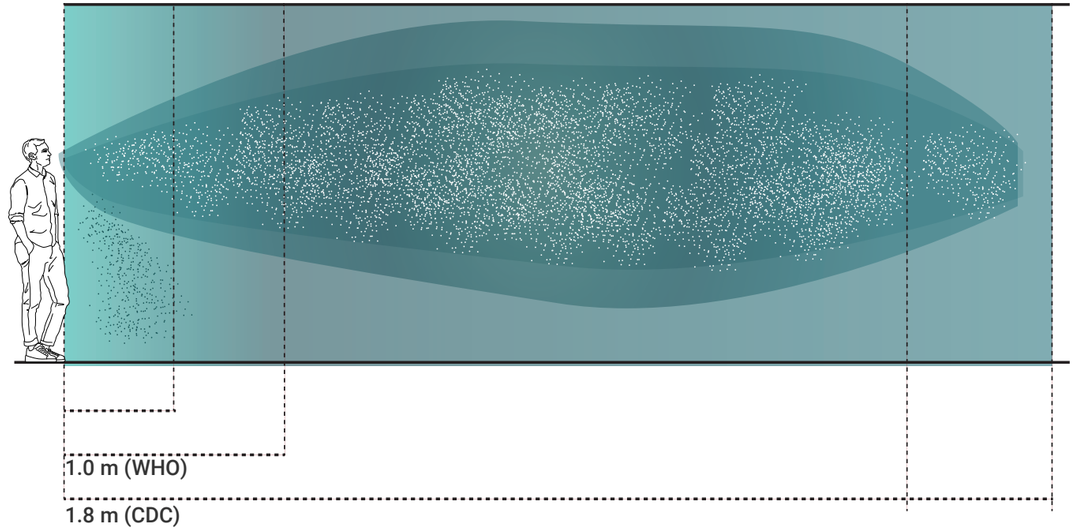
Different types of housing in Baringo County

References:
(4) Ondiba IM, Oyieke FA, Ong'amo GO, Olumula MM, Nyamongo IK, Estambale BBA (2018) Malaria vector abundance is associated with house structures in Baringo County, Kenya. PLoS ONE 13(6): e0198970. https://doi.org/10.1371/journal.pone.0198970

3.2 AIR - BORNE

The COVID-19 pandemic started has exhibit some preventive actions to control Air-borne dieases.

As shools demosntrate a high risk of spreading diseases such as COVID-19 ventilation, social distancing and proper hygiene practices are crucial to stop the spread and reduce cases.



WHO classification of infectious respiratory droplets

Droplets > 5 µm

Aerosol < 5

LTL ARCHITECTS has developed the Manual of social distancing. A document which illustrate differente strategies and analises the relation between Covid-19 and physical environment based on cientific research. **(5)**

References:
(5) Paul Lewis, David J. Lewis and Marc Tsurumaki, in collaboration with Guy Nordenson, and supported in part by Princeton University Funding for Rapid, Novel and Actionable Covid-19 Research Projects. (23, 06, 2020). COVID-19: MANUAL OF SOCIAL DISTANCING: https://issuu.com/djlewis72/docs/200622_manualphysicaldistancing_draft

3.2.1 FLEXIBILITY

Social distancing is necessary to prevent the spreading of Air-borne diseases, According to the CDC and the WHO, it is necessary to maintiain distances from 1m to 1.8 meters between people to control the spread of COVID- 19.

However, studies have shown that the distance droplets can travel up to 8 meters when someone coughs or sneezes without mask protection. **(7)**

This is why it is necessary to design spaces that are open and flexible, allowing social distance and adaptability for different activities.

This can be done, from the conception of the design with open spaces and large structures.

On the other hand, the covid-19 pandemic has shown the need for adaptability of public buildings such as sports centers, parking lots or even schools. Although not ideal, in a time of hospital crisis these could be used as care, vaccination or hospitalization centers.

3.2.2 VENTILATION

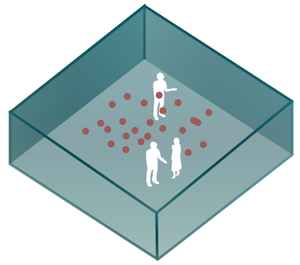
Ventilation is another factor of high importance that have to be considered in Air-borne diseases control.

A study made by WHO analyzed droplet emission caused by coughing and speaking, taking in account the distribution of droplet size, distance traveled, speed and trajectory, and airborne time in relation to the air ventilation. It took place in three different rooms to compare the droplets reduction in time with different ventilation conditions:
1. No ventilation
2. Poor ventilation (only mechanical)
3. Good ventilation (mechanical and natural) **(7)**

It was found that in the well-ventilated room after 30 seconds, the number of droplets was reduced by half, in unventilated room took about 5 minutes. And in the poorly ventilated room, the number of drops was halved in 1.4 min.

This is a sample of how you can reduce the spread of diseases through ventilation in buildings.

1 .



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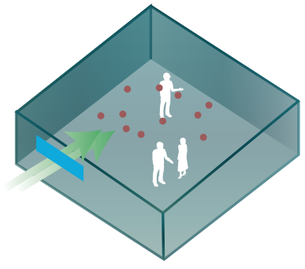

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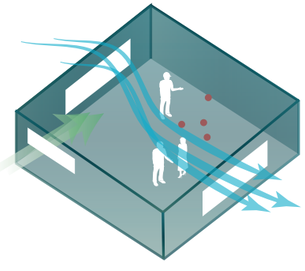


References:
(6) Bourouiba L. Turbulent Gas Clouds and Respiratory Pathogen Emissions: Potential Implications for Reducing Transmission of COVID-19. JAMA. 2020;323(18):1837–1838. doi:10.1001/jama.2020.4756
(7)Somsen GA, van Rijn C, Kooij S, Bem RA, Bonn D. Small droplet aerosols in poorly ventilated spaces and SARS-CoV-2 transmission. Lancet Respir Med 2020; published online May 27. https://doi.org/10.1016/S2213-2600(20)30245-9.

3.2.3 HAND WASHING FACILITIES

Proper hygiene practices are important for preventing both, waterborne, and airborne diseases outbreaks by breaking the contamination chain.
The design of hygiene stations such as hand washing facilities must meet standard specifications for them to function properly. Recommended by the WHO/UNICEF, Three sets of criteria should be taken into consideration: **(8)**

- *First, the station should enable recommended handwashing.*
- *Second, the design should be adapted to the local context, allowing local manufacturing, management and repair and adequate use of water and soap.*
- *Third, the design should provide a pleasant, convenient user experience for all users.*

Also, there are some specifications proposed by UNICEF, hand washing facilities design:

- *The handwashing station must be relevant, accessible for persons with disabilities and acceptable for the intended user of the facility, considering height, colour, attractiveness, and the ease of the product use*
- *The design should allow easy regular cleaning/ disinfecting of taps, basins, soap dispensers and frequently touched surfaces.*
- *The facility should easily accommodate soap*
- *Temporary solutions can usually be constructed with low-cost materials such as a bucket or a bottle with tap and are quick and usually simple to build.*
- *In permanent solutions, the durability of the materials, including their heat resistance and protection against rust (iron) and rotting (wood), needs to be considered*

References:
(8) Handwashing Stations and Supplies for the COVID-19 response, UNICEF, World Health Organization; 2020. https://www.unicef.org/media/75706/file/Handwashing%20Facility%20Worksheet.pdf

3.3 WATER - BORNE DISEASES

The challenges to controll water-borne diseases in poor countries might be reduced by developing infrastructure for WASH accesibility.

As mentioned before, the most effective ways to prevent death and illness in children are related to hygiene, sanitation and drinking water systems.

3.3.1 THE DISASTER-RESILIENT TOILET

As reported by WHO in 2019, 4.2 billion people do not have safely managed sanitation services. **(10)**

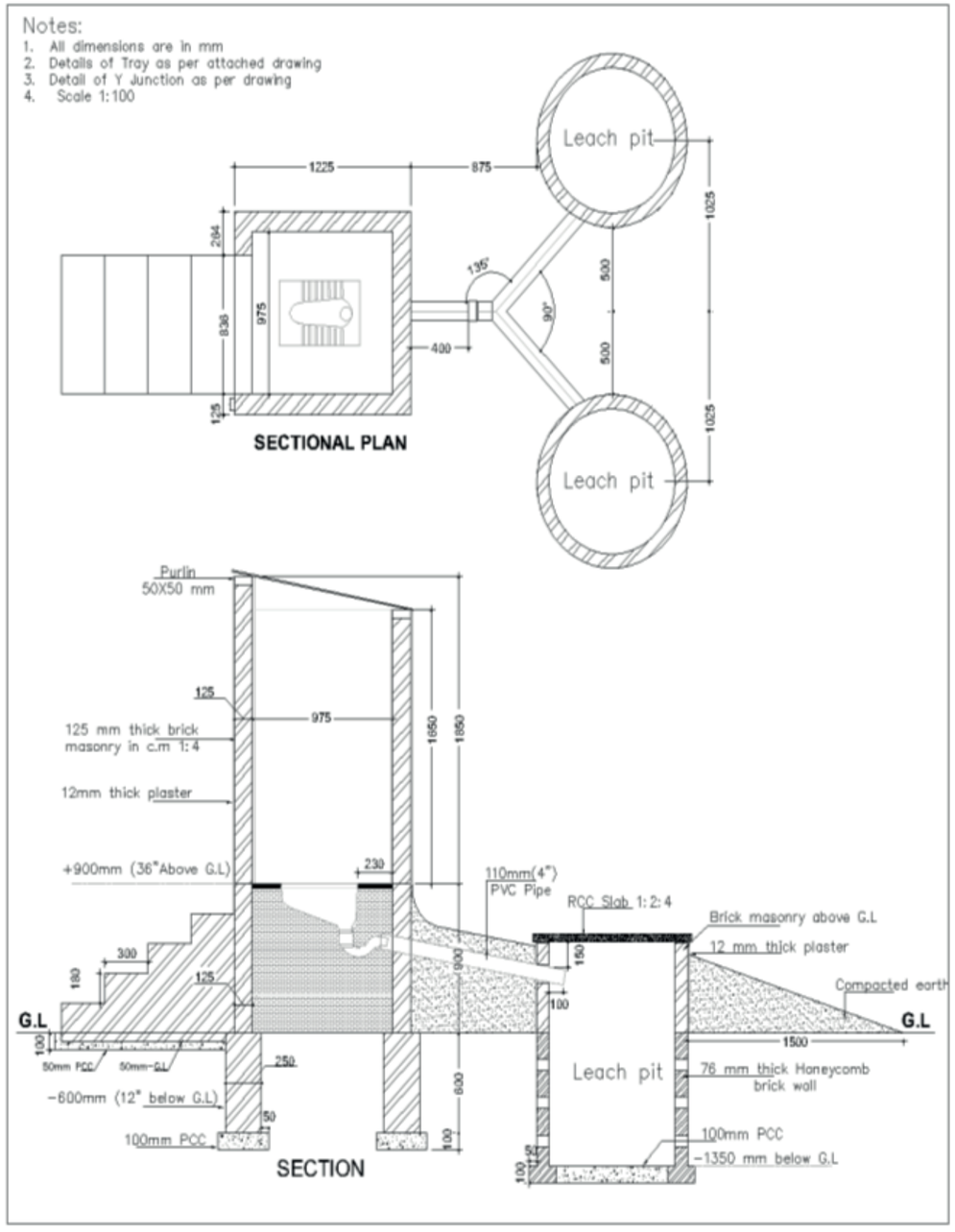
Pit latrine is the most common primary means of sanitation, which generally lack a physical barrier, such as concrete, between stored excreta and soil and/or groundwater. this can expose and increase the risk of contamination.

Against this, UNICEF has developed many projects of Disaster Resilient Toilets (DRT), which have specific caracteristics to improve sanitation practices and communties.**(10)** One example of this is the project of DRT in Assam and Gujarat, India.
By improving some main characteristic of the toilets, the risk and exposure to disasters can be reduced:

- *Increase the depth of the foundations to at least 2 feet below the ground to increase the stability of the structure*
- *Increase the current height of the plinth to at least 2 feet to maintain functionality during low floods*
- *Design the toilets with pillars/columns at the four corners as this will prevent the toppling of the latrine*
- *Include a door-frame in the design*
- *Rising the pit, To have increased capacity and ensure the pits function during flooding*
- *Plastering the pit, To ensure that leachate does not leak into the soil surface or other buildings*

References:
(9) World Health Organization. (19, 06, 2019). 1 in 3 people globally do not have access to safe drinking water: https://www.who.int/news/item/18-06-2019-1-in-3-people-globally-do-not-have-access-to-safe-drinking-water-unicef-who
(10) Development of a Disaster-Resilient Toilet: lessons from the States of Assam and Gujarat, India , UNICEF; 2020. https://www.unicef.org/rosa/media/11801/file

Disaster Resilient toilet **(10)**



REFERENCES

References:
(1) Lindsay SW, Davies M, Alabaster G, Altamirano H, Jatta E, Jawara M, Carrasco-Tenezaca M, von Seidlein L, Shenton FC, Tusting LS, Wilson AL, Knudsen J. Recommendations for building out mosquito-transmitted diseases in sub-Saharan Africa: the DELIVER mnemonic. Philos Trans R Soc Lond B Biol Sci. 2021 Feb 15;376(1818):20190814. doi: 10.1098/rstb.2019.0814. Epub 2020 Dec 28. PMID: 33357059; PMCID: PMC7776930.

(2) Snow WF. 1987. Studies of house-entering habits of mosquitoes in The Gambia, West Africa: experiments with prefabricated huts with varied wall apertures. Med. Vet. Entomol. 1, 9-21. (10.1111/j.1365-2915.1987.tb00318.x)

(3)Lorenz von Seidlein, K. I. (08 de 2017). Affordable house designs to improve health in rural Africa: a field study from northeastern Tanzania:

(4) Ondiba IM, Oyieke FA, Ong'amo GO, Olumula MM, Nyamongo IK, Estambale BBA (2018) Malaria vector abundance is associated with house structures in Baringo County, Kenya. PLoS ONE 13(6): e0198970. https://doi.org/10.1371/journal.pone.0198970

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(6) Bourouiba L. Turbulent Gas Clouds and Respiratory Pathogen Emissions: Potential Implications for Reducing Transmission of COVID-19. JAMA. 2020;323(18):1837–1838. doi:10.1001/jama.2020.4756.

(7)Somsen GA, van Rijn C, Kooij S, Bem RA, Bonn D. Small droplet aerosols in poorly ventilated spaces and SARS-CoV-2 transmission. Lancet Respir Med 2020; published online May 27. https://doi.org/10.1016/S2213-2600(20)30245-9.

(8) Handwashing Stations and Supplies for the COVID-19 response, UNICEF, World Health Organization; 2020. https://www.unicef.org/media/75706/file/Handwashing%20Facility%20Worksheet.pdf

(9) World Health Organization. (19, 06, 2019). 1 in 3 people globally do not have access to safe drinking water: https://www.who.int/news/item/18-06-2019-1-in-3-people-globally-do-not-have-access-to-safe-drinking-water-unicef-who.

(10) Development of a Disaster-Resilient Toilet: lessons from the States of Assam and Gujarat, India , UNICEF; 2020. https://www.unicef.org/rosa/media/11801/file

4. THE METHODOLOGY

4.1 THE PROJECT APPROACH

The following chapter is an effort from a team investigation consisting: Andrea Matevska, Jana Tosheva, Erika Cerra and Juan Pablo Benavides.

The following chapter selects the possible existing, reformulated, and new tools and methodologies to be adopted in a structured way to collect, analyze and systematize information on the dangers and vulnerabilities to such dangers of a given community. This information is used to diagnose and classify natural or man-made multi-hazards present within the community, from which to develop a new analysis tool, called “The Tool Matrix”, which allows us to develop action matrices. for the individual Hazards studied and for the problems inherent to the educational system. The developed matrices are subsequently compared and expanded through the identification of the needs and capabilities of the community involved in the process, in order to derive the best action solution to be adopted within the project. The chapter emphasizes the importance of the community in the choice of actions, and identifies which tools may not be participatory in the event that there is no possibility of involving the community (see the case study). The purpose of the new tools and methodologies is therefore to facilitate the reading and identification of action solutions in relation to the problems, needs and abilities of the place of study, with the aim of creating a resilient and resistant to climatic and social problems.

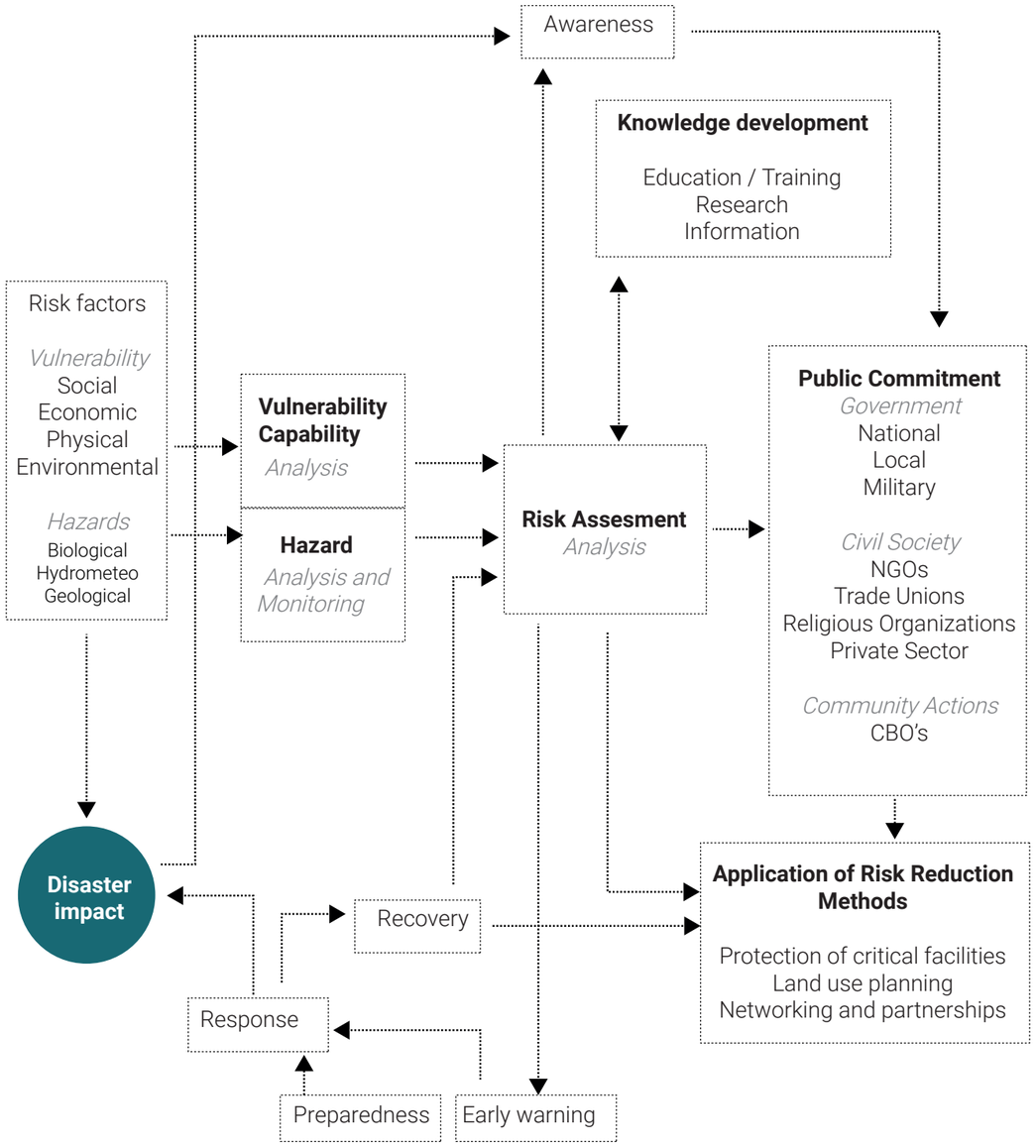
4.2 THE VCA TOOL

The VCA is a tool developed by the IFRC which uses a series of participatory techniques to collect and analyze information about a specific community.

It allows governments and organizations to evaluate problems and vulnerabilities are in communities, identifying which risk should be prioritized. (IFRC, 2006). (1)

After the evaluation, organizations and communites can work together to find sustainable solutions that the local people can develop using their own capacities.

References:
(1)International Federation of Red Cross and Red Crescent Societies (2006), What is VCA? An introduction to vulnerability and capacity assessment, 2006. Available from: https://www.dsm-consulting.ch/images/imagesite/CBDRM/CBDRM_31.pdf



4.2.1 DIRECT OBSERVATION

One of the most important research tools for the assessment is the direct observation. It helps the VCA team understand the context in which information is being collected. All members of the VCA are continuously recording what they observe in the field area. It provides details and describe the situation that may be causing some problems or situations within the community.**(2)**

4.2.2 FOCUS GROUP

A focus group discussion is a tool which can help to collect many perspectives from a specific topic. It is a dialogue between a selected group of individuals in a community, which must be well informed about the issue debated. Some of the most frequent problems come from the differences that the participants might have. For this reason, it is important that the facilitator has good leadership and abilities to moderate a discussion. **(2)**

4.2.3 MAPPING TOOL

The mapping tool is important to understand better the place of the assessment. They can be made by the community indicating important information such as the location of hazards and risks. Also, they can provide data about important services for the districts including resources that might need to be protected. **(2)**

4.2.4 SEASONAL CALENDAR

It is a tool that allows the evaluation of frequency of events, hazards and disasters that may occur in a community through time. By comparing the most important events in the months of the year the VCA team can define in which periods the risks are more frequent or impactful. This analysis provides the community with information to make decisions considering their hazards such as flooding, epidemics, droughts, conflict hazards and important social situations. **(2)**

References:
(2)International Federation of Red Cross and Red Crescent Societies (2007), VCA toolbox with reference sheets, 2007. https://www.humanitarianlibrary.org/sites/default/files/2014/02/vca-toolbox-en.pdf

Seasonal calendar example

Categories	Months												Impacts
	Dic	Jen	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
Socio-Conditions													
- Low/High Income			X								**X**		
Immigration (migration)				**X**	**X**	**X**	X	X					
Social Conditions													
- Children Out ofschool	X		X				**X**						
- Domestic violence													
Environment													
- Rainfall period								**X**	**X**	**X**	**X**		
- Drought period													
- Temperature(High/Low)						**X**	**X**						
Health													
Cholera outbreak			**X**	**X**	**X**	**X**							
- COVID-19 outbreak		**X**							**X**				
-Malaria outbreak													
Natural Hazard													
- Cyclon													
- Eathquake			**X**										
- Flood							**X**	**X**	**X**	**X**	x		

4.2.5 ANNUAL CALENDAR

Doing the VCA, it is important to have a historical view of the community development. The annual calendar explains the most important past events that the community had to affront, including environmental and social behaviours. By having this general view, taking decisions for new projects can be more effective and wiser. It can show changes in dwellings, natural resources, river levels, livestock, and hazards, and helps people to understand their vulnerability to certain risks. **(3)**.

4.2.6. LIVELIHOODS AND CAPACITY ANALYSIS

Livelihoods analysis creates an inventory of a household's assets and how they are applied as a "bundle" to its income earning. It is a powerful tool to identify the areas of a household's vulnerability and what capacities it has to protect itself from hazards. **(2)**

Coping strategies analysis focuses on what people do when they are already affected by a hazard (e.g. drought). Coping strategies are what come into play when dealing with the hazard. They are what families (and communities) rely on to develop means to maintain their livelihoods during and after a disaster.**(2)**

Hazard Type	Year	Impact
Floods	*1992*	
Cyclon	*1997*	
Others:		
- Disease	*2003*	

References:
(3)Plan International (2010), Child Centred DRR Toolkit, 2010. https://resourcecentre.savethechildren.net/pdf/5146.pdf/

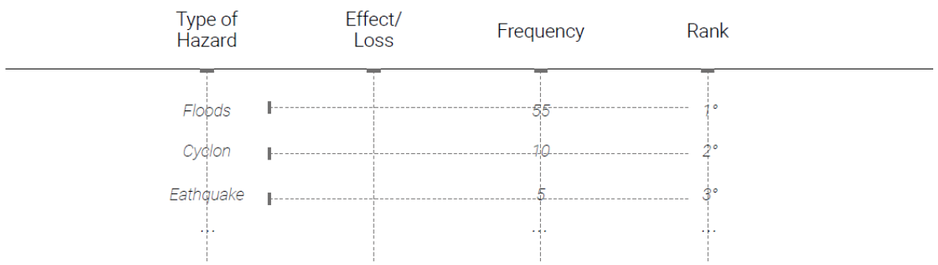
4.2.7 THE RANKING METHOD

This is a method that allows classifying and selecting the hazards and risks found in the participatory process. it can provide a hierarchy and find the most impacting ones.

In our case, the exercise will be limited to the identification and classification of the hazards and Hazards studied,
such as Floods, Eathquakes, Cyclon and Storm, to proceed with the development of the Tool Matrices.

The ranking method compares the disasters identified by the community and makes a comparison between them taking into account the frequency and impact. Thus, determine which are the urgent ones to take into consideration for future projects. (3)

Once the priority Hazards have been established, the community re-examines the previously analyzed data to identify the impacts, in terms of vulnerability, that these have on the environment and society; and to reflect on the existing and desired capabilities needed to address or minimise the problem/risk identified.



References:
(3)Plan International (2010), Child Centred DRR Toolkit, 2010. https://resourcecentre.savethechildren.net/pdf/5146.pdf/

4.3 THE MATRIX

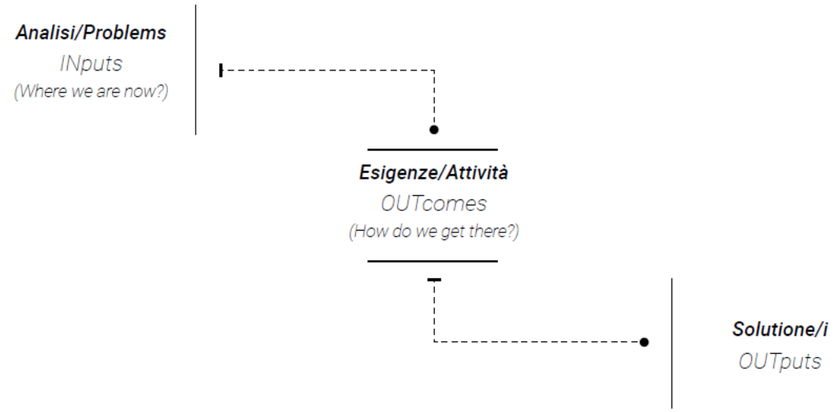
The Tool defines the methodology for the development of matrices intended as a first strategic approach to the project, which will support the identification of possible resilient and resistant solutions to the problems identified in the risk analysis, to be used within the project and moreover, it can be understood as a tool for gathering the skills of the community in relation to a specific problem and need.

The matrices proposed in the following pages are non-exhaustive tools, knowledge of the problem and of the possible solutions that can be used in different global contexts and therefore on a large scale, therefore they require external support, such as general or local manuals and above all through direct cooperation actions with the community. local (therefore with the development of the process described above) for the collection of useful information, such as local cultural needs and solutions (economic, material, technological, volumetric, social solutions) in order to obtain the least impact on society and the environment.

To develop the matrices we use the analysis extrapolated in the process (through the use of tools) from which the problems and vulnerabilities (INputs) for each identified hazards are obtained.

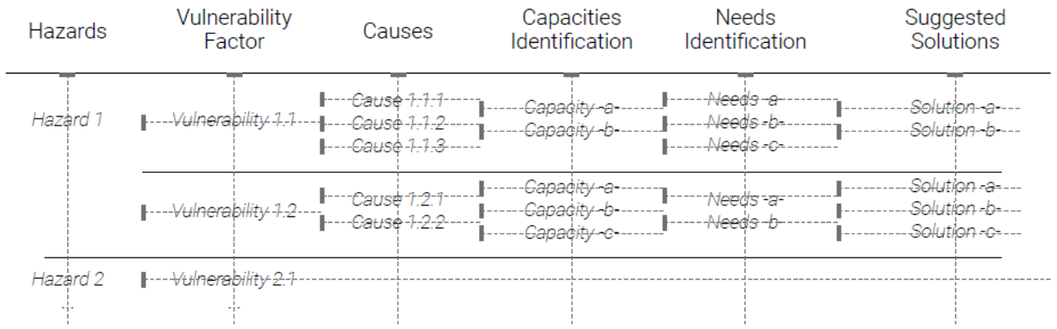
From the same analysis we collect useful information to identify the Needs / Activities (OUTcomes) to be carried out (How do we get there?).

Lastly, we identify the capabilities, as well as the best Solution/s (OUTputs) to be used for each extrapolated problem and need.



We therefore develop a table (Table 9) that contains the vulnerabilities (problems) identified for each Hazard (found through the Ranking Method) and the causes of these vulnerabilities, the needs and capabilities identified for each vulnerability, and finally the likely actions to transform vulnerabilities in capacity (Suggested Solutions).

Capacities come to our support when the community itself identifies them, and moreover, they will be able to understand how to take actions based on the skills they already possess.



4.3.1 THE OUTCOMES:

The Needs / Activities (outcomes)are directly linked to the analyzes carried out and therefore require a knowledge of the place and the community that requires them.
In our specific case, the possibility of having a direct confrontation with the community is reduced, if not zero, with this we search for possible OUTcomes strategies from the information obtained and from the available programs that define design standards. The matrix as a strategic approach seeks to respond to natural disasters associated with climatic conditions.

For this reason, the needs that guide the design process derive from different plans, which are set out below.

4.3.2 HUMANITARIAN NEEDS

On the humanitarian level, we consider three manuals:

Humanitaria Character and Minimum Humanitarian Standards in Humanitarian Response (Sphere, 2018), which provide practical, guidance for planning, managing or implementing an adequate humanitarian response.

The characteristics of the Shelter therefore reflect the importance of fulfilling physiological and safety needs in the first place, as well as laying the foundations for satisfying the needs of belonging, esteem and self-fulfillment.
Therefore, some guidelines relating to the following areas are made explicit: liveability, privacy, safety, adequacy of spaces and materials, natural light and ventilation, thermal comfort, accessibility to health services **(4)**; L'INEE Minimum Standards for Education (The Inter-Agency Network for Education in Emergencies, 2010) provides key actions and guidance notes.

The manual aims to improve the quality of educational preparation, response and recovery, increase access to safe and relevant learning opportunities and ensure accountability in the provision of these services.

Therefore, some guidelines relating to the following areas are explained: Equal Access, Protection and well-being 4; Towards A Learning Culture of Safety and Resilience Technical Guidance for Integrating Disaster Risk Reduction in the School Curriculum (United Nations Educational, Scientific and Cultural Organization, 2014) this technical guide recognizes the importance of adopting a holistic education framework for risk and resilience. In addition to considering natural hazards, this framework examines the man-made risks that the education sector faces, such as violent conflict. While not dealing with this topic in detail, the guide supports the integration of conflict risk reduction and DRR (Disaster Risk Reduction) in education.**(5)**

These guidelines were useful for identifying the Safe Criteria / needs to be adopted in the education sector, considering the socio-cultural context, natural hazards and violent conflicts, such as: Equal Access (in and around the school) considering an inclusive environment (in terms of location, gender, lenguage, race, religion and learning environment), flexible and accessible; Quality of education in terms of protection and well-being and appropriate facilities and services. The needs described above must necessarily be accompanied by the needs deriving from the condition of the pre and post disaster, whatever the surrounding conditions, two concepts remain valid: the need to control the temporal variable and the economic variable.

References:
(4) Sphere Association. The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response, fourth edition, Geneva, Switzerland, 2018.

4.3.3 NEEDS OF THE CLIMATIC CONTEXT

A further area that needs deepening is the climatic context in which the project is located, since the set of meteorological characteristics of a place substantially influences the needs of the individual who lives there and consequently the requirements that dwelling must meet. The needs adopted are limited to maximizing or minimizing ventilation and solar radiation and protection from rain and humidity. These suggest the best action to take in the climatic context in which we are.

4.3.4 NEEDS OF THE RISK SCENARIO

Disaster Risk Reduction tools can include strategies regarding location, materials and construction techniques as well as design precautions. For the development of the actions / needs are listed the possible and already existing buildings resilient to floods high or not. Suggesting the best type according to the site where you are and the alluvial characteristics.

4.3.5 COMPATIBILITY AND MATERIAL DURABILITY NEEDS:

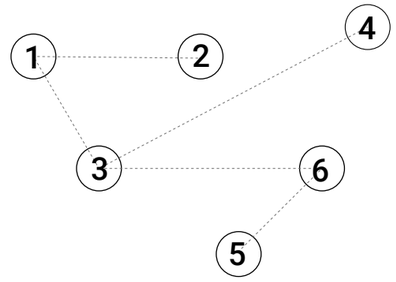
After carrying out an analysis on the availability of materials, economics and local construction techniques, it is important to identify which of the available materials are compatible with each other. The performance of the foundations, walls and roofing are dictated by the compatibility and durability of the materials and components. Various incompatibilities, as well as poor durability of the materials affect the overall duration of the building and minimize the benefit of the initial invested capital.

In the last phase, various usable solutions are defined which should not be understood as unique or irrevocable solutions but on the contrary as strategic, cognitive and expandable tools from guides, manuals or the capacities of the community involved, for the subsequent development of the project.

4.4 DEVELOPMENT OF THE MATRX

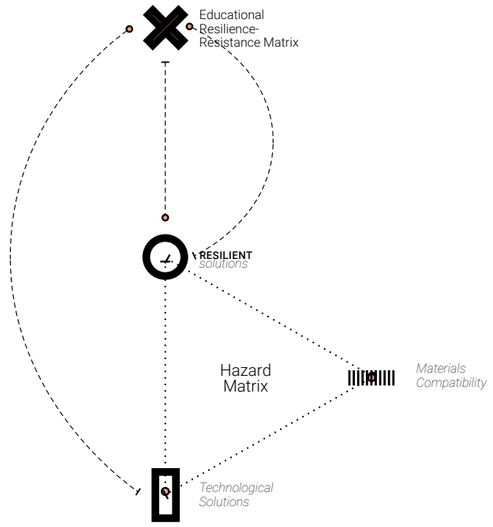
Generally, the matrix can be understoeod as an agglomeration of elements that constitute the point of origin of a shape or space.
To create the matrices and be able to simplify the collection and union of information, we use a structure known in mathematics as Grafo, whose application lies in a wide range of areas.
This mathematical structure is supportive for its excellent schematization ability.

What is a Grafo?: Basically, a graph is a set of elements, called Nodes connected to each other, using lines called Arches.

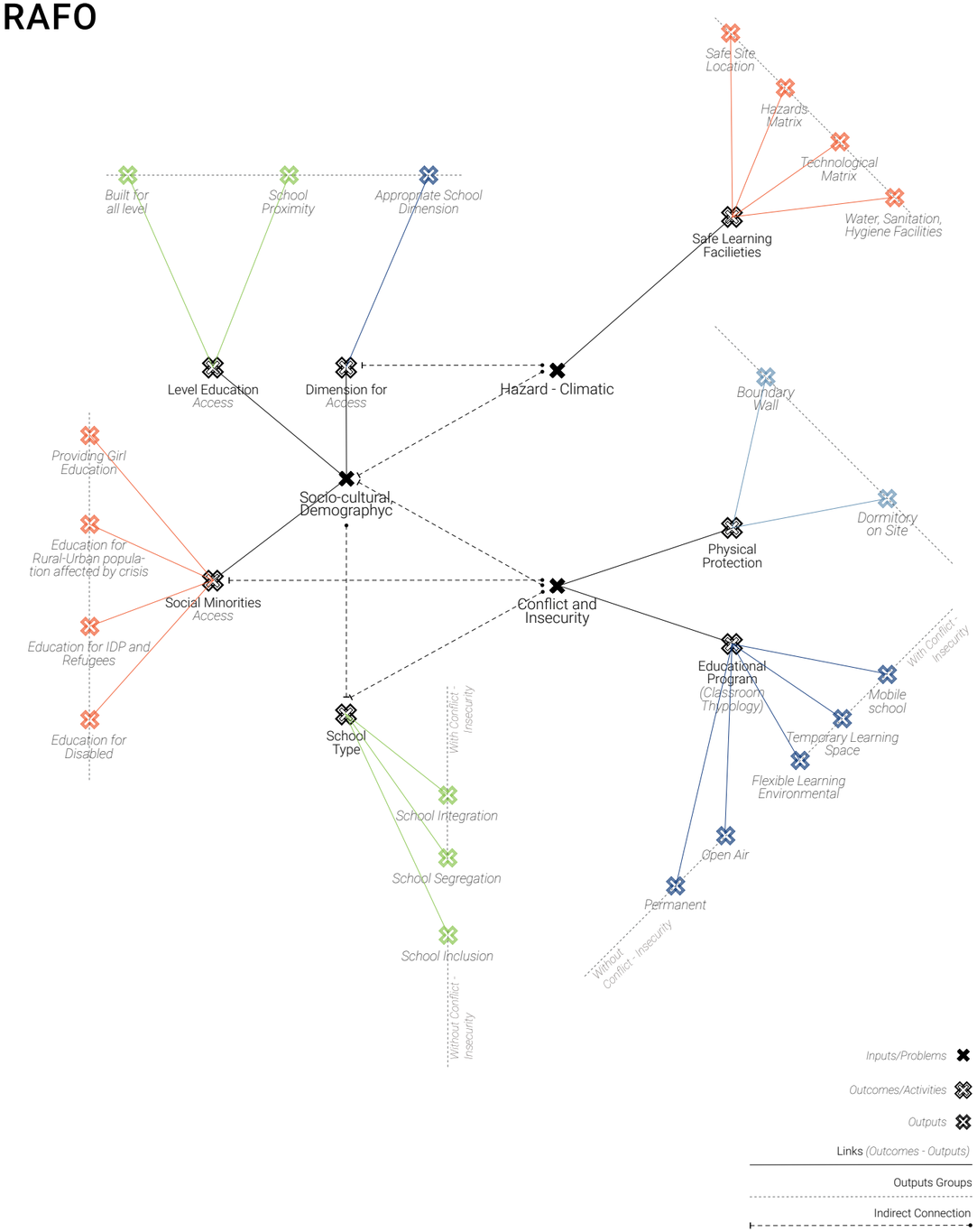


For a simpler reading, the Graphs are then inserted into a particular device, such as the Adjacency Matrix, which identifies the final structure of the Matrix tool. This is defined in mathematics as a square binary matrix having as rows and columns the “names” of the nodes of the graph.

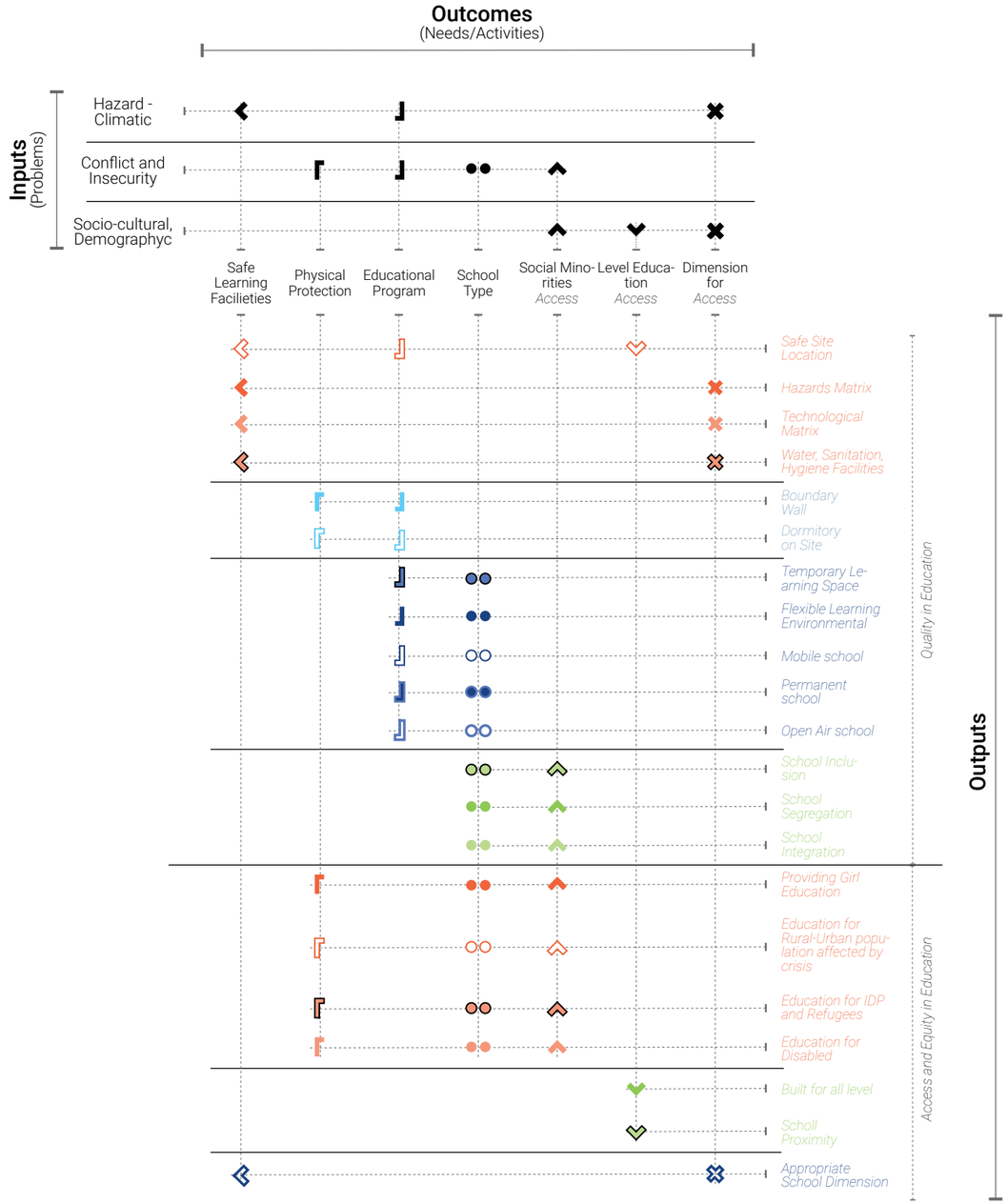
The matrix will be filled in proximity of the connection point between two or more nodes, in case the graph itself has a connection between the same nodes.



4.4.1 EDUCATIONAL RESILIENCE - RESISTANCE GRAFO

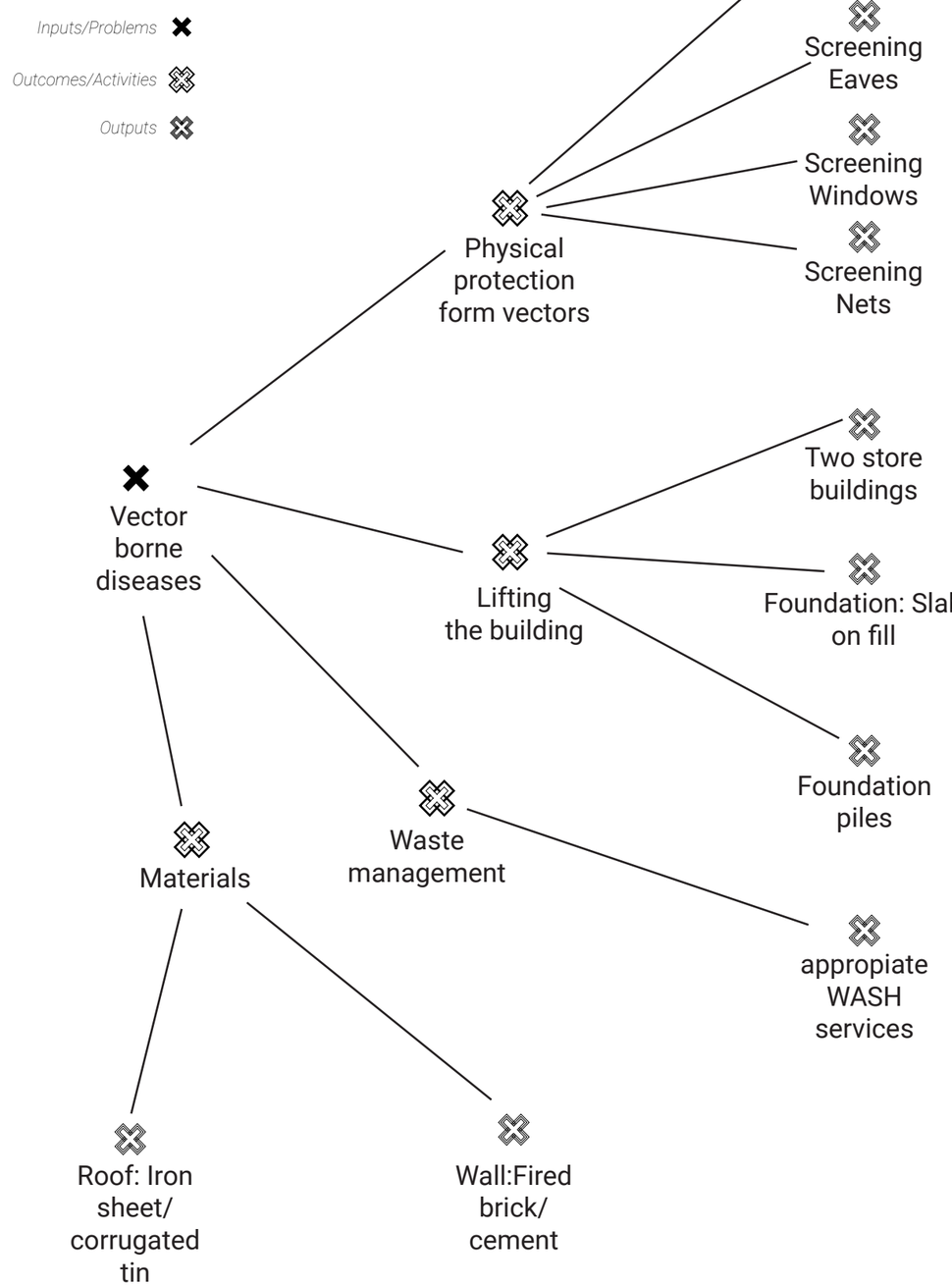


4.4.2 EDUCATIONAL RESILIENCE - RESISTANCE MATRIX

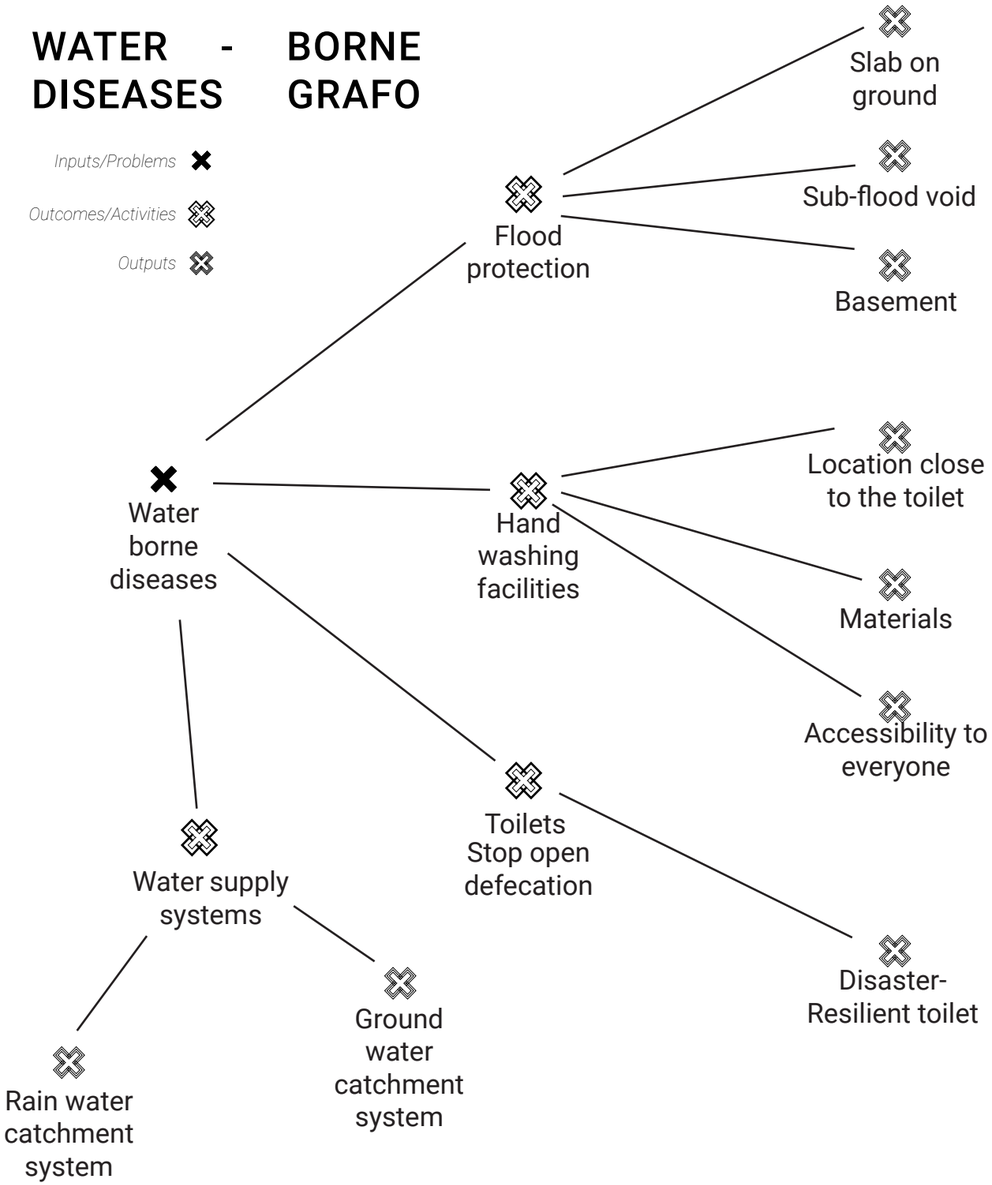


4.4.3 DISEASES GRAFO

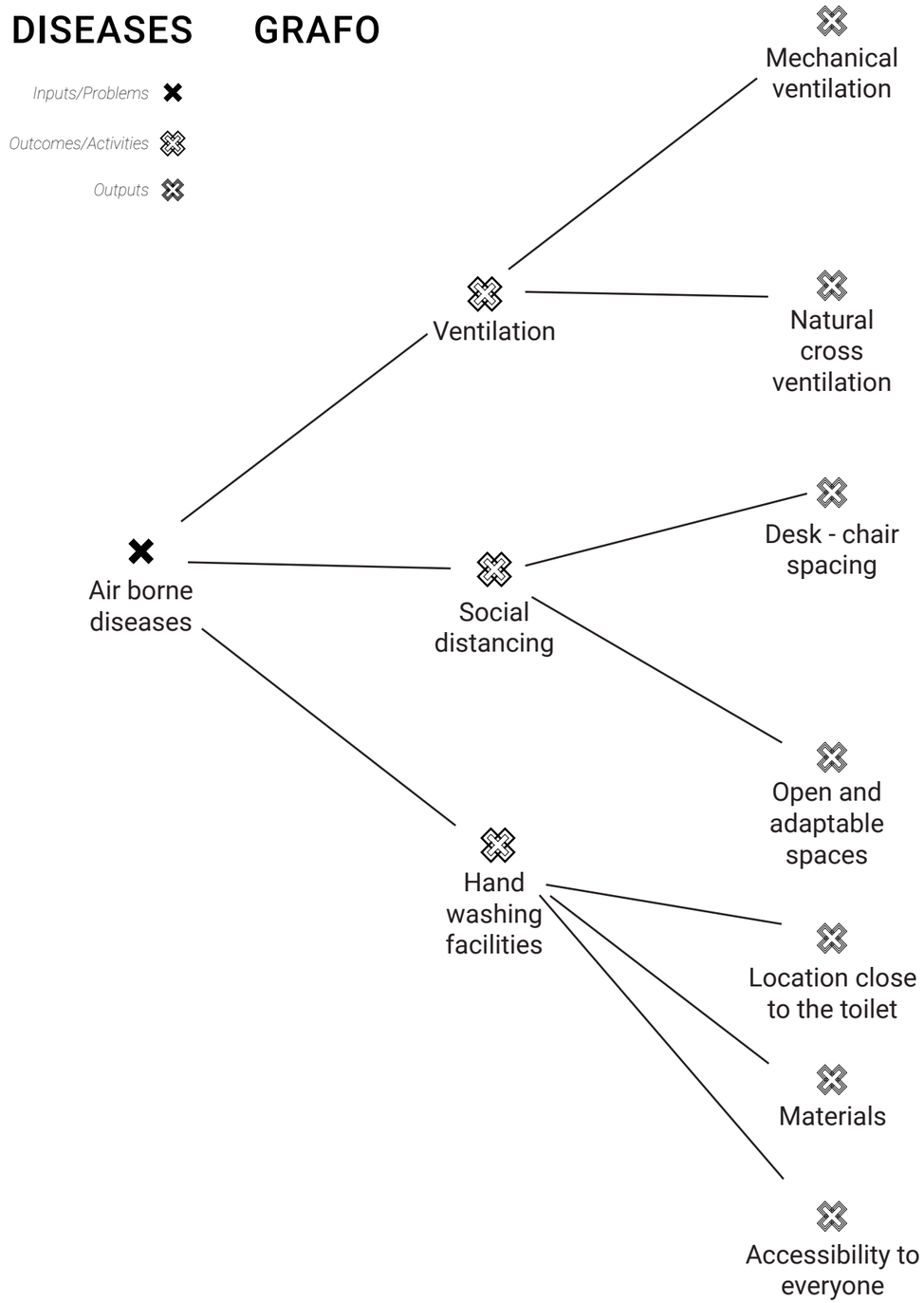
VECTOR - BORNE DISEASES GRAFO



WATER - BORNE DISEASES GRAFO

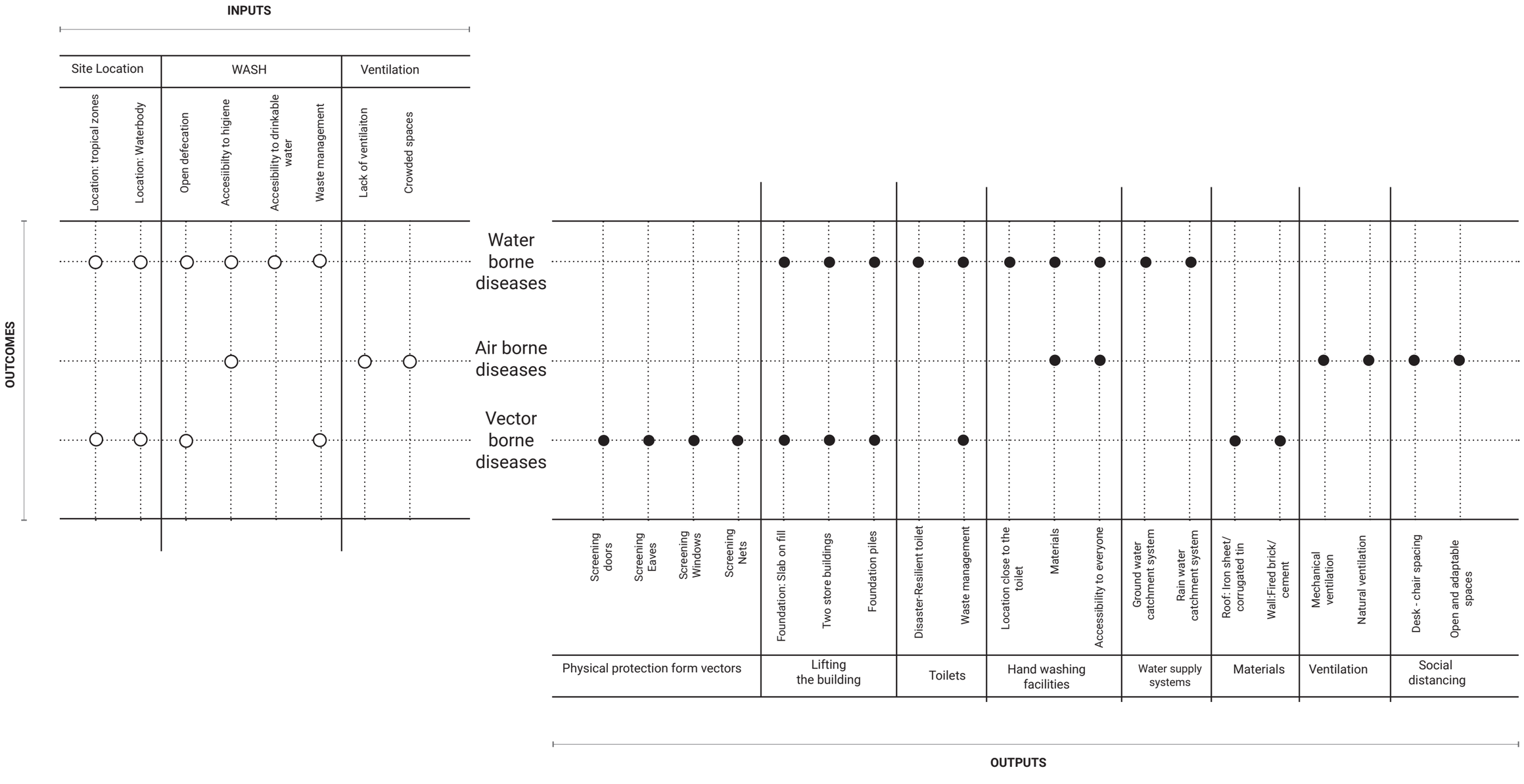


AIR - BORNE DISEASES GRAFO

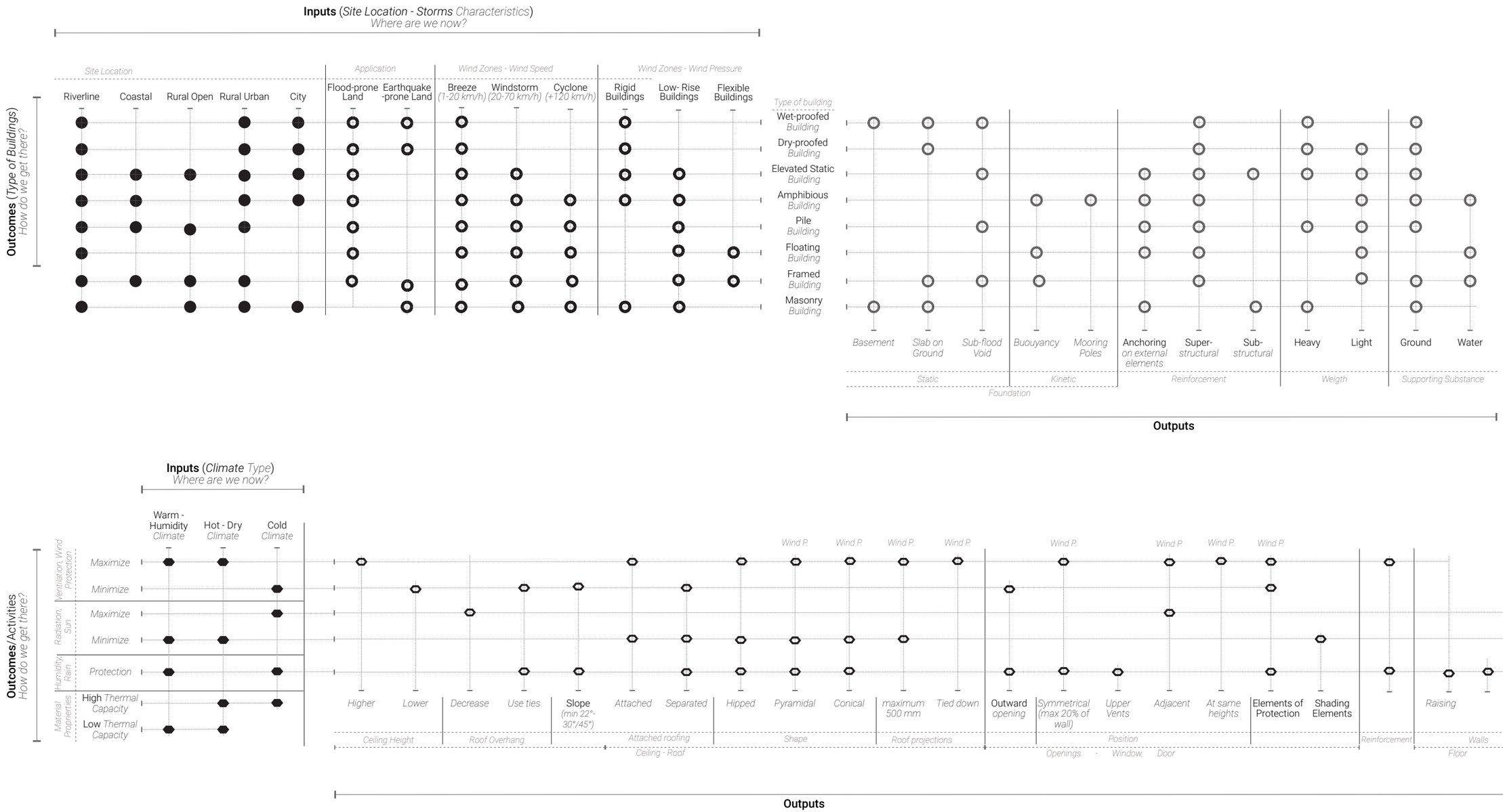


4.4.4 THE MATRIXES

Infectious Diseases Matrix

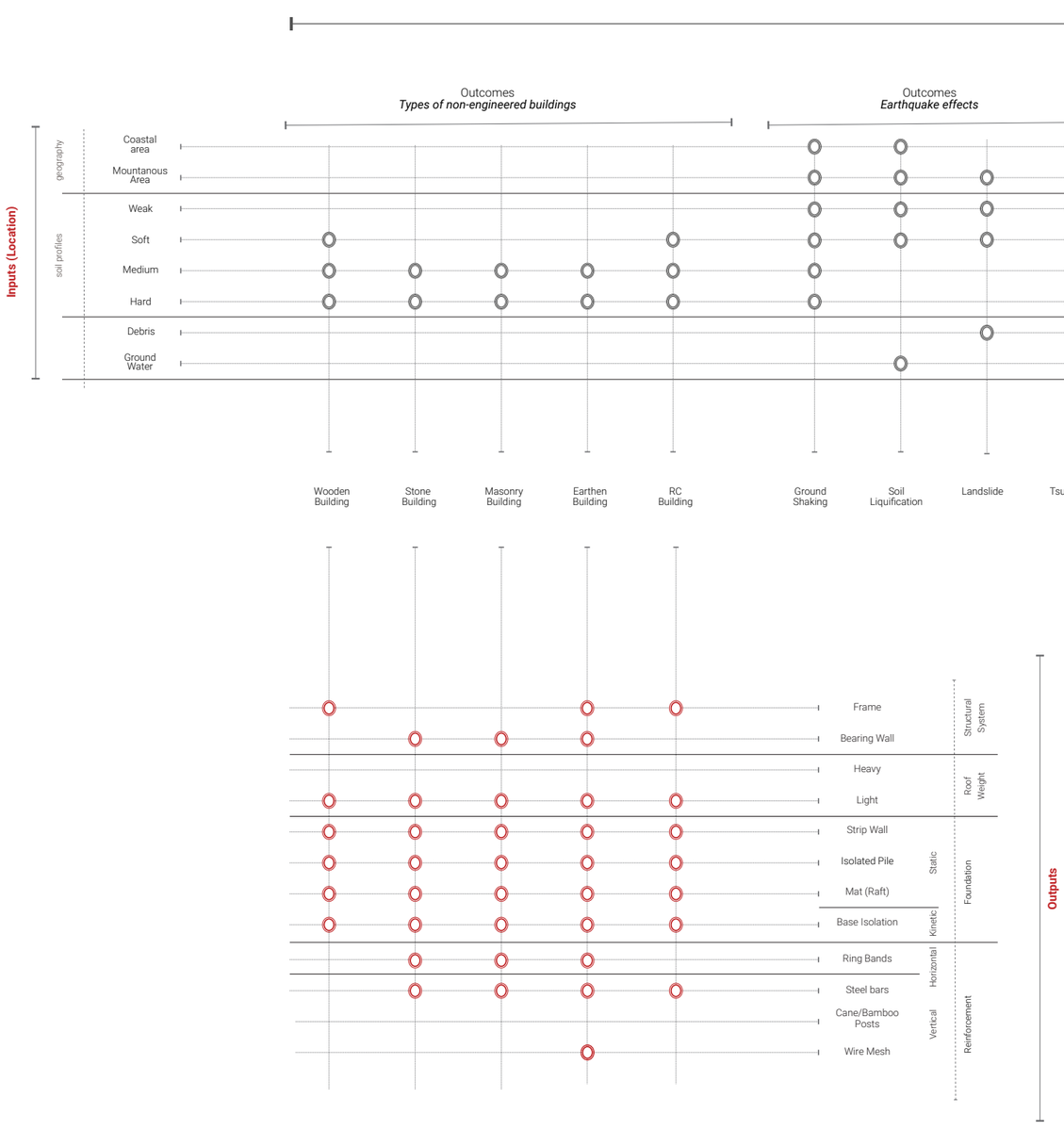


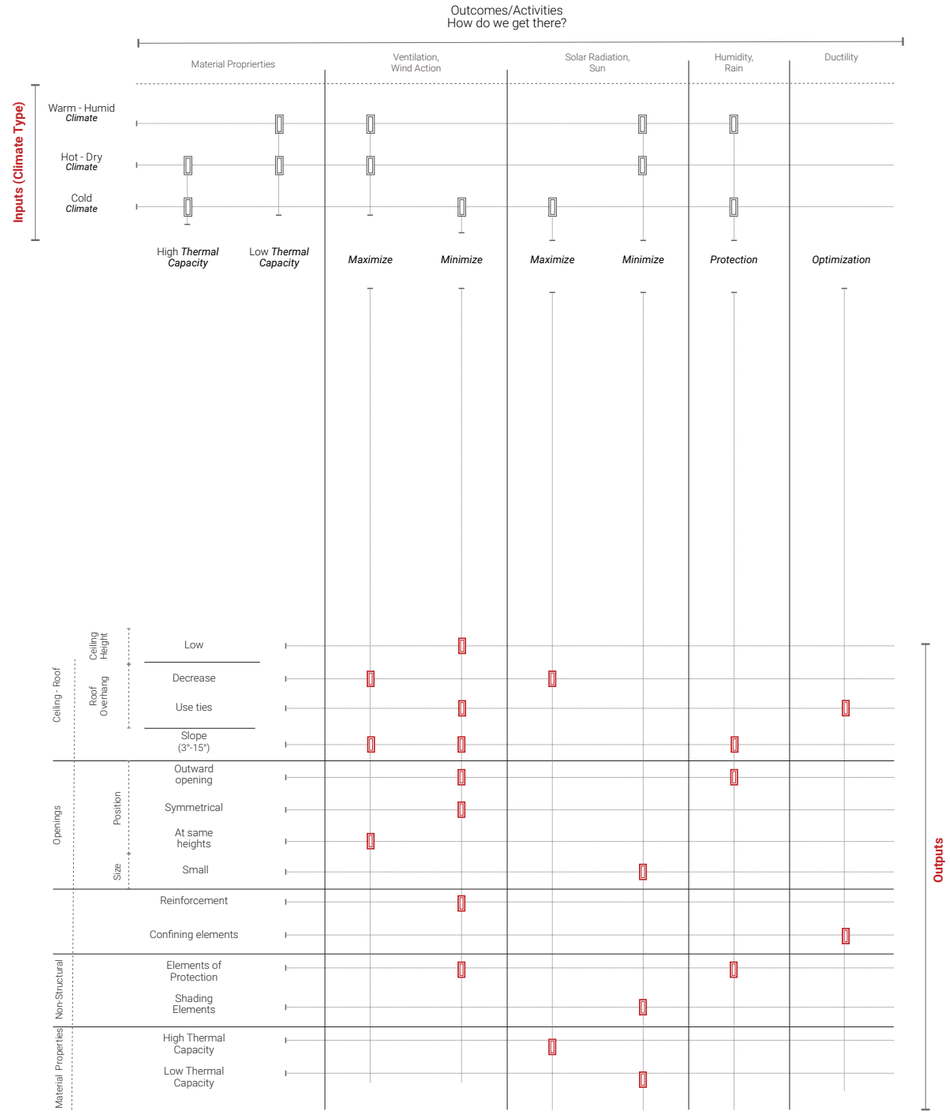
Storm Proof Matrix



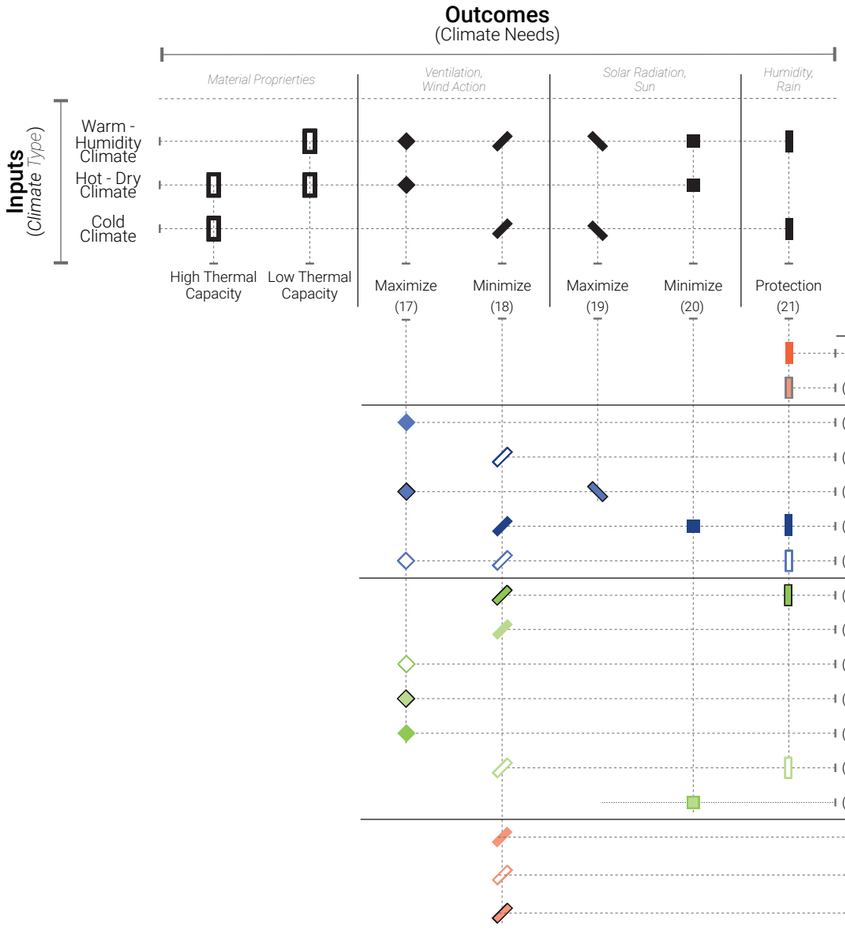
Technological Matrix

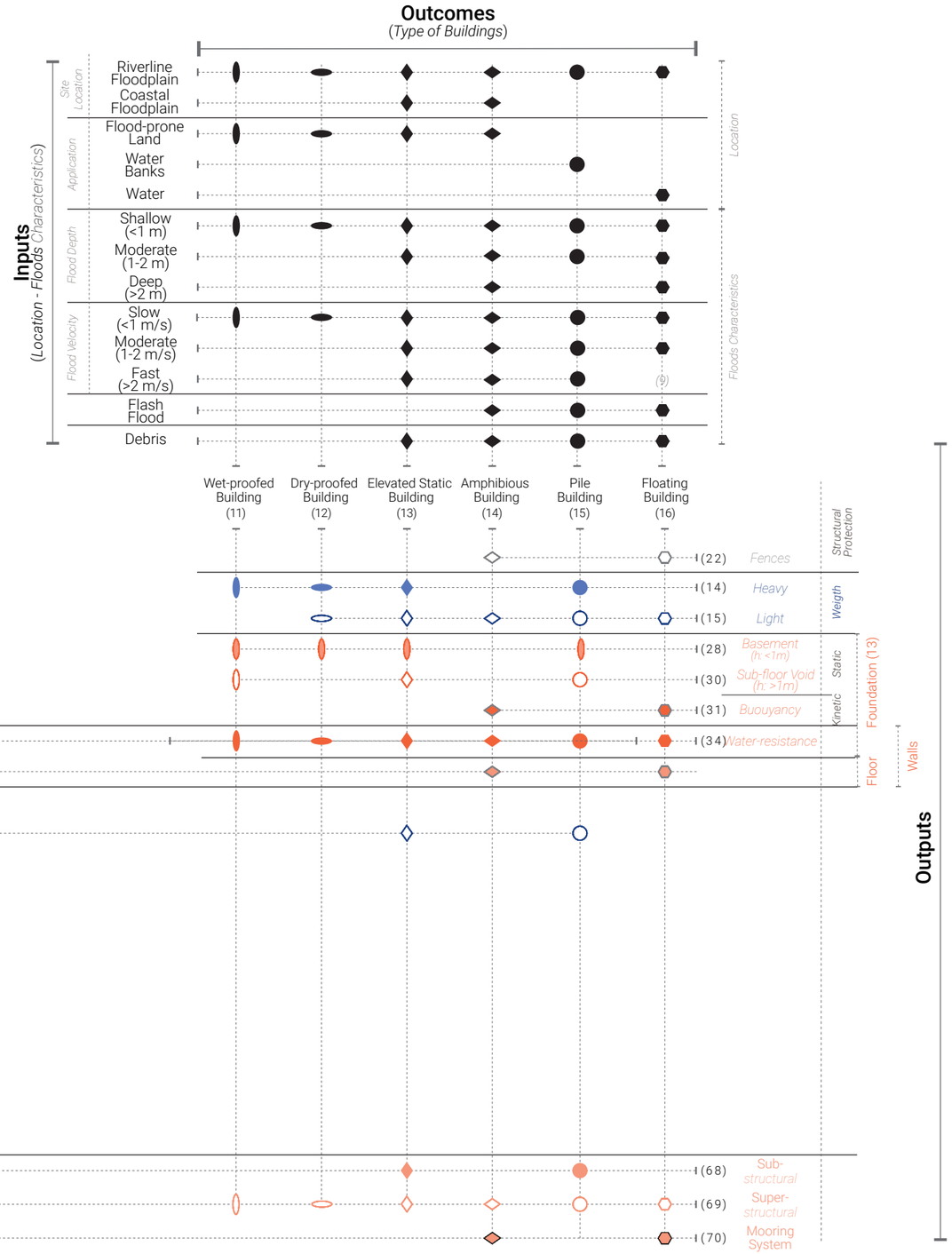
Seismic Proof Matrix





Flood matrix





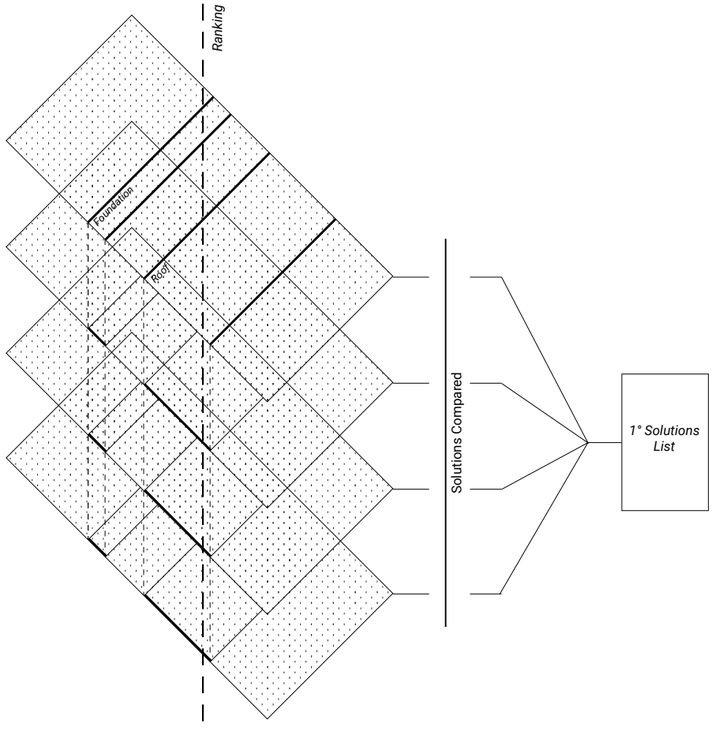
Technological Solutions

Flood Proofing (Resilient Solutions) ([1])

4.5 SOLUTIONS COMPARED

The methodology that will be described below has the purpose of comparing the different solutions of the individual Hazards Matrix previously identified and classified by priority through the Ranking Method, therefore only in the case of Multi-Hazards.

For the graphic development we use only the OUTcomes and OUTputs (of each developed matrix), the latter divided into categories of groups (macro-groups) equally present in each Hazard Matrix.
The final purpose is, therefore, to obtain a first list of solutions compared (1st Solution List), to then be able to move on to the next step which will be to implement the primitive list, considering the capabilities of the community, only in the case in which this will be involved.



Outcomes (simbols)

- [1] Safe Learning Facilieties
- [2] Physical Protection
- [3] Educational Program
- [4] School Type
- [5] Social Minorities Access
- [6] Level Education Access
- [7] Dimension for Access

Outputs (colors)

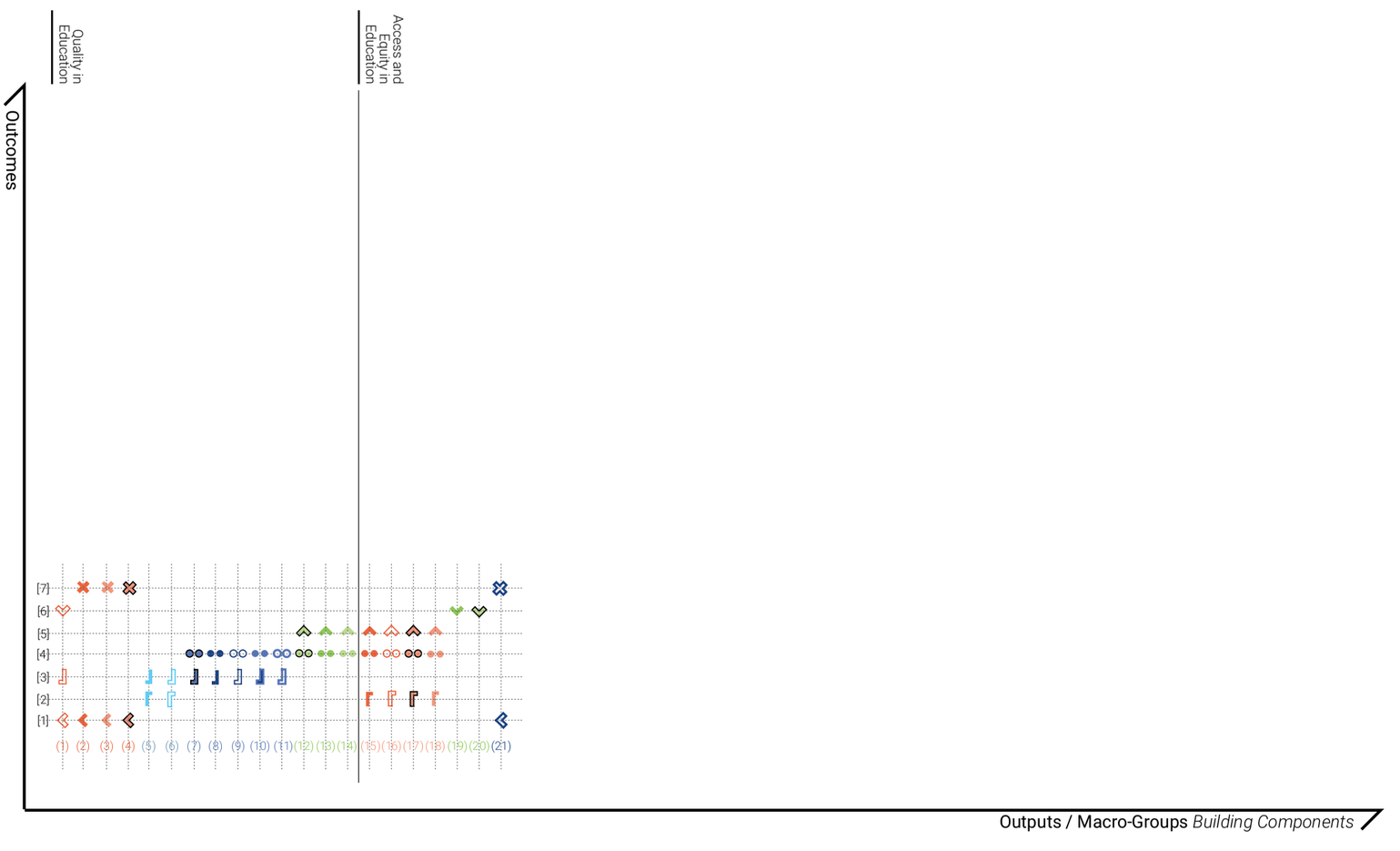
Quality in Education

- (1) *Safe Site Location*
- (2) *Hazards Matrix*
- (3) *Technological Matrix*
- (4) *Water, Sanitation, Hygiene Facilities*
- (5) *Boundary Wall*
- (6) *Dormitory on site*
- (7) *Temporary Learning Space*
- (8) *Flexible Learning Envirnmenal*
- (9) *Mobile School*
- (10) *Permanent School*
- (11) *Open Air School*
- (12) *School Inclusion*
- (13) *School Segregation*
- (14) *School Integration*

Access and Equity in Education

- (15) *Providing Girl Education*
- (16) *Education for Rural-Urban*
- (17) *Education for IDP and Refugees*
- (18) *Education for Disabled*
- (19) *Built for all level*
- (19) *School Proximity*
- (21) *Appropriate School Dimension*

4.5.1 EDUCATIONAL RESILIENCE - RESISTANCE



Outcomes (simbols)

Type of Disease
- [1] Vector Borne Disease
- [2] Air Borne Disease
- [3] Water Borne Disease

Eathquake Effect
- [4] Tsunami
- [5] Landslide
- [6] Soil liquification
- [7] Ground motion

Type of Building
- [8] Earthen Building
- [9] Stone Building
- [10] Masonry Building
- [11] Wet-proofed Building
- [12] Dry-proofed Building
- [13] Elevated Static Building
- [14] Amphibious Building
- [15] Pile Building
- [16] Floating Building

Ventilation, Wind
- [17] Maximize
- [18] Minimize

Solar Radiation, Sun
- [19] Maximize
- [20] Minimize

Humidity, Rain
- [21] Protection

Foundation/Wall Materials
- [22] Fired Brick
- [23] Concrete/ Concrete Brick
- [24] Mud Brick
- [25] Adobe Brick
- [26] Wood and Mud

Roof Materials
- [27] Steel (Iron sheet)
- [28] Timber (Wood)
- [29] Bamboo

Outputs (colors)

Social Distancing
- (1) *Desk-Chair spacing*
- (2) *Open and adapted space*

Toilets
- (3) *Disaster-resilient toilet*
- (4) *Waste management*

Hand Washing Facilities
- (5) *Location close to the toilet*
- (6) *Materials*
- (7) *Accessibility to everyone*

Water Supply
- (8) *Ground catchment System*
- (9) *Rain Water catchment system*

Structural System
- (10) *Frame*
- (11) *Bearing wall*

Weigth
- (12) *Heavy*
- (13) *Ligth*

Structural protection
- (14) *Screening Doors*
- (15) *Screening Eaves*
- (16) *Screening windows*
- (17) *Screening Nets*
- (18) *Boundary wall*
- (19) *Set-back*
- (20) *Fences*

Foundation
Static
- (21) *Two store building*
- (22) *Pile Foundation*
- (23) *Strip wall*
- (24) *Mat*
- (25) *Base isolation*
- (26) *Basement (h <1m)*
- (27) *Sub-floor void (h: >1m)*

Kinetic
- (28) *Buouyancy*

Material Characteristics
- (29) *Water-resistance*
- (30) *Carbon footprint*
- (31) *Maintenance*

Floor
- (32) *Raising*

Roof
Ceiling Height
- (33) *Higher*
- (34) *Lower*

Roof Overhang
- (35) *Decrease*
- (36) *Increase*
- (37) *max 500 mm*
- (38) *Use ties*

Roof Shape
- (39) *Slope (min 20°-30°)*
- (40) *Slope (22-30°/45°)*
- (41) *Hipped*
- (42) *Pyramidal*
- (43) *Conical*

Roof Weigth
- (44) *Light*
- (45) *Heavy*

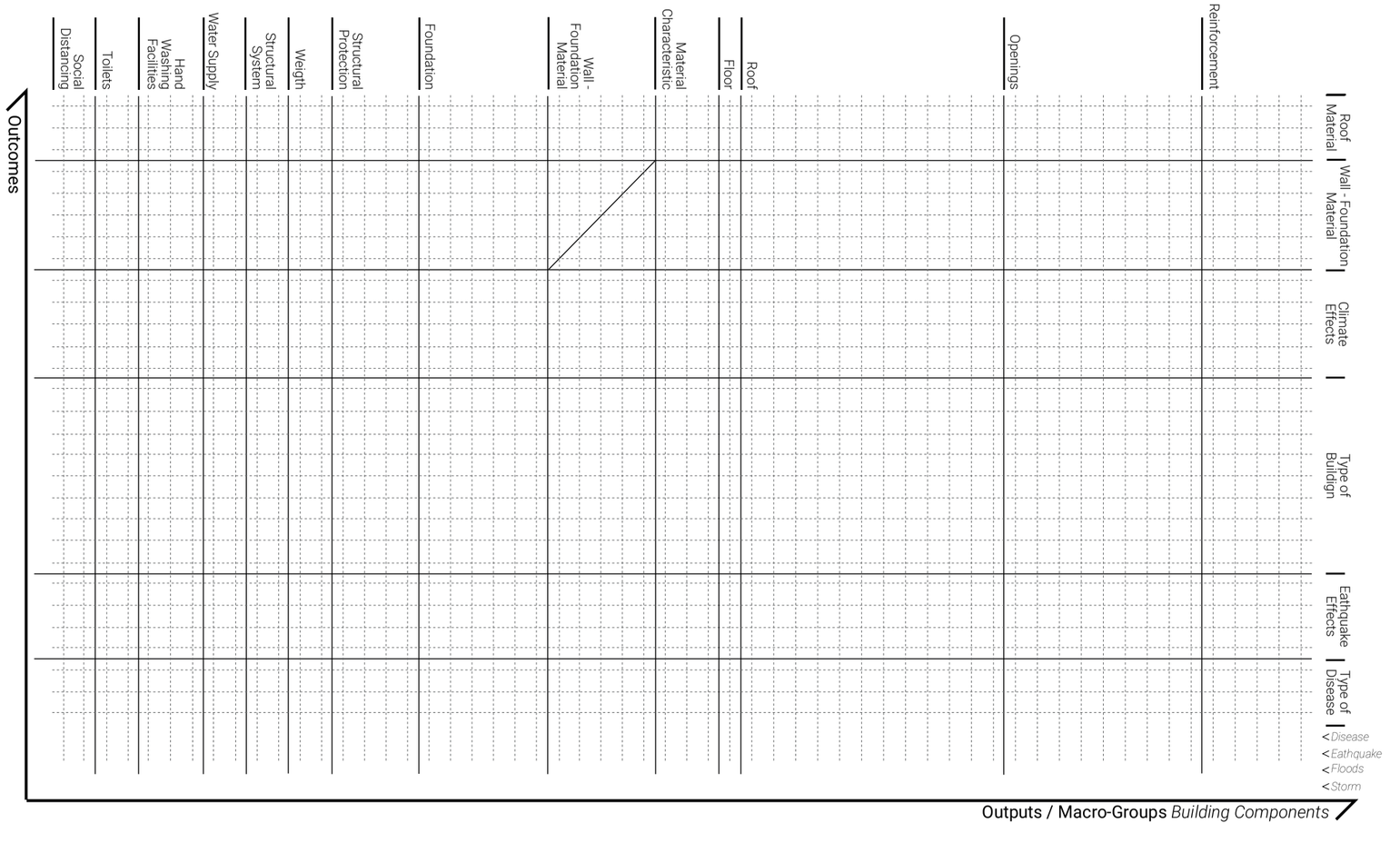
Openings
Type of ventilation
- (46) *Mechanical ventilation*
- (47) *Natural Ventilation*

Position
- (48) *Outward opening*
- (49) *Symmetrical (Max 20% of wall)*
- (50) *At same heights*
- (51) *Upper*
- (52) *Adjacent*
- (53) *At different heights*
- (54) *Elements of Protection*
- (55) *Shading Elements*

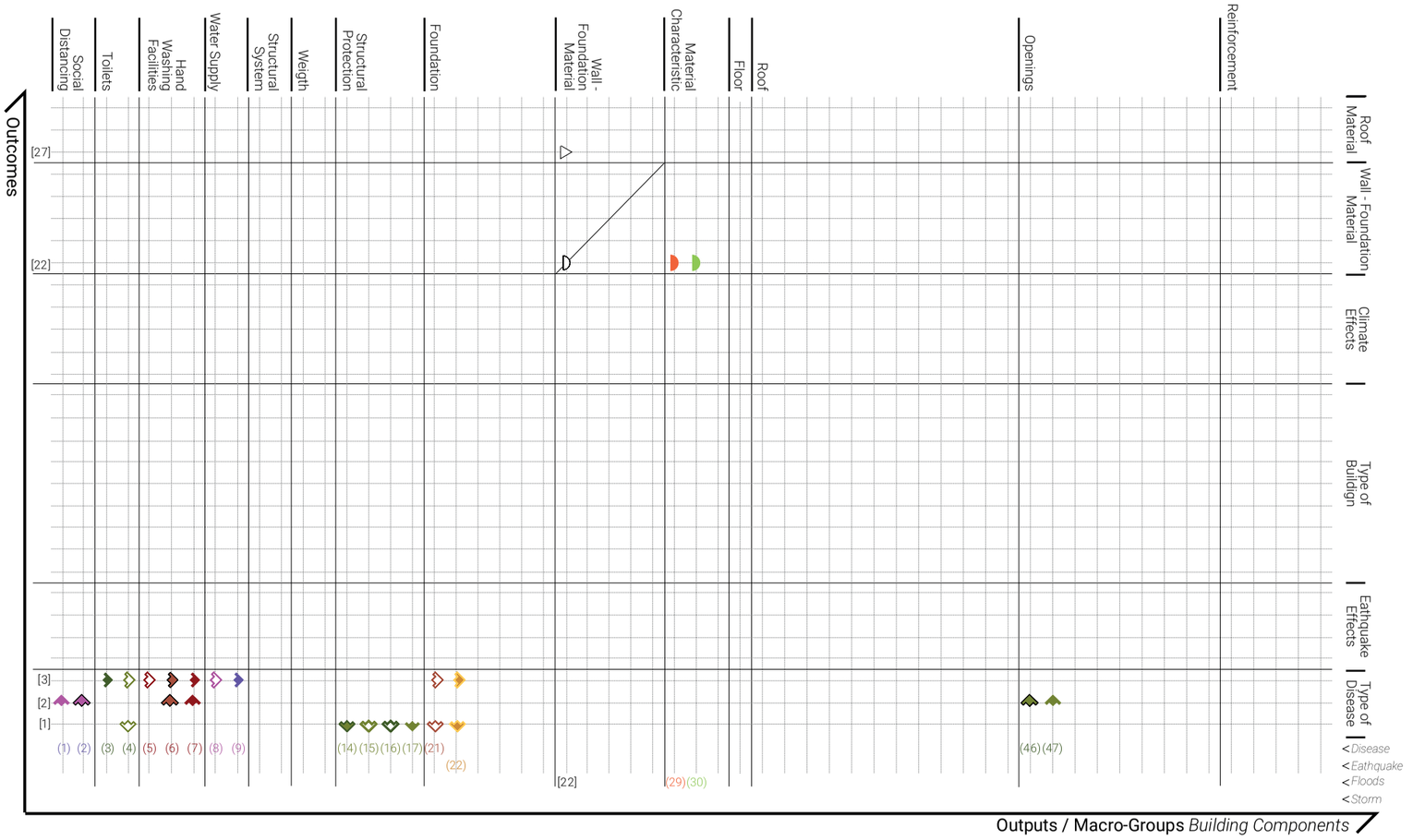
Reinforcement
Horizontal
- (56) *Ring beams*
- (57) *Collar bands*
- (58) *Mooring system*

Vertical
- (59) *Wire mesh*
- (60) *Wood post*
- (61) *Steel bar*
- (62) *Super-structural*
- (63) *Sub-structural*

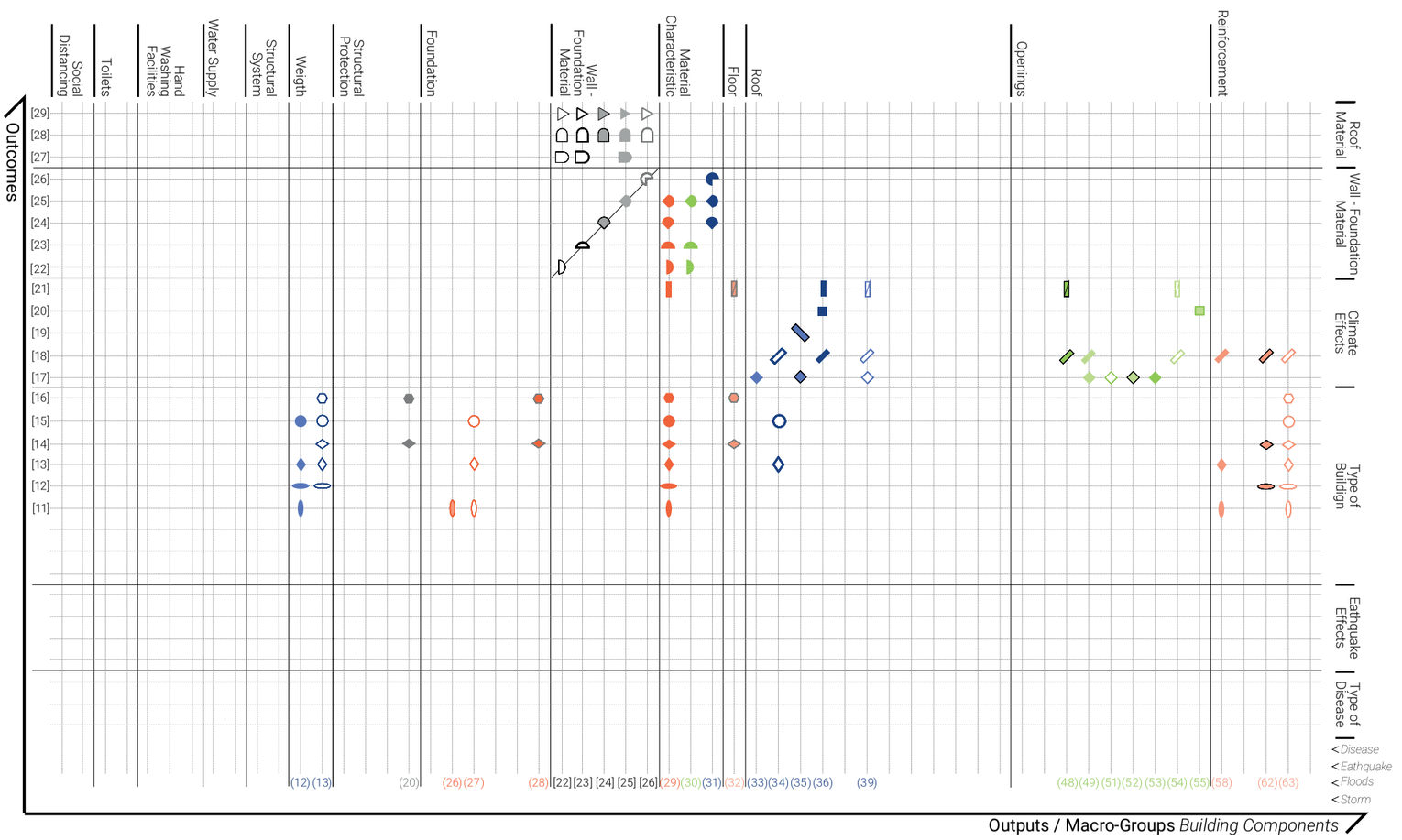
4.5.2 THE2D SPACE



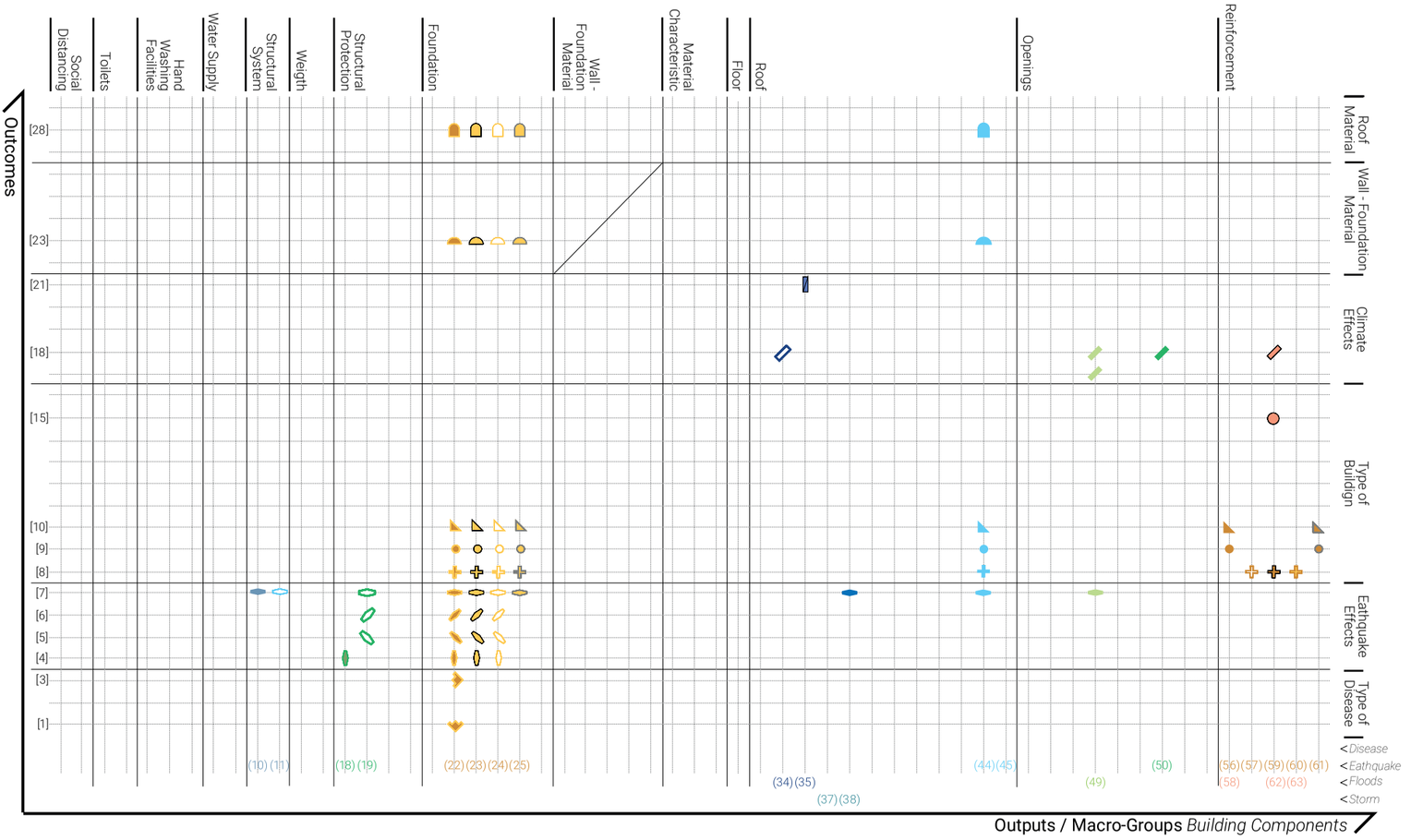
4.5.3 THE DISEASES MATRIX



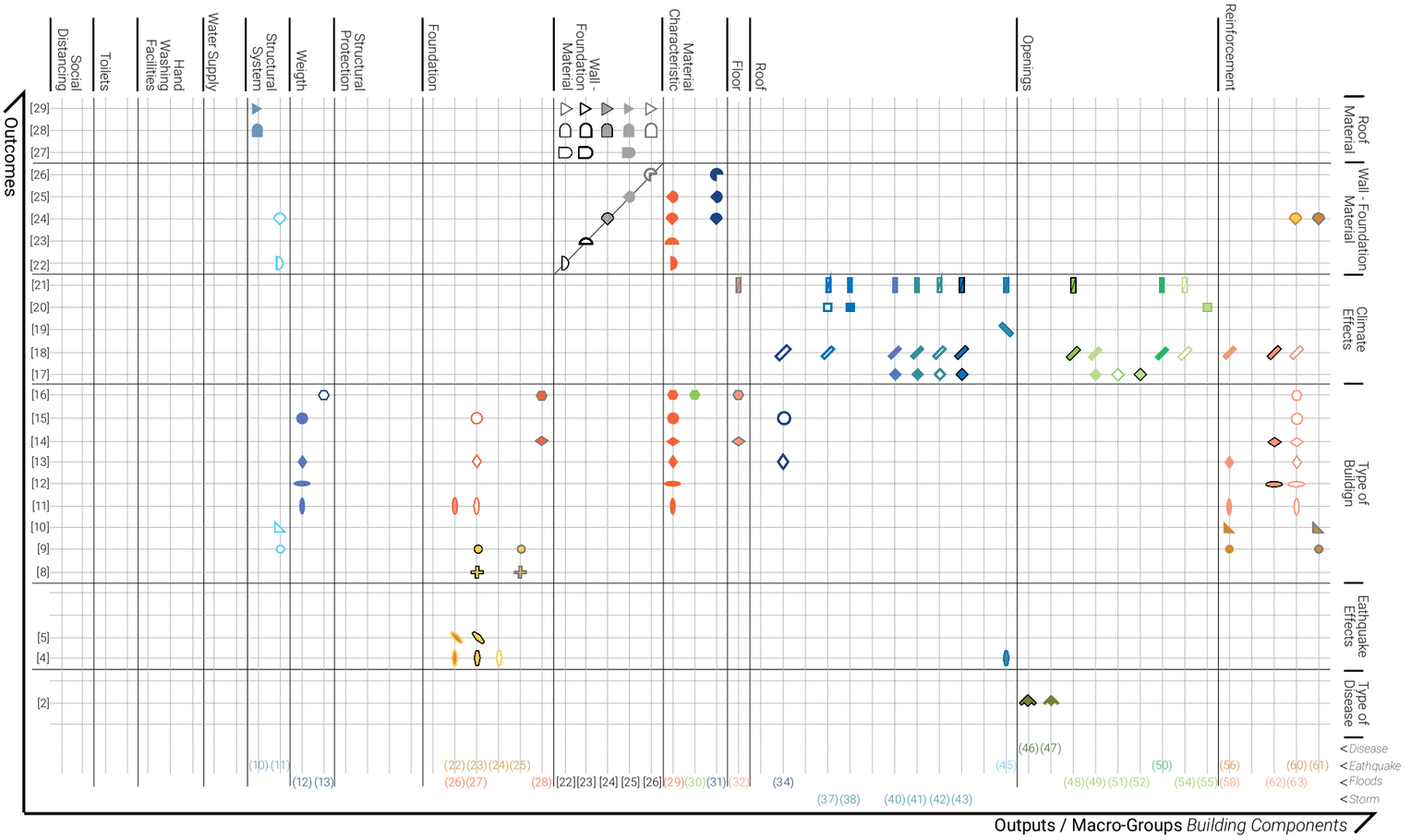
4.5.4 FLOODING MATRIX



4.5. 5 EARTHQUAKES MATRIX



4.5.6 STORMS MATRIX

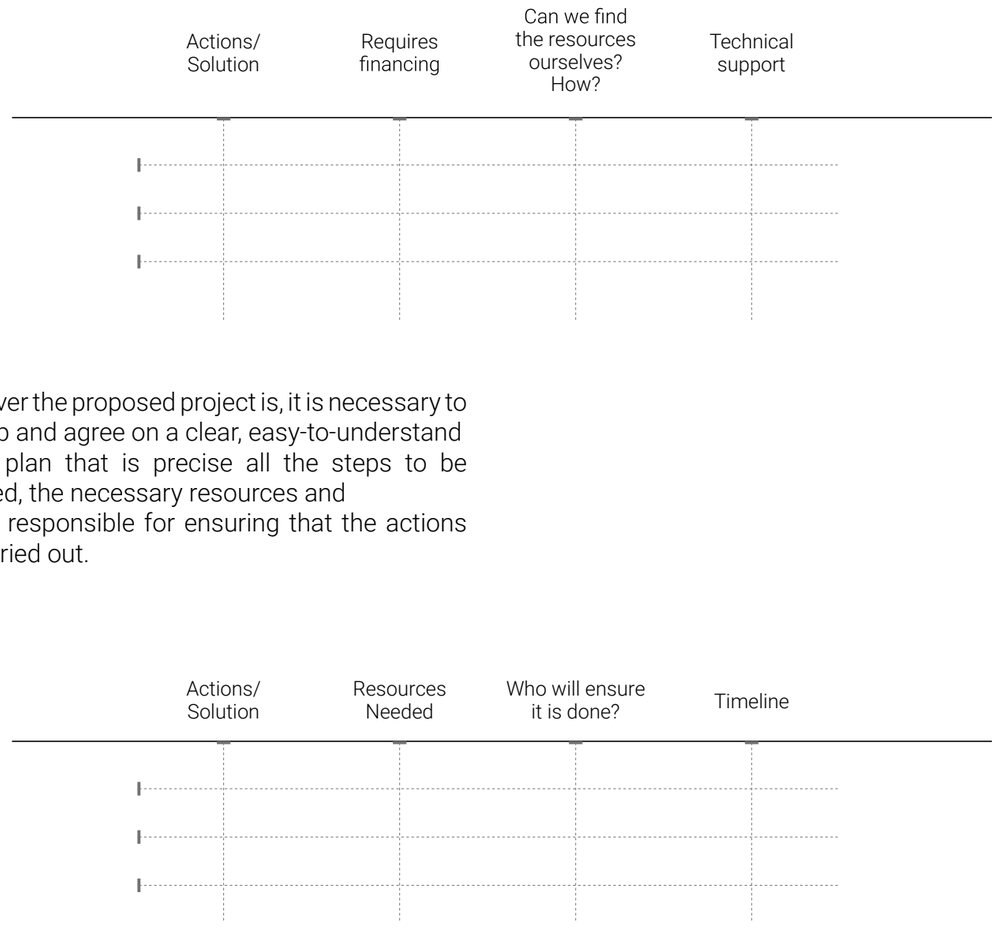


4.6 IMPLEMENTATION OF THE SOLUTIONS

The next step of the process consists in evaluating in detail how realistic each solution obtained from the Comparison of Matrices is and what is needed to implement it (time, money, materials, people involved, construction skills). Then, we implement the solutions obtained from Compared Solutions considering the capabilities identified in the community (identified with Tool 6 - Livelihoods and capacities analysis), building with them The Final Solutions List.

4.6.1 ENSURE THAT THE PROJECT WILL BE DONE

Determine the realistic solutions, local people will have to determine how they will acquire what they need and whether the actions require specific skills, available within the community or outside, and where they can be found.



Whatever the proposed project is, it is necessary to develop and agree on a clear, easy-to-understand action plan that is precise all the steps to be followed, the necessary resources and who is responsible for ensuring that the actions are carried out.

REFERENCES

References:
(1)International Federation of Red Cross and Red Crescent Societies (2006), What is VCA? An introduction to vulnerability and capacity assessment, 2006. Available from: https://www.dsm-consulting.ch/images/imagesite/CBDRM/CBDRM_31.pdf

(2)International Federation of Red Cross and Red Crescent Societies (2007), VCA toolbox with reference sheets, 2007. https://www.humanitarianlibrary.org/sites/default/files/2014/02/vca-toolbox-en.pdf

(3)Plan International (2010), Child Centred DRR Toolkit, 2010. https://resourcecentre.savethechildren.net/pdf/5146.pdf/

(4) Sphere Association. The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response, fourth edition, Geneva, Switzerland, 2018.

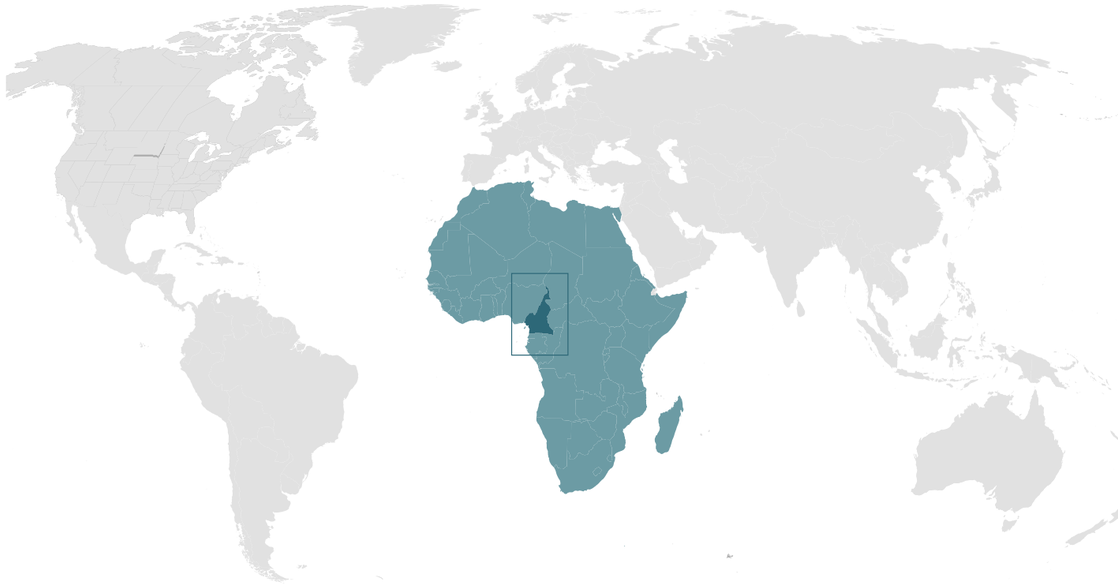
5. THE CASE STUDY

5. 1 CAMEROON

As a case study for the matrix test, we are going to take as an example a developing state such as Cameroon in sub-Saharan Africa.

Due to the social and political problems this country is facing, many people is being displaced and the humanitarian aid is needed, Mainly for children, that are the group of people more affected.

It not only has climatic hazards , and illnesses threatening the poores communities, but also problems of internal conflict, which increase the vulnerability and affects the development and education of children.



5.1.1 LOCATION

HTTPS://WWW.CIRCLEOFBLUE.ORG/2015/

Cameroon is African country located in west-central Africa. It is a lower-middle-income country with a population of over 25 million (2020).**(1)**

It is surrounded by Gabon and the Republic of the Congo to the south, Nigeria to the west and north; Chad to the northeast and the Central African Republic to the east.

Its coastline lies on the Bight of Biafra, part of the Gulf of Guinea and the Atlantic Ocean.

According to United Nations Development Programme, It ranks 150 out of 189 on the Human Development Index (UNDP, 2019), and 39 per cent of the country's population lives below the poverty line. Also, The country ranks 141 among the 189 countries as per its level of gender inequality. **(2)**

References:
(1) The World Bank. (10, 10, 2021). Cameroon overview: https://www.worldbank.org/en/country/cameroon/overview#1
(2) Human Development Report 2019 Beyond income, beyond averages, beyond today: Inequalities in human development in the 21st century: UNDP; 2019. http://hdr.undp.org/sites/default/files/hdr2019.pdf

5.1.2 CONTEXT OF CRISIS

Humanitarian assistance in Cameroon is necessary. Currently, the country is affected by three, complex humanitarian situations:

1. Displacement caused by continuous violence in the Lake Chad Basin

2. Violence in the North-West and SouthWest regions

3. The presence of over 280,000 refugees from the Central African Republic (CAR) in the eastern regions (East, Adamawa and North).

"Humanitarian needs are compounded by structural development deficits and chronic vulnerabilities that further challenge the long-term recovery of affected people." OCHA (2021).

According to the Cameroon Humanitarian Needs Overview 2021 **(3)**:

4.4 million people will need humanitarian assistance in Cameroon in 2021

1.9 million (44 per cent) of the people in need are displaced people (IDPs, refugees, returnees).

1.8 million (41 per cent) are host community members, thus demonstrating the impact that sharing the already limited resources with the displaced population has on host community members.

675,000 (15 per cent) are "others" – people neither displaced, nor hosting displaced people.

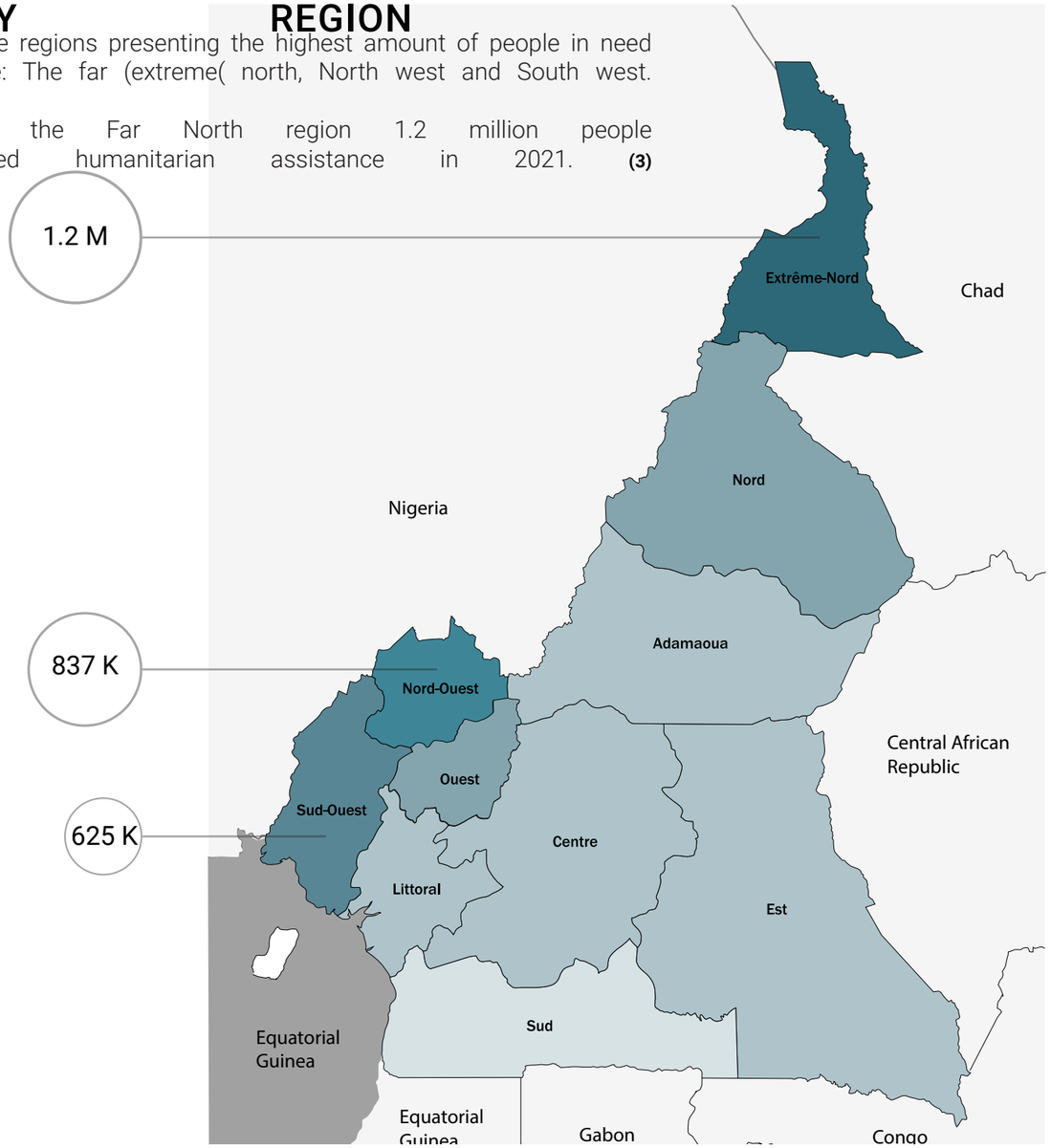
(Source: UN Photo/Eskinder Debebe) https://www.crisisgroup.org/africa/central-africa/cameroon/cameroon-confronting-boko-haram

References:
(3) OCHA; Cameroon Humanitarian Needs Overview 2021 (March 2021): OCHA; 2021. http://hdr.undp.org/sites/default/files/hdr2019.pdf

PEOPLE IN NEED BY REGION

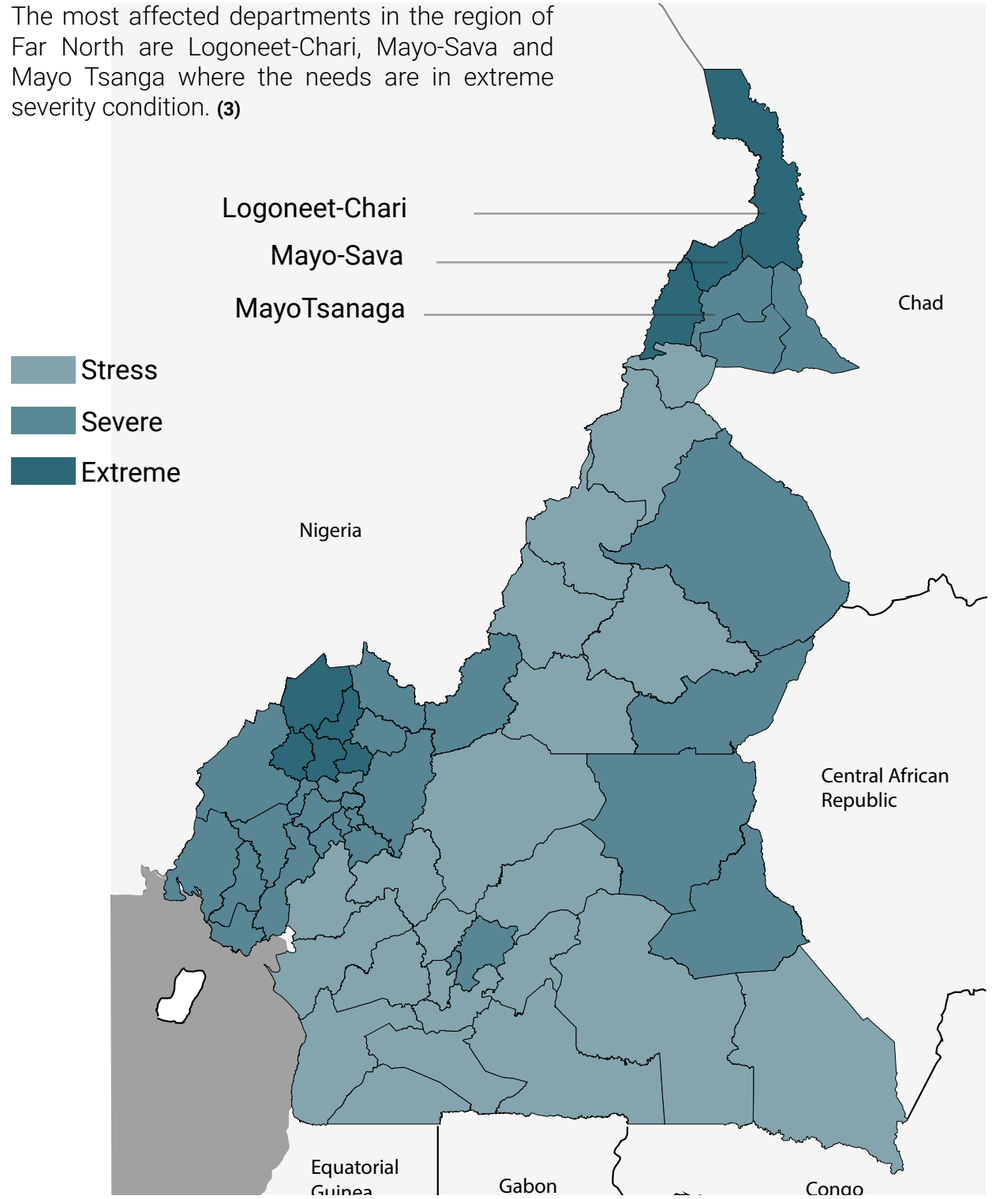
The regions presenting the highest amount of people in need are: The far (extreme(north, North west and South west.

In the Far North region 1.2 million people need humanitarian assistance in 2021. **(3)**



SEVERITY OF NEEDS

The most affected departments in the region of Far North are Logoneet-Chari, Mayo-Sava and Mayo Tsanga where the needs are in extreme severity condition. **(3)**



References:
(3) OCHA; Cameroon Humanitarian Needs Overview 2021 (March 2021): OCHA; 2021. http://hdr.undp.org/sites/default/files/hdr2019.pdf

5.1.3 CHILDREN SITUATION

The humanitarian crisis are affectinig millions of children in Cameroon. According to the OCHA, 2.3 million of children between 0 – 17 years old are in need. **(3)**

In the Far North, **37 per cent of IDP** (internal displaced people) are children under five and the average number of children per household is 5.8. **(3)**

They are, with the host populations, among the most exposed to the lack of access to drinking water, poor access to health care, hygiene problems, epidemics, and the consequences of poor harvests which can lead to rapid deterioration of their nutritional status. **(3)**

Thus, the conflict is related to several physical and psychological consequences such as: Violence, family separation, recruitment by armed groups, sexual violence, kidnaping and child marriage.
These various issues have been aggravated by COVID-19 prevention measures such as lock down and school closure, leading young girls to be confronted with a less protective living

Population in need

WOMEN

CHILDREN

(Source: UN Photo/Eskinder Debebe)

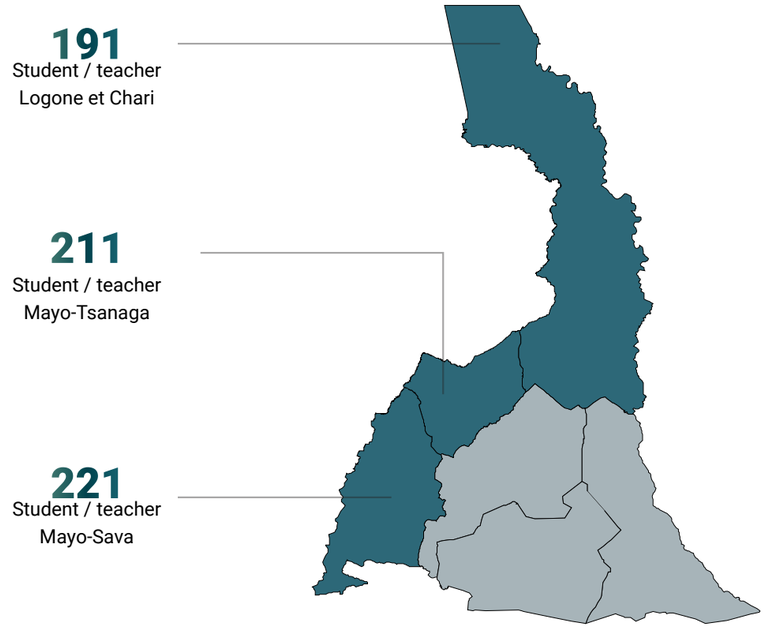
The current crisis situation affecting Cameroon, leaves thousands of children out of school. Due to the limited capacity of school system, the violence, attacks and threats to education almost 1.9 million school aged students need assistance in education. **(3)**

In the Far North, because of protracted displacement, many schools had to closed. The most affected provinces are Logone et Chari, Mayo – Sava and Mayo Tsanga.

By 2021, 62 schools are still closed, and 50 others have been destroyed for years, affecting about 35,000 students.

Also, school infrastructure and personnel already struggling to respond to the increasing demands in locations with a large displaced population, are now also requested to respect COVID-19 related social distancing measures. In addition, in 18 schools armed men in uniform provide education services to protect the schools and students but making the school susceptible to attack by NSAGs and endangering the girls and boys who attend these schools.

The student per teacher ratio in the three crisis-affected divisions in the Far North region is 211 students per teacher in Mayo-Tsanaga, 191 in Logone et Chari and 121 in Mayo-Sava. (OCHA, 2021) **(3)**



HAZARDS

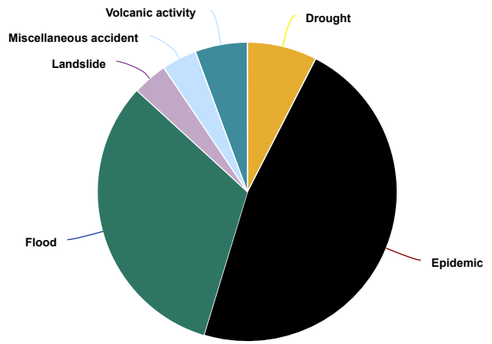
5.2 NATURAL HAZARDS

According to the world bank, the most frequent natural hazards in Cameroon are epidemics, floods, droughts, and landslides. Epidemics and floods together represent the 79% of all the hazards occurred from 1980 to 2020. **(4)**

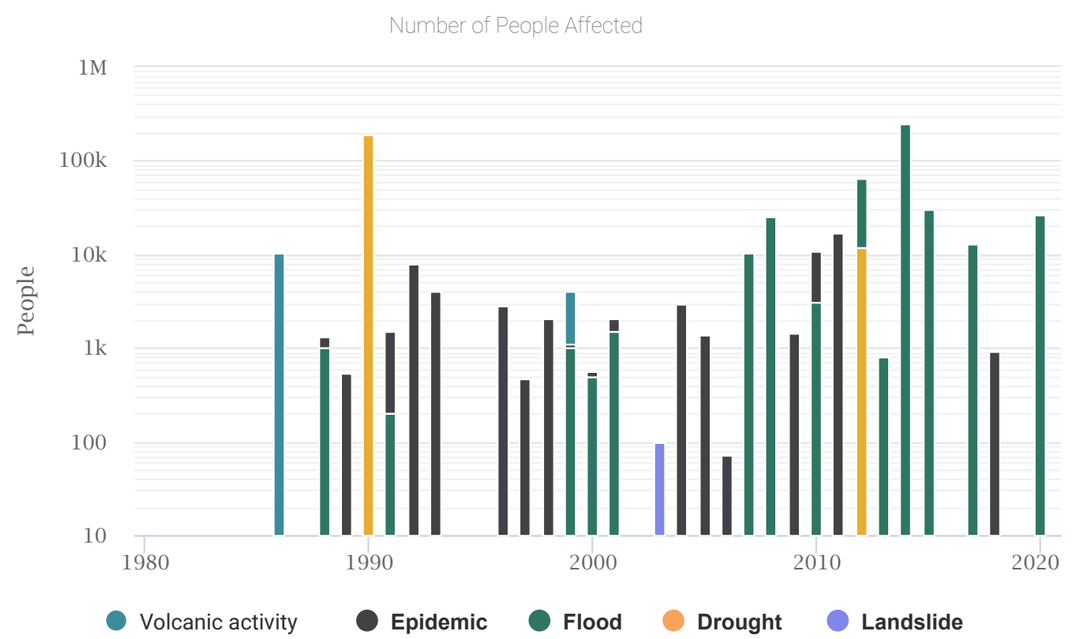
The average Annual natural hazard occurence of Epidemic is 25 (47.17%) and flooding is 17 (32,8%). These two types of hazards are related. According to the WHO, Floods can potentially increase the transmission of water and vector borne diseases, leading not only to infrastructural damage but health risks. **(4)**

Between the most common epidemic deseases in Cameroon we can find cholera, measles, meninguitis and Malaria.

Average Annual Natural Hazard Occurrence for 1980-2020



Key Natural Hazard Statistics for 1980-2020



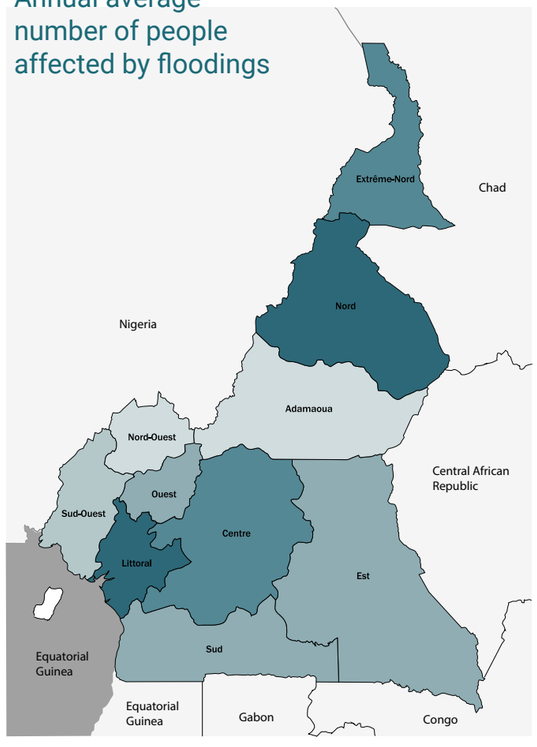
References:
(4) World Bank Group. (10, 10, 2021). Cameroon hazards overview: https://climateknowledgeportal.worldbank.org/country/cameroon/vulnerability

5.2.1 FLOODINGS IN FAR NORTH REGION

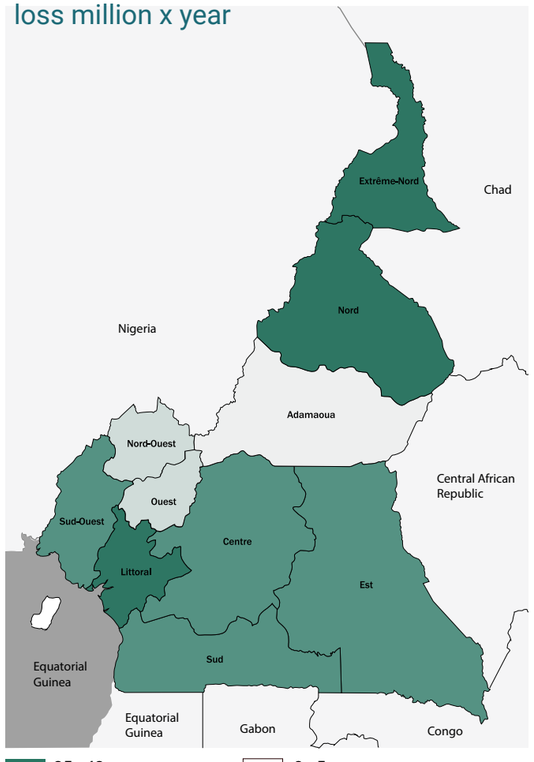
Floods in Cameroon cause loss of life, damage to houses, crops, livestock and road infrastructure, affecting hundreds of thousands of people at each occurrence. On average, more than 200.000 people are affected by floods every year in Cameroon **(5)**. All regions of the country are exposed to it but those that have suffered the most serious damage to date are the Littoral, the Far North and the North regions. According to INFORM Sahel, the Nord is at highest risk (8.4), followed by the Far North (7.7) and the Littoral (6.1).

The direct economic losses in Cameroon result from a complex combination between hazard and exposure geographycal distribution. (UNISDR, 2018).**(5)** The regions showing the biggest economic loses are the north, the far north and the Littorial.

Annual average number of people affected by floodings



Direct economic loss million x year



References:
(5) CIMA, UNISDR (2018). Cameroon Disaster Risk Profile.

5.2.2 FLASH FLOODS IN THE FAR NORTH REGION

Over time the North of Cameroon has suffered many floods leaving hundreds of people homeless and in a vulnerable situation. According to the historical report of floods with the greatest impact, the years where there has been the greatest impact are: 1994, 1996, 1997, 1998, 1999, 2000, 2005, 2006, 2007, 2010, 2012, 2013, 2014.

Flash floods in the North region and Far North Regions.

2012

Affected zones: Doreissou, Begué, Palam, Dougui, Pouss and Tekele villages.

People affected: 37,816.**(6)**

2013

Affected zones: River the town of Dougui, Kai Kai District.

People affected: 805. **(7)**

2014

Affected zones: Bibémi, Figuil, Mayo Oulo, Guider, Pitoa and Touboro District.

People affected: 255,214. **(10)**

2019

Affected zones: Nohoye, Pinfoung, Koundouma, Guiding, Sarahara, Lahai, Guirvidig, Dawaya, Gounmi and Mourna

People affected: 25,582. **(9)**

2020

Affected zones: the Logone and Chari, Mayo-Sava, Mayo Danay, and Mayo-Kani Divisions

People affected: 158,279. **(10)**

References:
(6) IFRC, Disaster relief emergency fund (DREF) Cameroon: Floods in the North and Far North Regions, (2012)
(7) IFRC, Disaster relief emergency fund (DREF)Cameroon: Flash floods, (2013)
(8) IFRC,DREF Final Report Cameroon: Floods, (2015)
(9) IFRC, Emergency Plan of Action (EPoA) Cameroon: Floods (2019)
(10) IFRC, Final Report Cameroon: Floods in Far North, (2021)

5.3 EPIDEMICS AND HEALTH

Flooding often led to a rise in waterborne diseases and health hazards such as dysentery, malaria, diarrhoea, catarrh, and cough. The situation is worsened by frequent epidemics (cholera, measles, and meningitis) in many parts of the country.

Besides, The need for safe drinking water remains critical in the whole country, even though the severity of needs varies by region. the main causes of death in Cameroun are HIV/AIDS, Malaria and diarrheal desases.

(Source: UN Photo/Eskinder Debebe) https://theglobalobservatory.org/wp-content/uploads/2017/06/June-23-Cameroon-water-e1498242613862.jpg

Water, Sanitation & Hygiene

In the Far North, access to safe drinking water is the primary concern of the displaced population.

In the North-West and South-West regions, a shortage of safe drinking water in rural areas leads people to rely on water from streams, rivers, and unprotected wells for drinking and domestic use. **(3)**

57 per cent of the population of the Far North does not have access to drinking water.

In the Far North, 86 per cent of the main refugee and IDPs sites do not have a minimum standard of safe drinking water supply or basic sanitation. **(3)**

The precarious living conditions of the population can also be exemplified by the lack of items necessary for compliance with hygiene standards and barrier measures against COVID-19. **(3)**

For example, 22 per cent of people living in IDP sites in Logone et Chari and 18 per cent in Mayo-Tsanaga do not have soap or hand sanitizers. **(3)** With regards to basic sanitation, latrines are often insufficient in number and insecure, leaving people to favor open defecation, resulting in poor personal and community hygiene practices. **(3)**

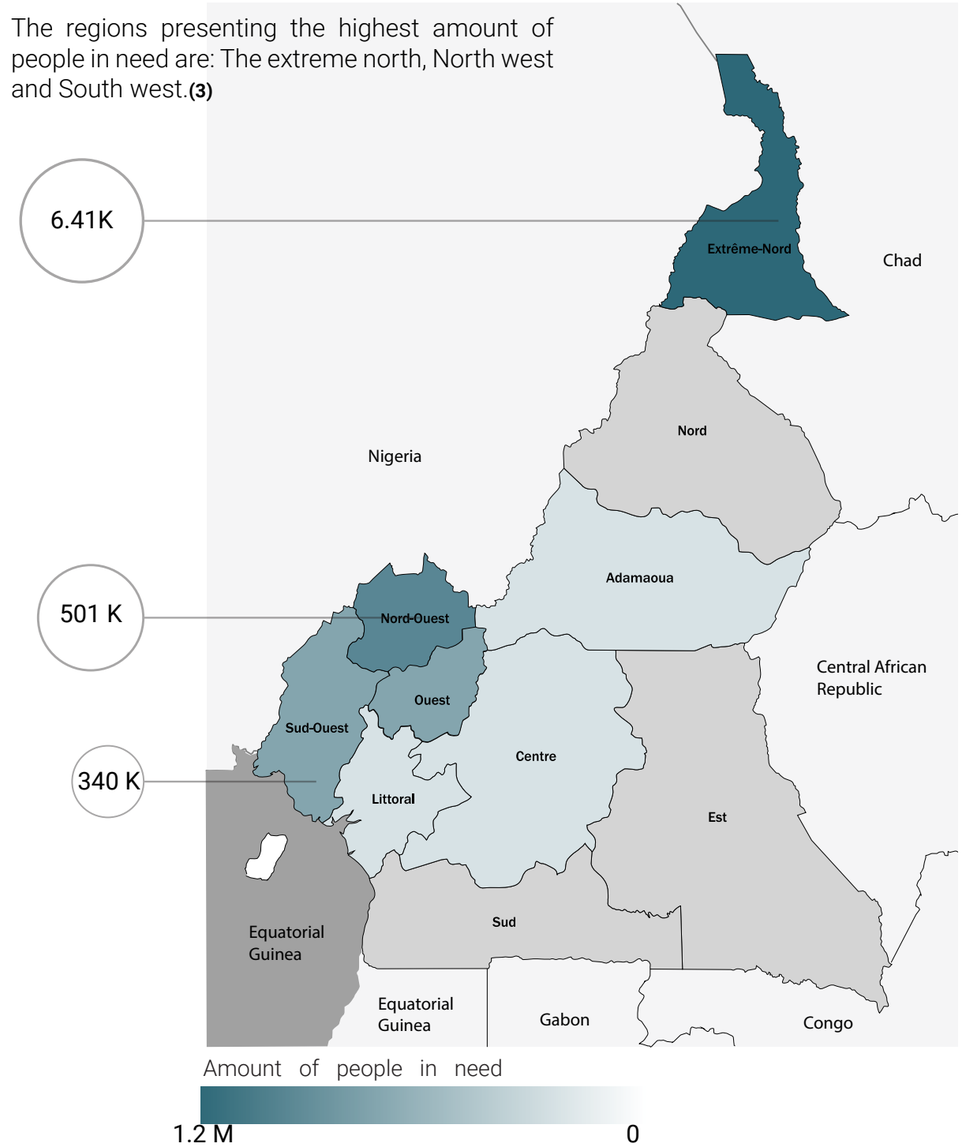
In the North-West and South-West regions, open defecation or construction of unsafe latrines is a common practice in most rural settings. In the Littoral and the West regions, over 75 per cent of IDPs need water and sanitation support. **(3)**

Open defecation in bushes and streams, sometimes used for cooking and other domestic chores, is common practice. Water borne diseases such as diarrhea, typhoid and cholera are common. **(3)**

References:
(3) OCHA; Cameroon Humanitarian Needs Overview 2021 (March 2021): OCHA; 2021. http://hdr.undp.org/sites/default/files/hdr2019.pdf

WASH PEOPLE IN NEED

The regions presenting the highest amount of people in need are: The extreme north, North west and South west.**(3)**

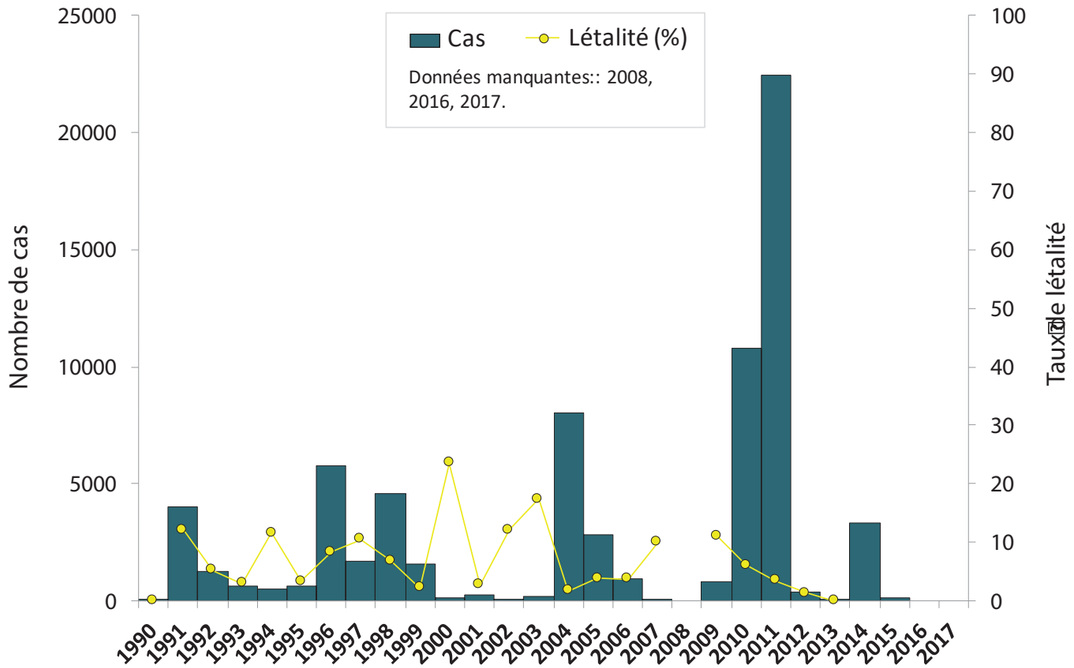


5.3.1 CHOLERA RISK IN CAMEROON

Cholera is an endemic disease that has left many victims in Cameroon in the last decades. Adequate water, sanitation and hygiene services are critical for patient care and for infection prevention and control. The WASH crisis of the country increase the risk to this natural hazard.

Major cholera epidemics have been recorded in 1991, 1996, 1998, 2004, 2010 and 2011. The main epidemics are recorded in the North and Far North regions. In the southern regions, cholera outbreaks are frequently recorded in the Littoral region. (OCHA, 2021) **(3)**

Annual number of cholera cases and case fatality rate in Cameroon 1990- 2017**(11)**

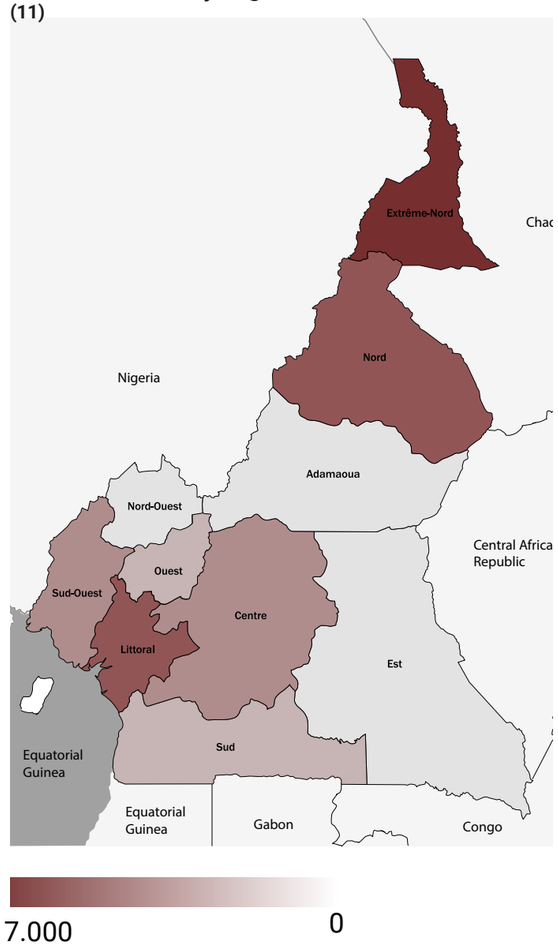


References:
(11) UNICEF. CHOLÉRA FACTSHEET CAMEROUN (2018). http://www.plateformecholera.info/attachments/article/220/Cholera%20Factsheet_Cameroun_2017_FINAL.pdf

CHOLERA IN FAR NORTH REGION

The most affected regions by cholera from 2010-2017 are the far north region. reporting 16.755 cases, The north region, with 5.803, the Litoral with 5.777 and the centre with 3.670. **(3)**

Cholera cases by region 2010-2017 **(11)**



Epidemiological parameters of epidemics of cholera by region (2010- 2017) **(11)**

RÉGION	Cas / Décès [1]	% du total des cas	Taux de létalité (%)	Récurrence (nbre d'épidémies)	Durée épidémique [2] (moyenne en semaines)
Extrême-Nord	16 775 / 904	44,9	5,4	6	21
Nord	5 803 / 324	15,5	5,6	5	23
Littoral	5 777 / 116	15,4	2,0	5	17
Centre	3 670 / 140	9,8	3,8	5	18
Sud - Ouest	3 454 / 46	9,2	1,3	2	31
Ouest	1 286 / 76	3,4	5,9	4	14
Sud	214 / 7	0,6	3,3	3	7
Adamaoua	213 / 19	0,6	8,9	2	9,5

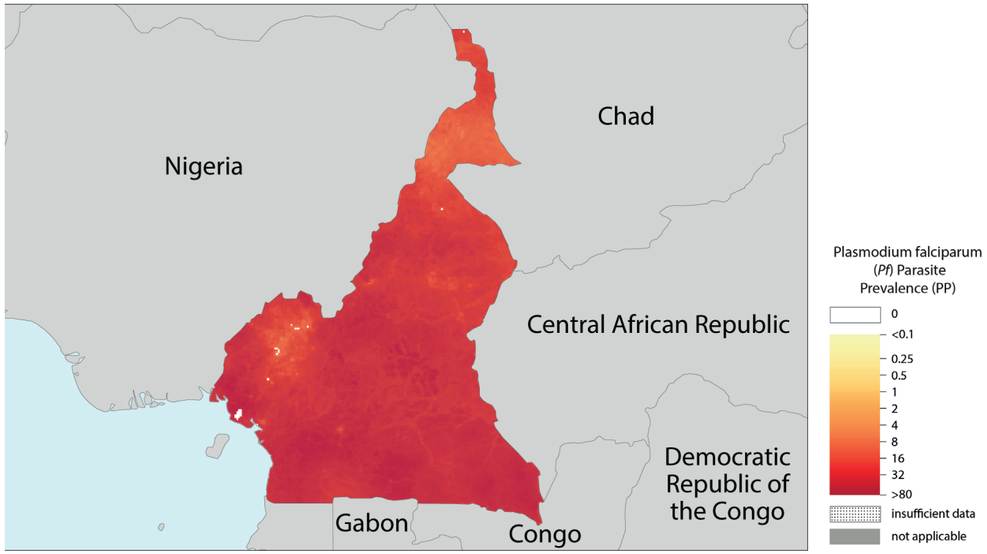
References:
(11) UNICEF. CHOLÉRA FACTSHEET CAMEROUN (2018). http://www.plateformecholera.info/attachments/article/220/Cholera%20Factsheet_Cameroun_2017_FINAL.pdf.

5.3.2 MALARIA IN CAMEROON

Malaria is a major public health problem throughout Cameroon, one of the 11 high-burden countries that account for more than 70% of the global malaria cases and deaths. (United States Agency for International Development, 2019) **(12)**

The 2018 World Malaria Report estimated that Cameroon accounted for 16% of malaria cases in the Central Africa region and 3% share of global malaria cases in 2017 (WHO, 2018). **(12)**

Geogrphycal distribution of Plasmodium falciparum parasite **(13)**



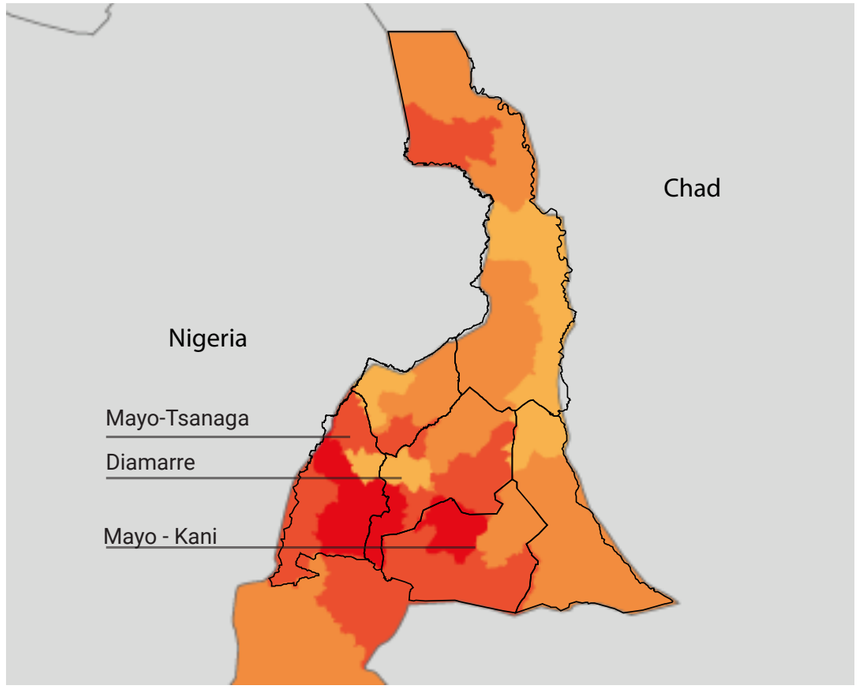
Malaria is still an important public health threat in Cameroon with the whole country exposed to the risk of transmission.

Every year, more than 200.000 persons are affected by the disease.**(13)**

References:
(12) World Malaria Report 2018. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO.
(13) WHO. Malaria country profile, Cameroon (2017). https://www.who.int/malaria/publications/country-profiles/profile_cmr_en.pdf?ua=1

INCIDENCE OF MALARIA IN CAMEROON

Malaria cases in the Far North 2017 **(13)**

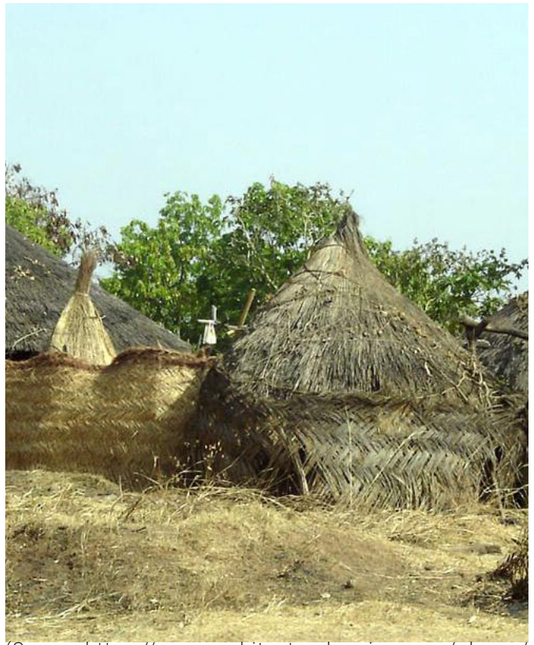


The socio-economic crisis of the people and the way of life of the communities in the north of the region exposes the communities to malaria.

The most affected departments in the Far North region in 2017 were Mayo-Tsanaga, Diamarre and Mayo- Kani. **(13)**

5.4 ARCHITECTURE VULNERABILITIES AND MATERIALS

The housing characteristics are important to evaluate the vulnerability of the people to Vector borne diseases such as Malaria. The materials of floors, walls, and roofs are related to the Mosquito incidence inside the house. A survey made in the North and Far North regions of Cameroon by United States Agency for International Development (USAID), have found revelevant data about dwellings characteristics in this area. **(14)**



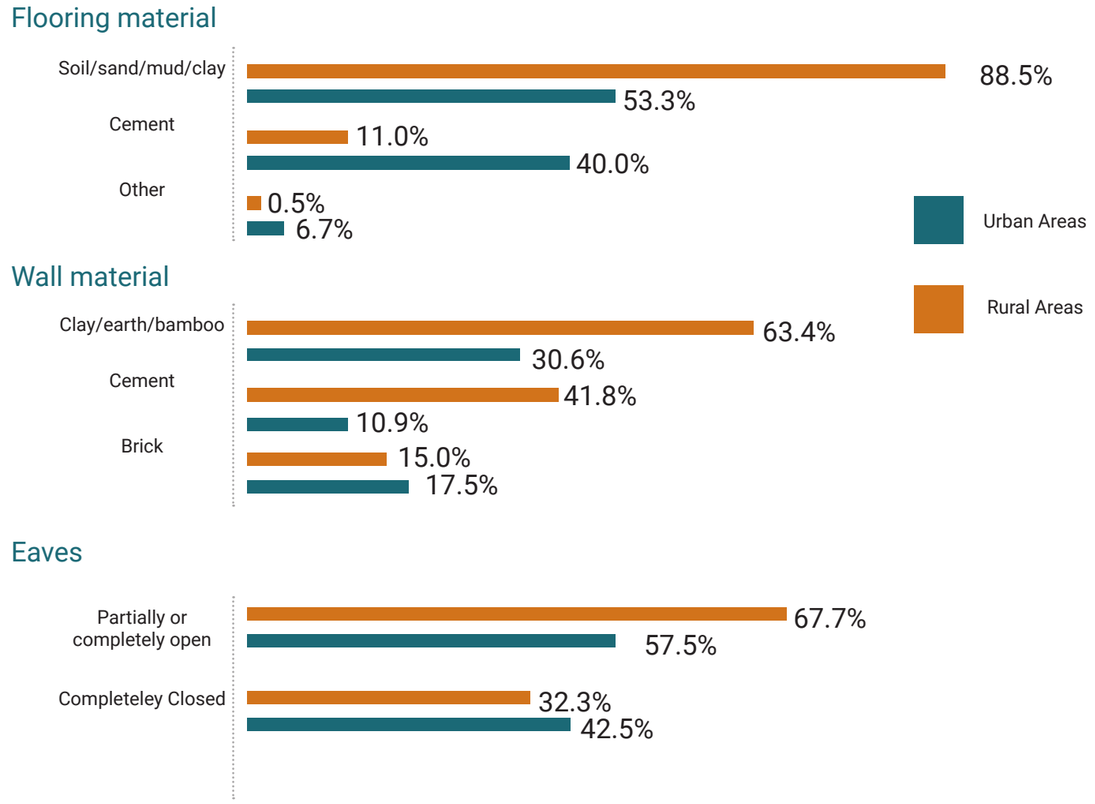
(Source:https://www.architectural-review.com/places/africa/exploring-eye-west-africas-vernacular-architecture

Housing characteristics, North and Far North regions, Cameroon, 2019

	FAR NORTH		
CHARACTERISTIC	RURAL (n=650)	URBAN (n=693)	TOTAL (n=1,343)
Average number of rooms usedfor sleeping in dwelling	2.5	2.2	2.4
Number of people per roomused for sleeping	2.3	2.3	2.3
Households with electricity	13.0	72.4	30.6***
FLOORING MATERIAL			
Soil/sand/mud/clay	88.5	53.3	76.2***
Cement	11.0	40.0	21.2***
Other	0.5	6.7	2.7**
WALL MATERIAL			
Clay/earth/mud/bamboo	63.4	30.6	51.9***
Cement	10.9	41.8	21.8***
Brick	15.0	17.5	15.9
Other	10.7	10.2	10.5
EAVES			
Partially or completely open	67.7	57.5	47.8*
Completely closed	32.3	42.5	35.9*

References:

(14) Survey on the Determinants of Behaviors Related to Malaria: Johns Hopkins University; (2020). : https://malariabehaviorsurvey.org/wp-content/uploads/2021/11/CAM-MBS-Report-2019-En.pdf.



According to the assesment, the bigest proportion of houses in urban and rural areas are exposed to malaria risk. As we can observe in the comparison, most of them are made of materials such as soil, mud, earth and clay which increase the mosquito insidence inside the dwelling.

Also, it is necessary to highlight that in rural areas , eaves are partially or completely open, increasing the risk mentioned.

After all these documentation it is possible to evidence the vulnerability of the far north region of Cameroon to vector borne diseases.

REFERENCES

References:
(1) The World Bank. (10, 10, 2021). Cameroon overview: https://www.worldbank.org/en/country/cameroon/overview#1

(2) Human Development Report 2019 Beyond income, beyond averages, beyond today: Inequalities in human development in the 21st century: UNDP; 2019. http://hdr.undp.org/sites/default/files/hdr2019.pdf

(3) OCHA; Cameroon Humanitarian Needs Overview 2021 (March 2021): OCHA; 2021. http://hdr.undp.org/sites/default/files/hdr2019.pdf

(4) World Bank Group. (10, 10, 2021). Cameroon hazards overview: https://climateknowledgeportal.worldbank.org/country/cameroon/vulnerability

(5) CIMA, UNISDR (2018). Cameroon Disaster Risk Profile.

(6) IFRC, Disaster relief emergency fund (DREF) Cameroon: Floods in the North and Far North Regions, (2012)

(7) IFRC, Disaster relief emergency fund (DREF)Cameroon: Flash floods, (2013)

(8) IFRC,DREF Final Report Cameroon: Floods, (2015)

(9) IFRC, Emergency Plan of Action (EPoA) Cameroon: Floods (2019)

(10) IFRC, Final Report Cameroon: Floods in Far North, (2021)

(11) UNICEF. CHOLÉRA FACTSHEET CAMEROUN (2018). http://www.plateformecholera.info/attachments/article/220/Cholera%20Factsheet_Cameroun_2017_FINAL.pdf.

(12) World Malaria Report 2018. Geneva: World Health Organization; 2018. Licence:
CC BY-NC-SA 3.0 IGO.

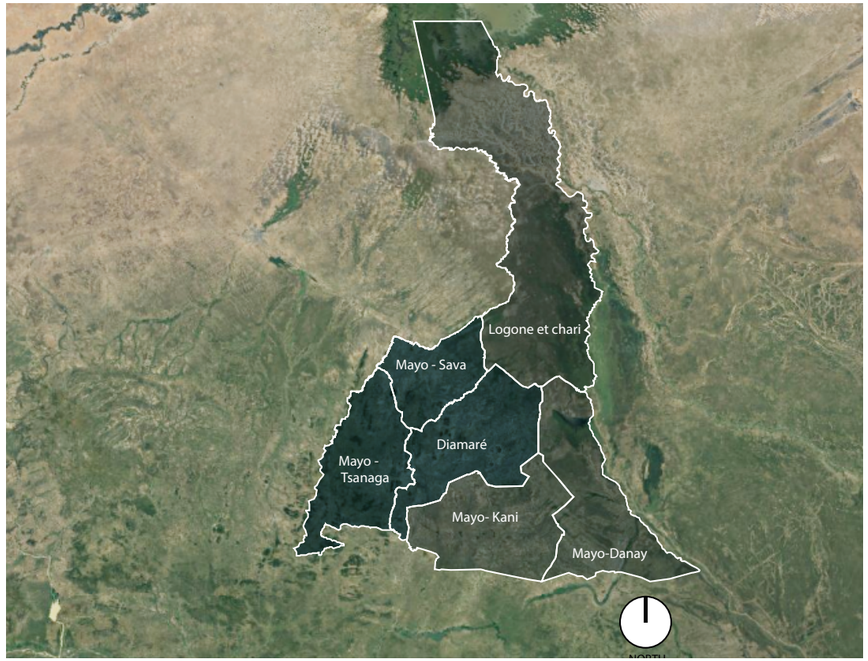
(13) WHO. Malaria country profile, Cameroon (2017). https://www.who.int/malaria/publications/country-profiles/profile_cmr_en.pdf?ua=1

(14) Survey on the Determinants of Behaviors Related to Malaria: Johns Hopkins University; (2020). : https://malariabehaviorsurvey.org/wp-content/uploads/2021/11/CAM-MBS-Report-2019-En.pdf.

6. THE FAR NORTH REGION

6.1 VCA FAR NORTH REGION

Location of study area



Areas of study

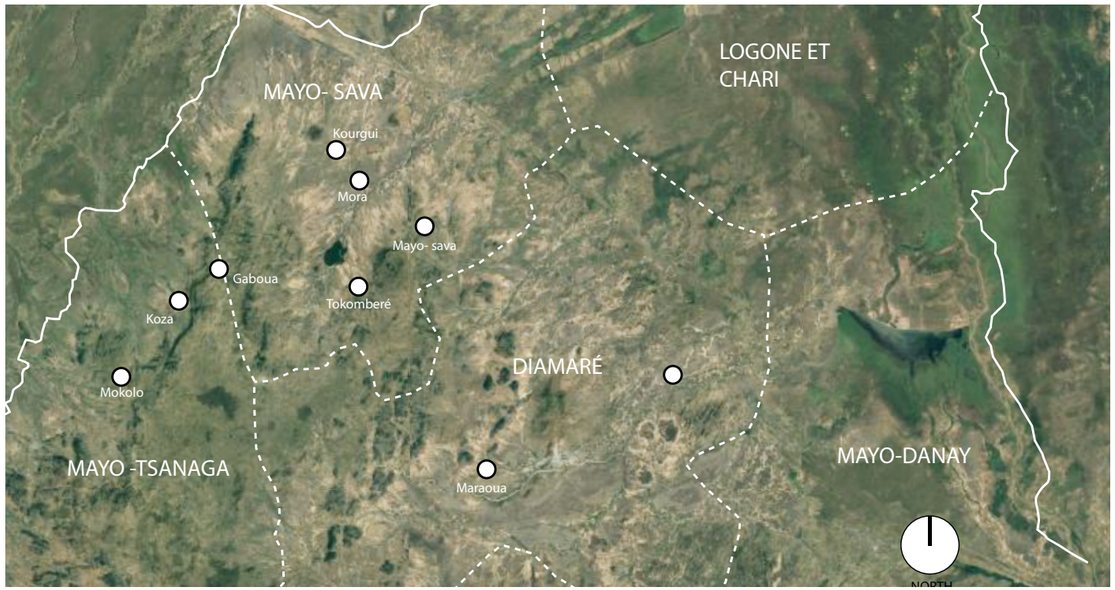
	Selected zones for the VCA	
Departments	Cities	Localities
Mayo-Sava	Mémé	Igawa 1 Igawa 2 Djamakia Bia
	Mora	Kourgui
	Tokombere	Godji-Godji
Mayo-Tsanaga	Mokolo	Ouro-tada
	Koza	Gaboua
Diamaré	Maroua 3	Dousongo
		Duogoi
		Louggueo
		Sarare

In the northern region, a VCA was carried out between 2017 and 2019 with the aim of highlighting the vulnerabilities and capacities of the host populations and internally displaced persons in Diamaré, Mayo-Sava and Mayo-Tsanaga.

In the three departments, more than 450 households (179 Diamaré, 137 Mayo-Sava, 134 Mayo-Tsanaga) participated in the household survey on which most of the analysis and recommendations of this evaluation are based. **(1)**

References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

6.1.1 LOCATION OF THE COMMUNTIES IN THE TERRITORY



Demographics of the communties

The majority of respondents (i.e. heads of households) were between 26 and 55 years old (82%). There were slightly more female than male participants (56% vs. 44%). Most were Muslim (79%) and a large part of the participants were internally displaced persons (77%). More than three-quarters of the people surveyed were married and mostly under a monogamous regime. In addition, only 0.7% of respondents were single. **(1)**

Sexe	Féminin	254	56%
	Masculin	200	44%
Age	5-11 ans	1	0
	12-18 ans	5	1%
	19-25 ans	22	5%
	26-35 ans	135	30%
	36-45 ans	131	29%
	46-55 ans	104	23%
	56-65 ans	40	9%
	> 65 ans	16	4%
State	Desplaced	349	77%
	Host	91	20%
	Retourned	14	3%

References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

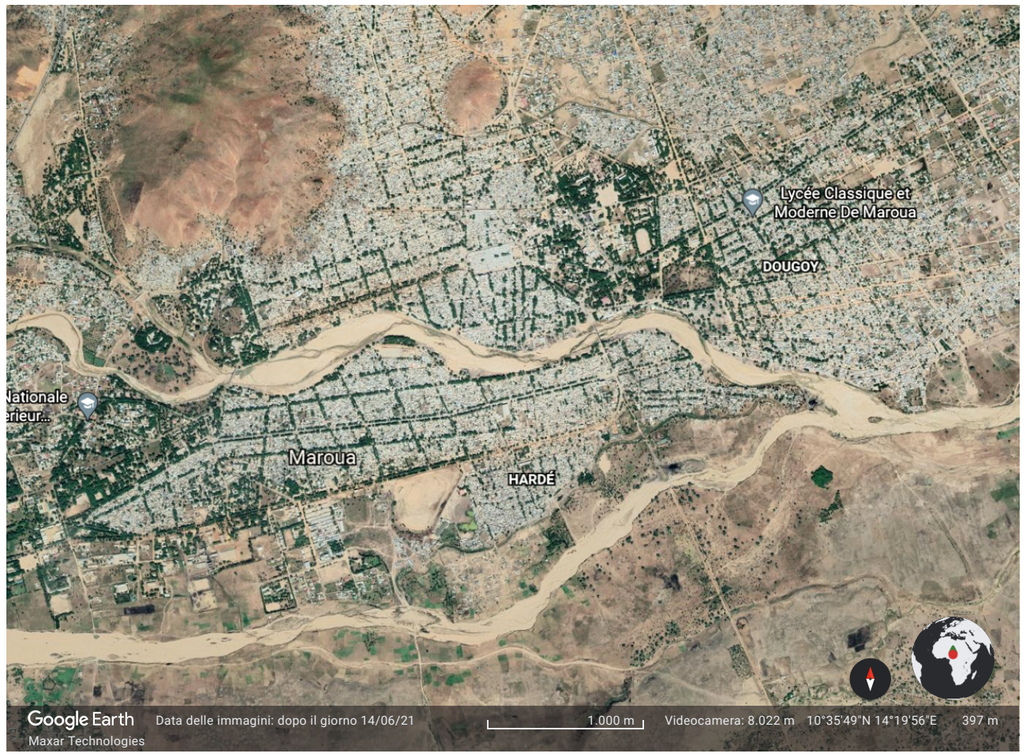
It is important to highlight that the communities surveyed in the VCA are characterized by being close to bodies of water such as rivers, which flood in periods of rain, exposing people to disaster risks and increasing infectious diseases in children

Kourgui

https://earth.google.com/web/search/MAYO+SAVA/@11.08493018,14.111163,418.51640137a,2393.43961883d,35y,12.0253271h,8.41737153t,0r/data=CigiJgokCWojA_o_Mi5AEVS5pX8HCSpAGc7__L... 1/1

References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

Maroua



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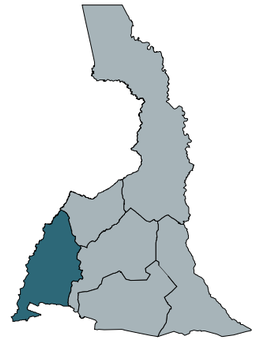
References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

6.1.2 DISTRIBUTION OF HOUSEHOLD SIZE

MAYO-SAVA

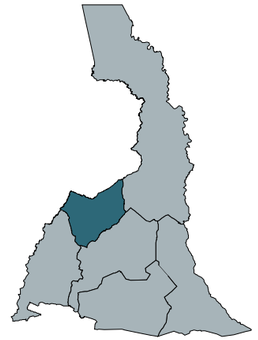
Among the Mayo-Sava respondents there was a wide variety of household sizes, from 2 to 19 members. Half of the households have between 5 and 8 members. The average household size is 8 and the median is 7 members. 87% of households have at least 3 children. The most common are households with 5 (20%), 4 (17%), or 3 children (13%). **(1)**



Location in the Region

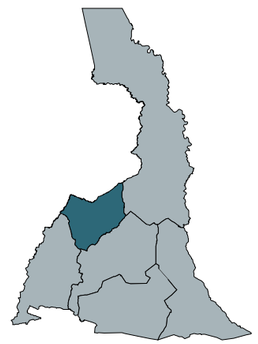
MAYO-TSANAGA

Among Mayo-Tsanaga respondents, household sizes also vary from 2 to 19 members. 47% of households have between 5 and 8 members. The average household size is 7.6 and the median is 7 members. 65% of households have 2 to 6 children, and 30% have more than 6 children. **(1)**



DIAMARÉ

Among the Diamaré respondents, households of 6 to 8 people are the most frequent, which represent 45% of households. The average household size is 7.6 and the median is 7 members. 13% of households have a pregnant woman and 20% a breastfeeding woman. A large proportion of households have more than 5 children, notably 44%. **(1)**



References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

6.1.3 LIVELIHOOD

For the displaced households, the main economic activities did not change much between before and after the displacement, with agriculture in the lead, then trade, and herding.

However, the proportion of the displaced population without activity before and after the displacement increased sharply from 1.9% to 9.1%. **(1)**

When asked about how many people in the household have income, 63% of households said that there was only one person receiving income. For 27% of households, two people have an income, and for 7% three people, and only 2.4% of households have four or more income. **(1)**

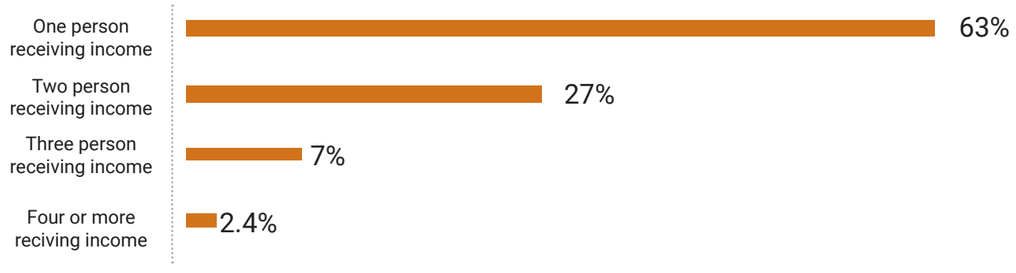
After the displacement and due to the deterioration of their situations, especially economic ones, many displaced people resorted to often harmful adaptation strategies:

-57% of them notably reduced the size of the meals or replaced certain foods with cheaper ones (56%). **(1)**

-Almost 28% of them have sacrificed adult meals for the benefit of children with a high number who go entire days without eating. **(1)**

-14% of the households reduced non-food expenses such as health and education. **(1)**

People in the household receiving income



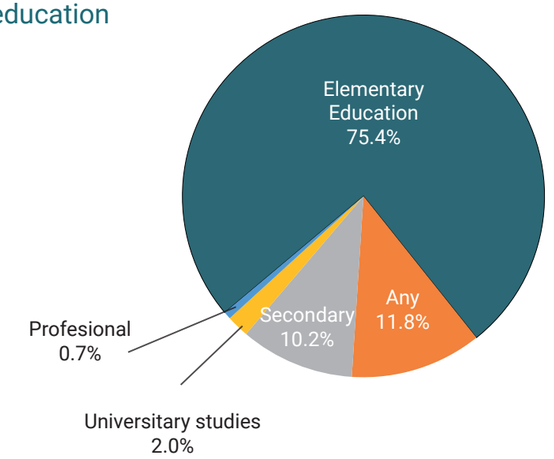
References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

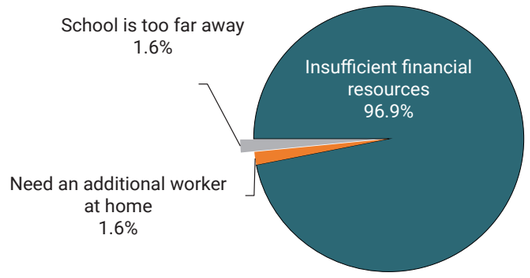
6.1.4 EDUCATION

There are several gaps in the education profile of the people
According to the data collected, The level of education of households is 75.4% limited to primary education, the 10.2% has reached the level of secondary education and only the 2% the level of university studies. 11.8% of the population has not received any education. **(1)**

The main reason mentioned why some children do not go to school is insufficient means (96.9%), while for 1.6% the reason is the distance to the nearest school too high or the need for an additional worker at 1.6%. **(1)**

Proportion of households by level of education





One of the difficulties faced by the displaced as a result of displacement is the loss of administrative documents, including birth certificates. The birth certificate is a document very often required for the enrollment of children in school. About 38.8% of children do not have birth certificates. Among the reasons mentioned for the absence of birth certificates, 51% are directly linked to the displacement (fire during an incursion of armed groups at 31.4%, lost during the flight or displacement at 19.6%) **(1)**

(Source: UN Photo/Eskinder Debebe) https://www.crisisgroup.org/africa/central-africa/cameroon/cameroon-confronting-boko-haram

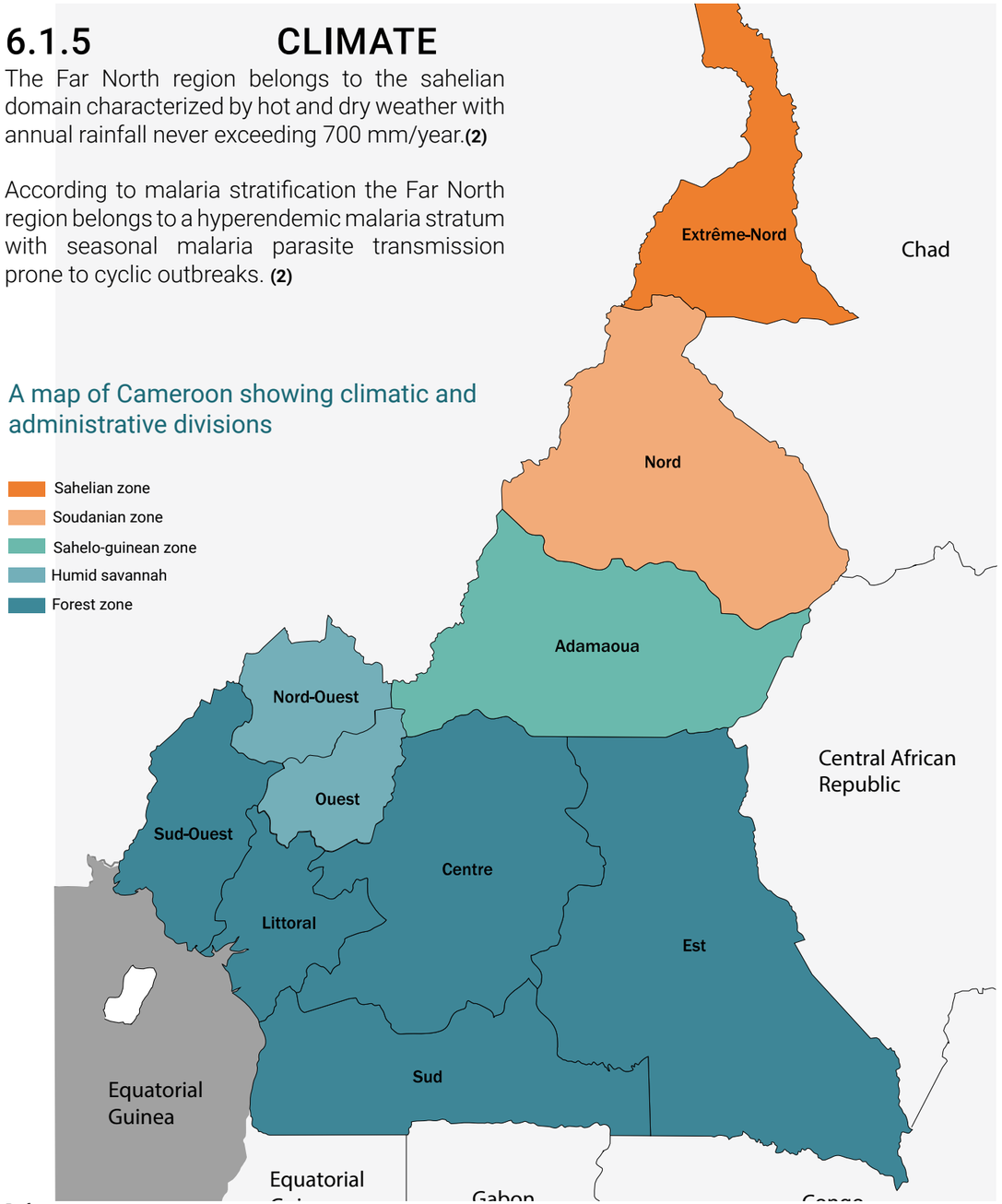
References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

6.1.5 CLIMATE

The Far North region belongs to the sahelian domain characterized by hot and dry weather with annual rainfall never exceeding 700 mm/year.**(2)**

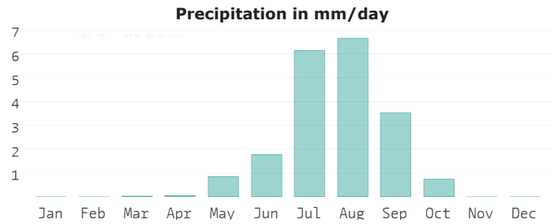
According to malaria stratification the Far North region belongs to a hyperendemic malaria stratum with seasonal malaria parasite transmission prone to cyclic outbreaks. **(2)**

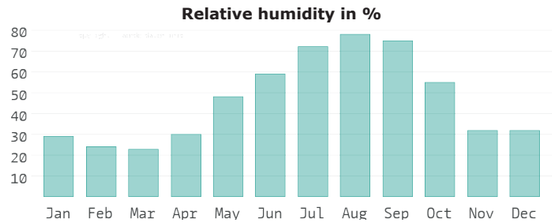
A map of Cameroon showing climatic and administrative divisions

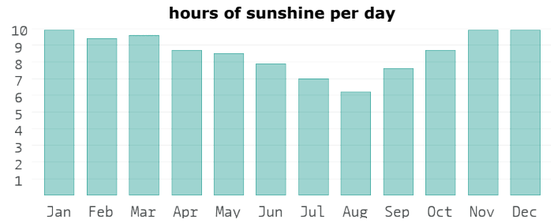


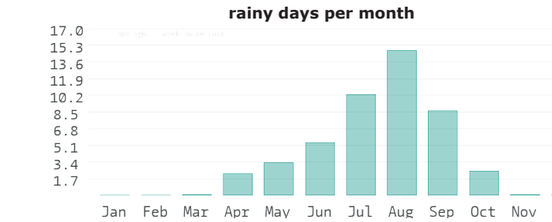
References:
(2) Antonio-Nkondjio, C., Ndo, C., Njiokou, F., Bigoga, J. D., Awono-Ambene, P., Etang, J., Ekobo, A. S., & Wondji, C. S. (2019). Review of malaria situation in Cameroon: technical viewpoint on challenges and prospects for disease elimination. Parasites & vectors, 12(1), 501. https://doi.org/10.1186/s13071-019-3753-8

The frequency of heavy precipitation events in the Far north region contributes to increases in severe flooding events, causing several damages and exposing people life. In addition to the immediate health hazards related with extreme precipitation events when flooding occurs, other hazards can often appear after it.









The bridge connecting Maroua to Mora collapsed (Far North) after heavy rains in 2020. **(4)**

References:
(3) World Data, Climate in Far North Cameroon, 2021
(4) World H24, CAMEROON: The bridge connecting Maroua to Mora has collapsed (Far North), 08- 2020

6.2 PRIORITY NEEDS

The main tools used during the evaluation where: focus group discussions (FGDs), semi-structured interviews with key informants, direct observation, a household survey, historical profile of the community, seasonal calendar, study of secondary and primary sources, and walking transverse.

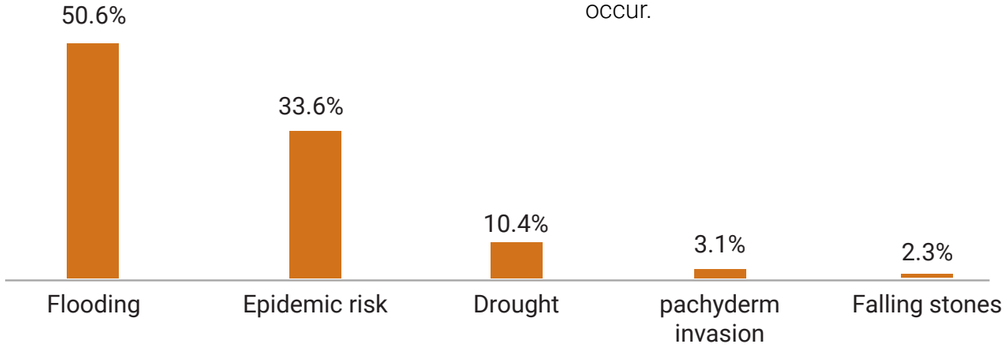
The clear priority need expressed by 83% of those consulted is food assistance, followed by health (79%) and shelter (64%). **(1)**

The conditions in which these people live put the most vulnerable populations such as children and the elderly at health risk. The epidemiological risk is due to the lack of health infrastructure and access to sanitary and hygienic services, it is common for outbreaks of vector and water-borne diseases to occur within the community.

Source: https://www.afrik21.africa/en/cameroon-concern-over-increased-flooding/

6.2.1 TYPOLOGY OF MOST FREQUENT DISASTER RISKS

Flood risk also high, is the most frequent disaster risk in the community. Due to poor conditions of the houses and because many of them are near rivers there is a high vulnerability to it. Floods are directly related to health risks, especially in places where the sanitary infrastructure is so precarious. Outbreaks of diarrhea, cholera and malaria increase when these types of events occur.



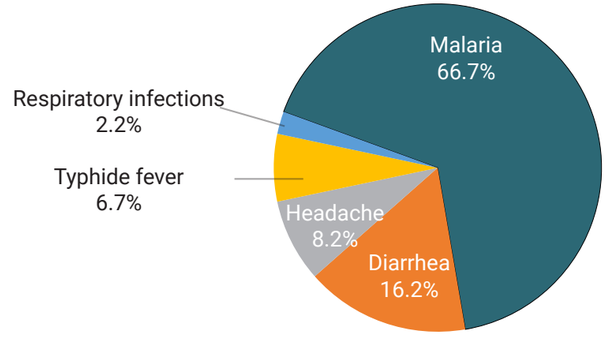
References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

For more than 50%, floods are the greatest risk, followed by the risk of epidemics at 33% Through the household survey as well as the mapping exercises, it was observed that in the vast majority of cases (92.6% of the people questioned), the areas most at risk are identified as being the areas close to mayo (name given to rivers and streams in the Far North region). Finally, when asked about the existence of early warning systems in the different areas of the study, 96.9% of respondents said they did not know if these systems exist. **(1)**

6. 2. 2. EPIDEMIC RISK

The most common disease in the community is malaria (80%). The built environment determines an important factor for outbreaks of vector borne diseases.

Multiple studies have showed that the characteristics of the materials, shape and openings of the houses in the amount of mosquitoes that can enter. Also the water and waste management is key to the prevention of epidemics.



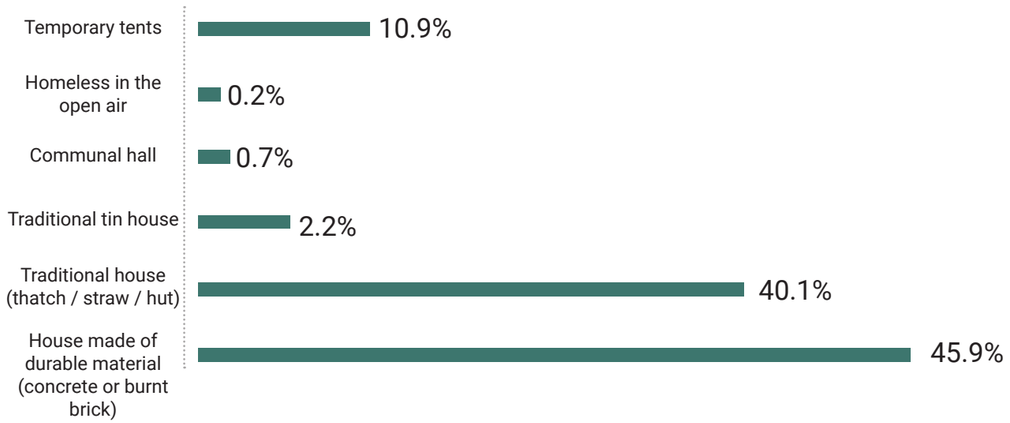
References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

6.2.3 DISTRIBUTION OF HOUSEHOLDS BY TYPE OF HOUSING

By type of dwelling, the majority of households live in a house made of durable material (cement, concrete blocks, sheet metal) and a traditional house (thatch, straw, hut).

The dwellings have 2 rooms on average. The distribution of housing types is as follows: 45.9% of households surveyed are housed in houses made of durable material (cement, breeze blocks, sheet metal), 40.1% are housed in traditional houses (thatch, straw, box) against 10.9% in temporary tents, 2.2% traditional tin house, 0.7% in common rooms (classrooms or other) and 0.2% are without shelter in the open air. **(1)**

This results show the vulnerability of contracting Malaria in dwelling. several studies already discussed has shown that the use of thatch, straw and mud can increase the incidence of mosquito in bedrooms.

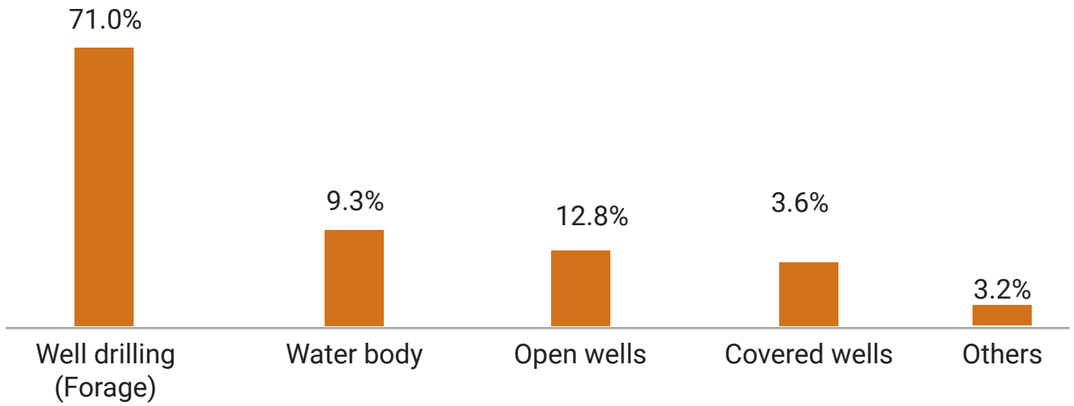


References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

6.2.4 WATER SUPPLY SOURCE

Regarding the source of water supply, the vast majority 71.0% of households use boreholes as a source of water. It should nevertheless be noted that some households use open wells 12.8%, rivers or lakes 9.3%, covered wells 3.6% and others 3.2% in a small proportion . **(1)**

Among the households surveyed, 63.2% of them are located less than 500m from the water point, 21% are located 1km from the water point and 15.1% are located more than 1km from the water point. water for their water supply. The vast majority of those who are more than 1km came from the locality of Gaboua in MayoTsanaga. **(1)**



Less than 500 m	285	63.2%
1 km	98	21.7%
more than 1km	6	15.1%
Total	451	100%

References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

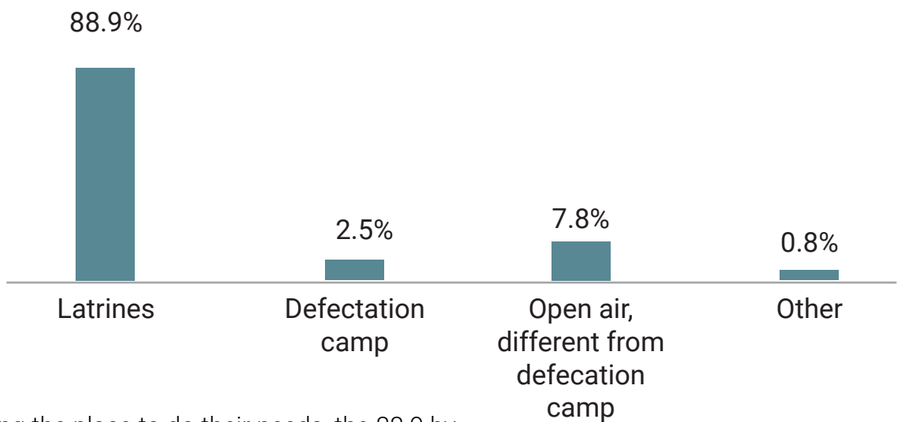
Regarding water treatment, 73.2% are not used to treating water before drinking it. This percentage is notably higher among people who mentioned diarrhea as one of the common illnesses.

When asked about the methods used to transport water, 53.1% of respondents expressed that they used an open container, which does not promote transport or storage in optimal hygienic conditions. 32% said they used a narrow container, reducing the risk of contamination, 10.4% a can, and 2.3% a water bottle. **(1)**

Source: https://reliefweb.int/report/cameroon/hunger-and-fear-stalk-survivors-attack-north-cameroon

6.2.5 SANITATION PRACTICES

The lack of sanitary infrastructure forces the community to use latrines or practice open defecation, putting their health and well-being at risk.



Regarding the place to do their needs, the 88.9 by the households use latrines, the 7.8 use open air places, 2.5% defecation camps and 0.8% others.

References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

6.2.6 TYPES OF LATRINES USED

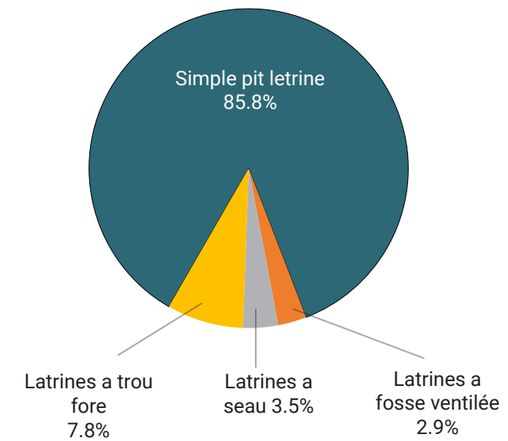
Different types of latrines are used by the community,

Among them, it should be noted that most of the households use simple pit letrine (85.8)%. Even if it is in a small proportion (7.8%) use pit latrines without a slab/open hole, being dangerously exposed to health risks. The 3.5% bucket latrine and only the 2.9 uses ventialted latrines. **(1)**

Pit latrines generally lack a physical barrier, such as concrete, between stored excreta and soil and/or groundwater (van Ryneveld and Fourie 1997).

Accordingly, contaminants from pit-latrine excreta may potentially leach into groundwater, thereby threatening human health through well-water contamination.

Taking in account the fact that the 71.0% of the households recolect water from the ground by well drillying system, it can be said that the use of latrines in the area exposes the population to a high risk of contracting Water borne diseases.



References:
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6.3 RESULTS FROM THE ASSESMENT

Due to the lack of infrastructure, the most vulnerable surveyed departments to floods and health risks are Mayo Tsava and Mayo Tsanaga.

As reported by the VCA **(1)**, in Mayo-Sava and in areas selected from Mayo-Tsanaga, the majority of the populations:

1. live in traditional dwellings or tents (particularly displaced populations)

2. do not always have access to latrines, with a significant proportion who practice open defecation.

3. The main activity of the people is agriculture, and many women especially have no economic activity.

4. In some of localities, particularly in Mayo-Tsanaga, access to handwashing facilities is not easy and something common, however especially in IDP camps, knowledge about the need to treat water is widespread.

5. Diarrhoea, like malaria, remains a common disease, especially among households not practicing water treatment.

In addition, the impact they have on the infrastructure of the communities generates a greater risk of outbreaks of diseases related to hygiene and sanitation.

It is also important to say that floods have another social impact on people's lives, generating consequences on education and household income.

6.3.1 SEASONAL CALENDAR

Although the seasonal calendar was not published in the IFRC report, an attempt was made to develop one taking into account the information acquired. Taking into account the months of the year in which there is more rain per day, it was possible to reach the conclusion that the floods occur in the months of June, July, August and September.

References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

Categories	Months											
	Dic	Jen	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Socio-Conditions												
- Low/High Income					X	X	**X**	**X**	**X**	**X**	X	
Immigration (migration)	X	X	X	X	X	X	**X**	**X**	**X**	**X**	X	X
Social Conditions												
- Children Out ofschool							X	X	X	X		
Environment												
- Rainfall period					X	X	**X**	**X**	**X**	**X**	X	
- Drought period	**X**	**X**	**X**								**X**	**X**
Health												
-Water borne diseases	X	X	X	X	X	X	**X**	**X**	**X**	**X**	X	X
- Air borne diseases	X	X	X	X	X	X	**X**	**X**	**X**	**X**	X	X
-Malaria outbreak	X	X	X	X	X	X	**X**	**X**	**X**	**X**	X	X
Natural Hazard												
- Flood					X	X	**X**	**X**	**X**	**X**	X	

6.3.2 RANKING METHOD

The ranking method is useful for summarize the main problems affecting the project site, classifying from the most impacting.

As reported before, flood is the most frequent As previously reported, floods are the most frequent hazard in the surveyed sites, followed by epidemics. These generate serious consequences in the community, affecting their way of life, economic income, access to education and loss of life.

Hazard	Frequency	Rank
Flood	**X**	1
Vector Borne Diseases	X	2
Water Borne Diseaes	X	3

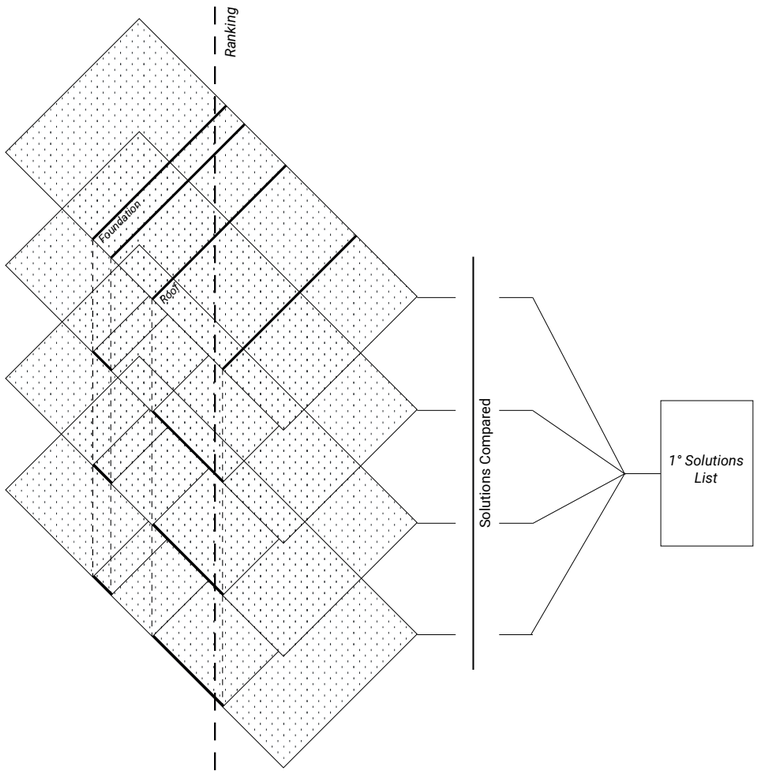
References:
(1) Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

6.4 SOLUTIONS COMPARED METHOD

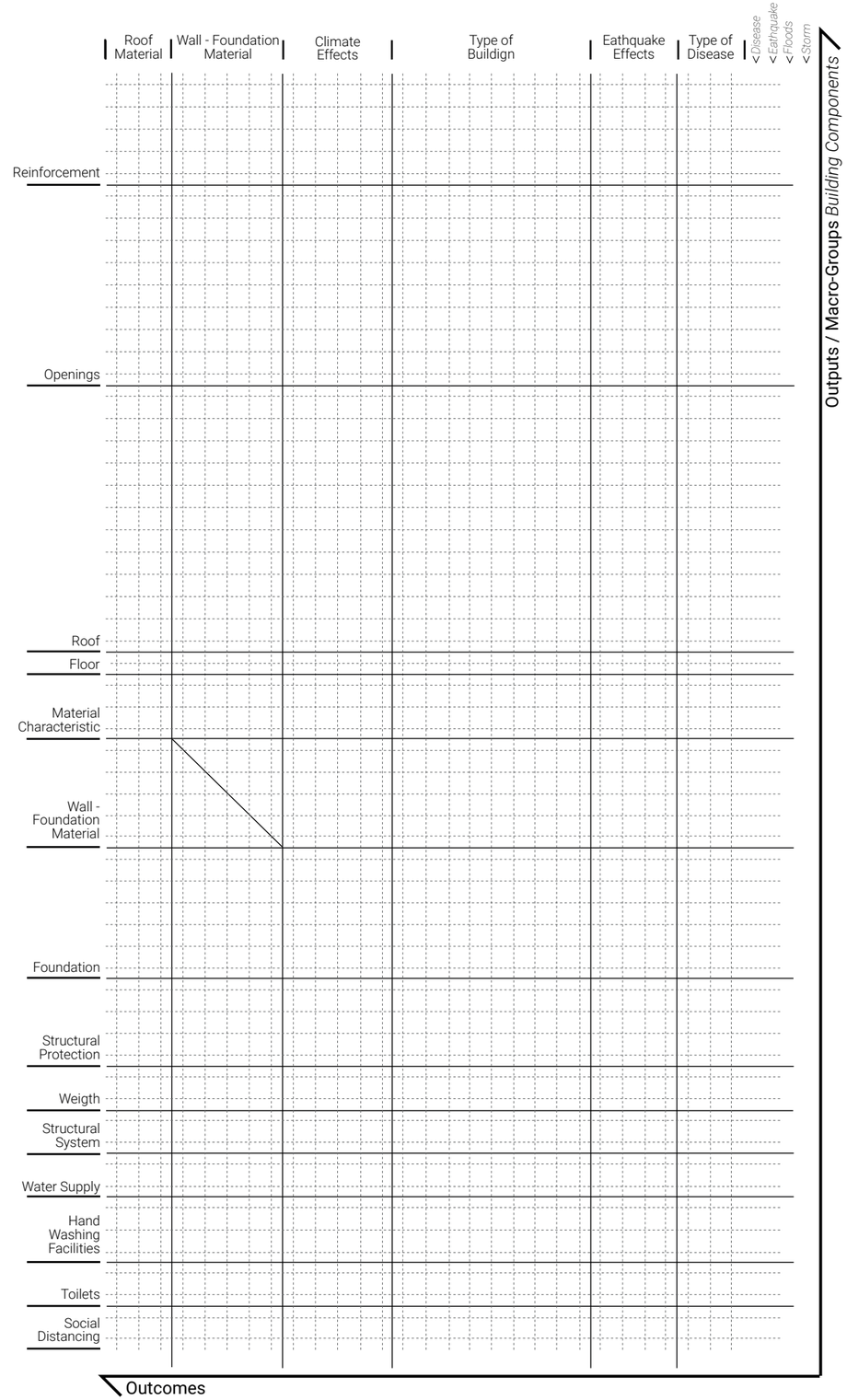
The identification of the most frequent danger and of the single outcomes support the development of the second method (Solutions compared) which consists in comparing the possible solutions, according to the outputs of each single selected matrix, and to the prevalence of a matrix over the other (see explanation in the previous chapter).

To make the solutions compared method easier to understand, it is developed below a graphic example divided into steps:
• The first step is to watch on the single matrices, from which to derive lists of solutions specifics of each problem

• The second step consists in comparing the solutions of each macro-group, identifying the one that best suits the context, with the aim of developing the first list of solutions.



THE 2D SPACE



Outcomes (simbols)

- [1] Safe Learning Facilieties
- [2] Physical Protection
- [3] Educational Program
- [4] School Type
- [5] Social Minorities Access
- [6] Level Education Access
- [7] Dimension for Access

Outputs (colors)

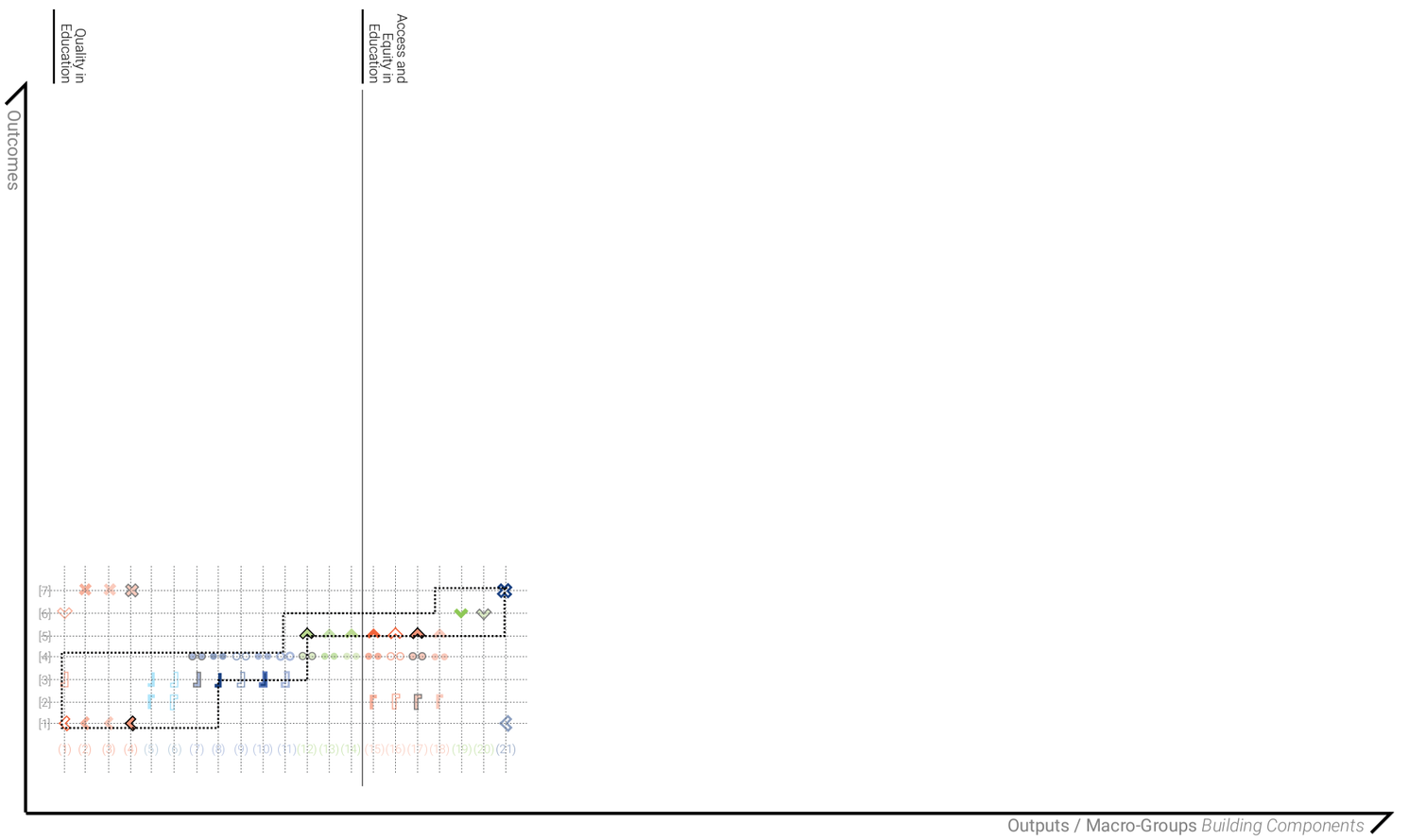
Quality in Education

- (1) *Safe Site Location*
- (2) *Hazards Matrix*
- (3) *Technological Matrix*
- (4) *Water, Sanitation, Hygiene Facilities*
- (5) *Boundary Wall*
- (6) *Dormitory on site*
- (7) *Temporary Learning Space*
- (8) *Flexible Learning Envirnmenal*
- (9) *Mobile School*
- (10) *Permanent School*
- (11) *Open Air School*
- (12) *School Inclusion*
- (13) *School Segregation*
- (14) *School Integration*

Access and Equity in Education

- (15) *Providing Girl Education*
- (16) *Education for Rural-Urban*
- (17) *Education for IDP and Refugees*
- (18) *Education for Disabled*
- (19) *Built for all level*
- (19) *School Proximity*
- (21) *Appropriate School Dimension*

EDUCATIONAL MATRIX



Outcomes (simbols)

Type of Disease
- [1] Vector Borne Disease
- [2] Air Borne Disease
- [3] Water Borne Disease

Eathquake Effect
- [4] Tsunami
- [5] Landslide
- [6] Soil liquification
- [7] Ground motion

Type of Building
- [8] Earthen Building
- [9] Stone Building
- [10] Masonry Building
- [11] Wet-proofed Building
- [12] Dry-proofed Building
- [13] Elevated Static Building
- [14] Amphibious Building
- [15] Pile Building
- [16] Floating Building

Ventilation, Wind
- [17] Maximize
- [18] Minimize

Solar Radiation, Sun
- [19] Maximize
- [20] Minimize

Humidity, Rain
- [21] Protection

Foundation/Wall Materials
- [22] Fired Brick
- [23] Concrete/ Concrete Brick
- [24] Mud Brick
- [25] Adobe Brick
- [26] Wood and Mud

Roof Materials
- [27] Steel (Iron sheet)
- [28] Timber (Wood)
- [29] Bamboo

Outputs (colors)

Social Distancing
- (1) *Desk-Chair spacing*
- (2) *Open and adapted space*

Toilets
- (3) *Disaster-resilient toilet*
- (4) *Waste management*

Hand Washing Facilities
- (5) *Location close to the toilet*
- (6) *Materials*
- (7) *Accessibility to everyone*

Water Supply
- (8) *Ground catchment System*
- (9) *Rain Water catchment system*

Structural System
- (10) *Frame*
- (11) *Bearing wall*

Weigth
- (12) *Heavy*
- (13) *Ligth*

Structural protection
- (14) *Screening Doors*
- (15) *Screening Eaves*
- (16) *Screening windows*
- (17) *Screening Nets*
- (18) *Boundary wall*
- (19) *Set-back*
- (20) *Fences*

Foundation
Static
- (21) *Two store building*
- (22) *Pile Foundation*
- (23) *Strip wall*
- (24) *Mat*
- (25) *Base isolation*
- (26) *Basement (h <1m)*
- (27) *Sub-floor void (h: >1m)*

Kinetic
- (28) *Buouyancy*

Material Characteristics
- (29) *Water-resistance*
- (30) *Carbon footprint*
- (31) *Maintenance*

Floor
- (32) *Raising*

Roof
Ceiling Height
- (33) *Higher*
- (34) *Lower*

Roof Overhang
- (35) *Decrease*
- (36) *Increase*
- (37) *max 500 mm*
- (38) *Use ties*

Roof Shape
- (39) *Slope (min 20°-30°)*
- (40) *Slope (22-30°/45°)*
- (41) *Hipped*
- (42) *Pyramidal*
- (43) *Conical*

Roof Weigth
- (44) *Light*
- (45) *Heavy*

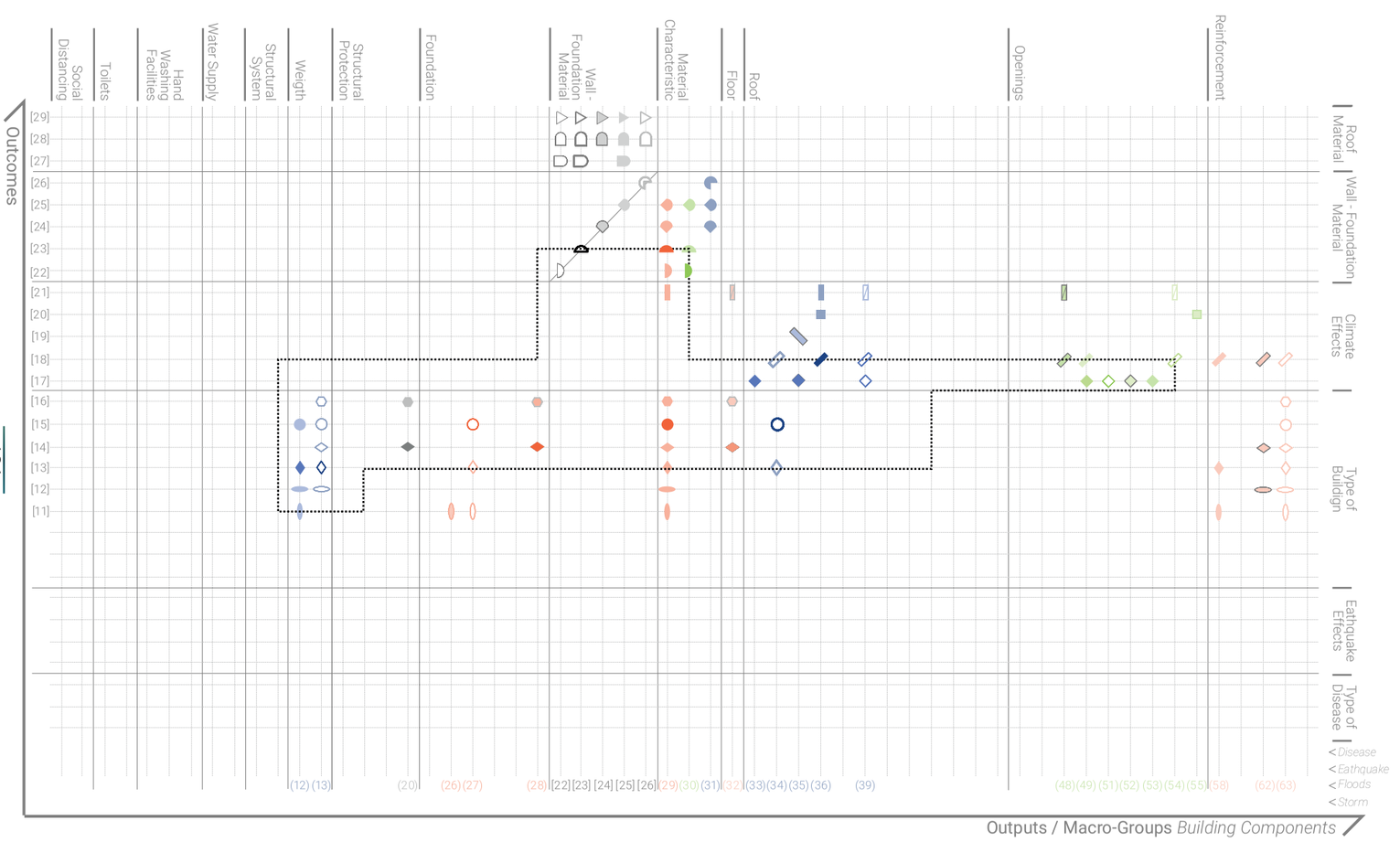
Openings
Type of ventilation
- (46) *Mechanical ventilation*
- (47) *Natural Ventilation*

Position
- (48) *Outward opening*
- (49) *Symmetrical (Max 20% of wall)*
- (50) *At same heights*
- (51) *Upper*
- (52) *Adjacent*
- (53) *At different heights*
- (54) *Elements of Protection*
- (55) Shading *Elements*

Reinforcement
Horizontal
- (56) *Ring beams*
- (57) *Collar bands*
- (58) *Mooring system*

Vertical
- (59) *Wire mesh*
- (60) *Wood post*
- (61) *Steel bar*
- (62) *Super-structural*
- (63) *Sub-structural*

FLOODING MATRIX



Outcomes (simbols)

Type of Disease
- [1] Vector Borne Disease
- [2] Air Borne Disease
- [3] Water Borne Disease

Eathquake Effect
- [4] Tsunami
- [5] Landslide
- [6] Soil liquification
- [7] Ground motion

Type of Building
- [8] Earthen Building
- [9] Stone Building
- [10] Masonry Building
- [11] Wet-proofed Building
- [12] Dry-proofed Building
- [13] Elevated Static Building
- [14] Amphibious Building
- [15] Pile Building
- [16] Floating Building

Ventilation, Wind
- [17] Maximize
- [18] Minimize

Solar Radiation, Sun
- [19] Maximize
- [20] Minimize

Humidity, Rain
- [21] Protection

Foundation/Wall Materials
- [22] Fired Brick
- [23] Concrete/ Concrete Brick
- [24] Mud Brick
- [25] Adobe Brick
- [26] Wood and Mud

Roof Materials
- [27] Steel (Iron sheet)
- [28] Timber (Wood)
- [29] Bamboo

Outputs (colors)

Social Distancing
- (1) *Desk-Chair spacing*
- (2) *Open and adapted space*

Toilets
- (3) *Disaster-resilient toilet*
- (4) *Waste management*

Hand Washing Facilities
- (5) *Location close to the toilet*
- (6) *Materials*
- (7) *Accessibility to everyone*

Water Supply
- (8) *Ground catchment System*
- (9) *Rain Water catchment system*

Structural System
- (10) *Frame*
- (11) *Bearing wall*

Weigth
- (12) *Heavy*
- (13) *Ligth*

Structural protection
- (14) *Screening Doors*
- (15) *Screening Eaves*
- (16) *Screening windows*
- (17) *Screening Nets*
- (18) *Boundary wall*
- (19) *Set-back*
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- (25) *Base isolation*
- (26) *Basement (h <1m)*
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Kinetic
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Material Characteristics
- (29) *Water-resistance*
- (30) *Carbon footprint*
- (31) *Maintenance*

Floor
- (32) *Raising*

Roof
Ceiling Height
- (33) *Higher*
- (34) *Lower*

Roof Overhang
- (35) *Decrease*
- (36) *Increase*
- (37) *max 500 mm*
- (38) *Use ties*

Roof Shape
- (39) *Slope (min 20°-30°)*
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- (43) *Conical*

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Openings
Type of ventilation
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- (49) *Symmetrical (Max 20% of wall)*
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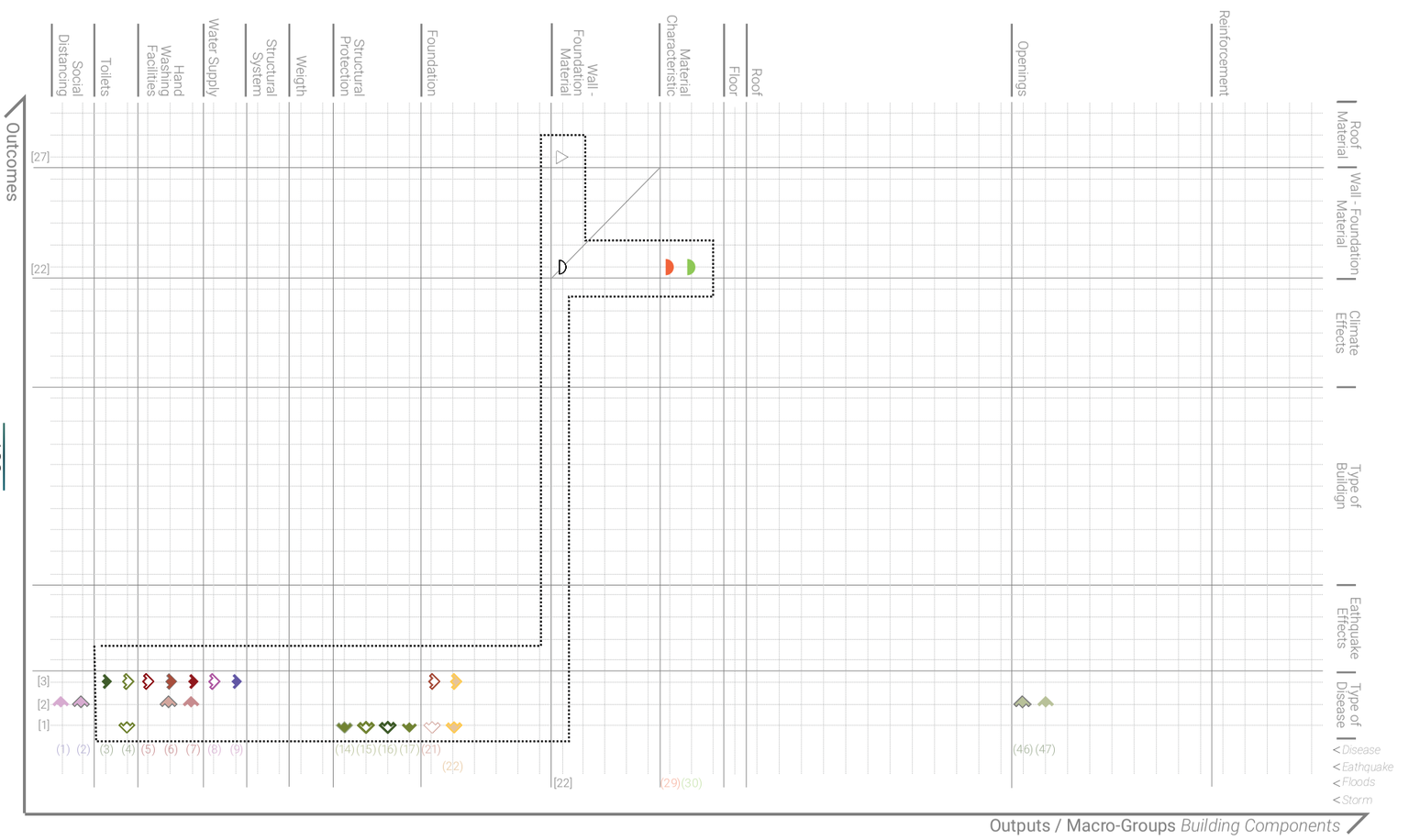
- (55) Shading *Elements*

Reinforcement
Horizontal
- (56) *Ring beams*
- (57) *Collar bands*
- (58) *Mooring system*

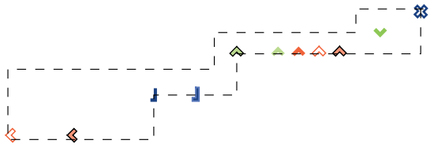
Vertical
- (59) *Wire mesh*
- (60) *Wood post*
- (61) *Steel bar*
- (62) *Super-structural*
- (63) *Sub-structural*

DISEASES MATRIX

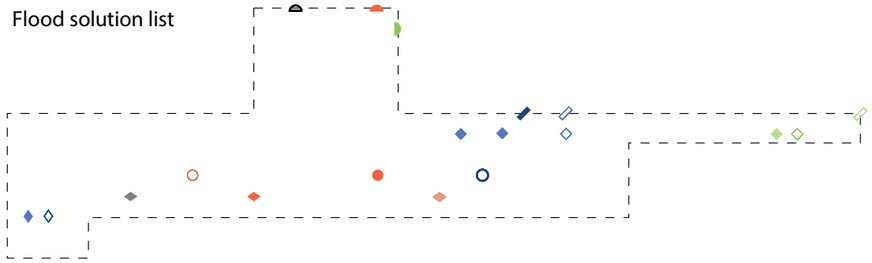


6.4 SOLUTIONS COMPARED METHOD

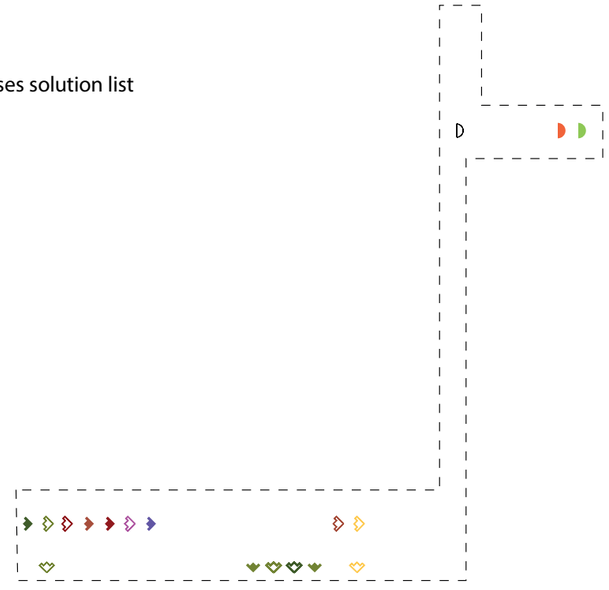
Education solution list



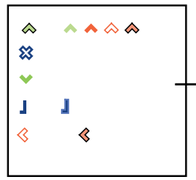
Flood solution list



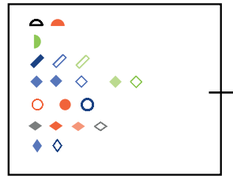
Diseases solution list



Education solution list



Flood solution list



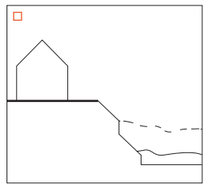
Diseases solution list

MATRIX TYPE	OUTCOMES	OUTPUTS	MACRO-GROUPS
Educational Resilience - Resistance Matrix	[1]	(1) (4)	Quality in Education
	[3]	(8) (10)	
	[5]	(12) (14)	Access and Equity in Education
		(15) (16) (17)	
	[6]	(19)	
	[7]	(21)	
Hazards Matrix (Flood - Storm - Eathquake - Disease)	[1]	(4)	Toilets
	[3]	(3) (4)	
		(7) (5) (6)	Hand Washing Facilities
		(8)	Water Supply
	[13]	(13)	Weigth
	[1]	(14) (16) (15)	Structural protection
	[13]	(20)	
		(22)	Foundation
	[1]	[22]	Wall materials
		[23]	
	[22]	(29) (31)	Material Characteristics
	[23]	(31)	
	[13]	(32)	Floor
		(33)	Roof
	[17]	(35) (38)	
		(40) (41) (45)	
	[19]	(35) (45)	
	[21]	(39) (41)	
	[17]	(51) (49) (50)	Openings
	[21]	(48) (54)	
	[13]	(56) (61)	Reinforcement

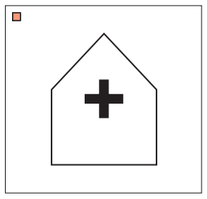
6.4.1 FIRST SOLUTIONS LIST

The first solution list, allows you to give a global view of the needs of the learning facilities. This is a guide that has the objective to respond to certain risks of the place through architectural strategies, divided into macro-groups groups such as structure, roof, materials, WASH, etc. All this in order to reach a solution for a sustainable and disaster-resilient learning facility. In the specific case of the communities analyzed, a building that can respond to flooding and reduces the risk of spreading diseases.

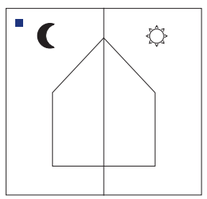
Quality in education



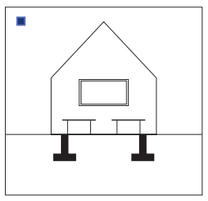
(1) Safe site



(4) Water, sanitation, hygiene facilities

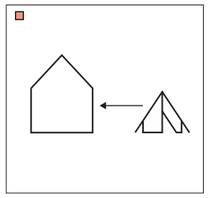


(8) Flexible learning space

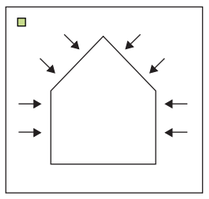


(10) Permanent school

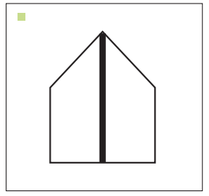
Access and equity



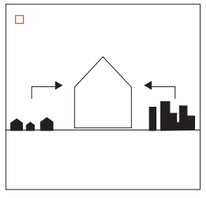
(17) Education for IDP and



(12) School inclusion



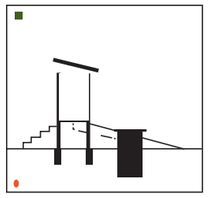
(14) School integration



(16) education for rural-urban

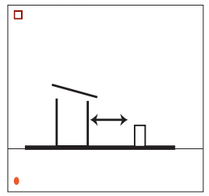
(19) Built for all level

Toilet



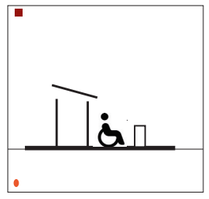
(3) Disaster resilient toilets

Hand washing facilites



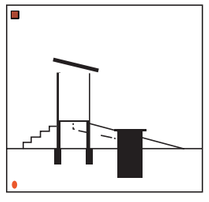
(5) Hand washing facilities

location close to the toilet



(7) Hand washing facilities

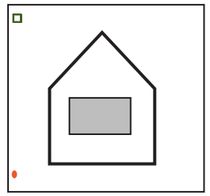
Accesibility



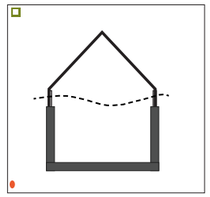
(6) Hand washing facilities

recommended materials

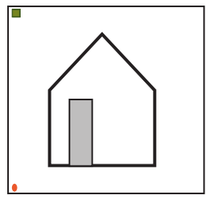
Vector protection



(16) Screening windows

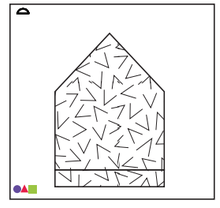


(14) Screening eaves

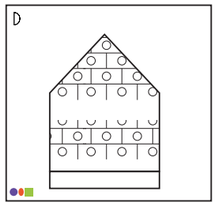


(15) Screening doors

Wall materials

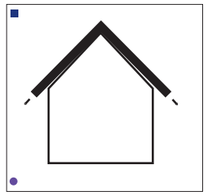


(23) Concrete

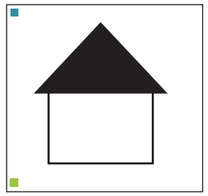


(22) Fired bricks

Roof



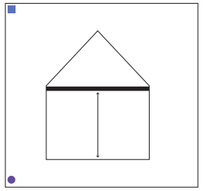
(35) Decrease roof overhang



(41) Hipped

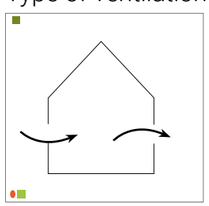
(27) Steel (iron sheet) material

Ceiling



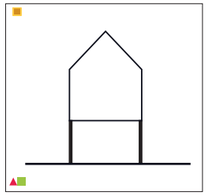
(33) increase ceiling height

Type of ventilation



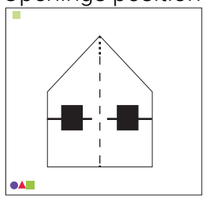
(47) Natural ventilation

Foundation

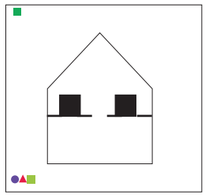


(22) Pile Foundation

Openings position

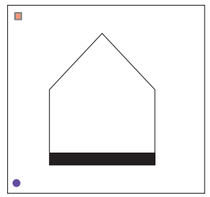


(49) Simetrical



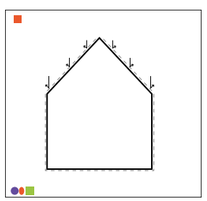
(50) At the same heights

Floor



(32) Raising

Material characteristics



(29) Water resistance

6.4.2 THE FINAL SOLUTION LIST

To make the tool work it is necessary to confront the global answers to the local answers taking in consideration the coping capacities of the community.

To do this, it is necessary to reorganize the information and define how the local people can contribute to the project development in terms of technologies and local knowledge. After, there will be another the final solution list with the strategies for constructing a safe learning building in a specific place.

However, even though the VCA contributed to have a general overview of the community, to make the tool work it is necessary to have more specific information about the local capacities of the local people.

7. CONCLUSION

In conclusion, there are multiple factors that influence children access to education, this occurs mainly in developing countries. Some of these factors are: conflict, natural disasters, access to WASH services and epidemics.

However, one way to contribute to the problem from architecture is to develop a design tool “the matrix tool”. which will be applied to educational buildings allowing a better design decision process in contexts of scarcity.
it will help to develop safer projects for educational activites, in areas of high risk and vulnerability to different hazards..

This tool gathers information on resilient construction against different types of disasters: floods, epidemics, earthquakes and storms. Through this and by working with local people, it is possible to reduce the vulnerabilities and risks that most affect children and families.

The methodology works based on the investigation of the conditions of the work area. Understanding climatic, social, economic, and environmental factors that give a guideline to understand the needs of the place and thus respond not only to one type of requirement but to multiple ones, in a complex and multidimensional way.

Also, the vulnerability and capacity assessment, is a fundamental part of the process, this methodology provides general information and the dangers to which the community is exposed, considering factors such as: who is affected, the frequency and the impact. With this information, the starting parameters of the process can be established, which applied in the matrix, give a response in certain results. Among these are the type of structure, materials, shape, openings, foundation typologies among others.

In addition, the matrix tool can be adapted and used taking into account the capacities of people, thus strengthening it with resources from the places where it is implemented, in a sustainable and efficient manner.

8. BIBLIOGRAPHY

CONCERNUNSA(2020) Olivia Giovetti, HOW DOES EDUCATION AFFECT POVERTY? IT CAN HELP END IT, 2020

UNESCO(2017), UNESCO's Global Education Monitoring (GEM) report, 2017.

UNITED NATION. (2020, 01 01). OBJETIVO DE DESAROLLO SOSTENIBLE. Tratto da https://www.un.org/sustainabledevelopment/es/inequality/

The Climate Crisis is a Child Rights Crisis:: Introducing the Children's Climate Risk Index. New York: United Nations Children's Fund (UNICEF), 2021.

United Nations. (2017, september 18). United nations. Conflict keeps 27 million children out of school, with girls at high risk of abuse – UN report

In the context of this study, conflict refers to violent conflict, including civil and interstate wars and armed rebellions. This definition is used in the World Bank publication by Buckland (2005)

UNICEF. (2020). UNICEF. Tratto da Education under attack: https://www.unicef.org/education-under-attack#:~:text=For%20children%20living%20in%20conflict,per%20cent%20compared%20to%202019.

UNESCO, Institute of stadistics. (2010). The quantitative impact of conflict on education

Their world. (07, 02, 2020). theirworld. 20 reasons why, in 2020, there are still 260m children out of school: https://theirworld.org/news/20-reasons-why-260m-children-are-out-of-school-in-2020.

World Health Organization. (13, 08, 2020). WHO. 2 in 5 schools around the world lacked basic handwashing facilities prior to COVID-19 pandemic — UNICEF, WHO: https://www.who.int/news/item/13-08-2020-2-in-5-schools-around-the-world-lacked-basic-handwashing-facilities-prior-to-covid-19-pandemic-unicef-who.

Progress on drinking water, sanitation and hygiene in schools: Special focus on COVID-19. New York: United Nations Children's Fund (UNICEF) and World Health Organization (WHO), 2020.

World Health Organization. (28, 01, 2022). WHO. Child mortality (under 5 years): https://www.who.int/news-room/fact-sheets/detail/levels-and-trends-in-child-under-5-mortality-in-2020

World Health Organization. (02, 03, 2020). Vector-borne diseases: https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases

Conroy, A.L., Datta, D. & John, C.C. What causes severe malaria and its complications in children? Lessons learned over the past 15 years. BMC Med 17, 52 (2019). https://doi.org/10.1186/s12916-019-1291-z.

Malaria control in schools.: Partnership for Child Development, London School of Hygiene and Tropical Medicine, Kenya Medical Research Institute-Wellcome Trust Research Programme, The World Bank; 2009.

World malaria report 2020: 20 years of global progress and challenges. Geneva:
World Health Organization; 2020. Licence: CC BY-NC-SA 3.0 IGO

World Health Organization. (02, 05, 2017). Diarrhoeal disease: https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease.

Brian Reed, Brian Skinner and Rod Shaw, WEDC.. The F diagram: https://wedc-knowledge.lboro.ac.uk/resources/posters/P004_The_F_Diagram.pdf.

State of the World's Toilets, WaterAid, 2007, based on data from WHO/UNICEF Joint Monitoring Programme.

Okullo, J. O., Moturi, W. N., & Ogendi, G. M. (2017). Open Defaecation and Its Effects on the Bacteriological Quality of Drinking Water Sources in Isiolo County, Kenya. Environmental health insights, 11, 1178630217735539. https://doi.org/10.1177/1178630217735539.

World Health Organization. (2020). Pneumonia: https://www.who.int/health-topics/pneumonia#tab=tab_1

World Health Organization. (02, 11, 2018). Influenza seasonal: https://www.who.int/news-room/fact-sheets/detail/influenza-(seasonal).

World Health Organization. (14, 10, 2021). Tuberculosis: https://www.who.int/news-room/fact-sheets/detail/tuberculosis .

World Health Organization. (12, 11, 2021). Worldwide measles deaths climb 50% from 2016 to 2019 claiming over 207 500 lives in 2019: https://www.who.int/news/item/12-11-2020-worldwide-measles-deaths-climb-50-from-2016-to-2019-claiming-over-207-500-lives-in-2019

UNICEF. (12, 11, 2021). Childhood diseases: https://www.unicef.org/health/childhood-diseases

UNICEF. (03, 03, 2021). COVID-19: Schools for more than 168 million children globally have been completely closed for almost a full year: https://www.unicef.org/rosa/press-releases/covid-19-schools-more-168-million-children-globally-have-been-completely-closed.

The World Bank, UNESCO and UNICEF (2021). The State of the Global Education Crisis: A Path to Recovery. Washington D.C., Paris, New York: The World Bank, UNESCO, and UNICEF.

.

Lindsay SW, Davies M, Alabaster G, Altamirano H, Jatta E, Jawara M, Carrasco-Tenezaca M, von Seidlein L, Shenton FC, Tusting LS, Wilson AL, Knudsen J. Recommendations for building out mosquito-transmitted diseases in sub-Saharan Africa: the DELIVER mnemonic. Philos Trans R Soc Lond B Biol Sci. 2021 Feb 15;376(1818):20190814. doi: 10.1098/rstb.2019.0814. Epub 2020 Dec 28. PMID: 33357059; PMCID: PMC7776930.

Snow WF. 1987. Studies of house-entering habits of mosquitoes in The Gambia, West Africa: experiments with prefabricated huts with varied wall apertures. Med. Vet. Entomol. 1, 9-21. (10.1111/j.1365-2915.1987.tb00318.x)

Lorenz von Seidlein, K. I. (08 de 2017). Affordable house designs to improve health in rural Africa: a field study from northeastern Tanzania:

Ondiba IM, Oyieke FA, Ong'amo GO, Olumula MM, Nyamongo IK, Estambale BBA (2018) Malaria vector abundance is associated with house structures in Baringo County, Kenya. PLoS ONE 13(6): e0198970. https://doi.org/10.1371/journal.pone.0198970

Paul Lewis, David J. Lewis and Marc Tsurumaki, in collaboration with Guy Nordenson, and supported in part by Princeton University Funding for Rapid, Novel and Actionable Covid-19 Research Projects. (23, 06, 2020). COVID-19: MANUAL OF SOCIAL DISTANCING: https://issuu.com/djlewis72/docs/200622_manualphysicaldistancing_draft

Bourouiba L. Turbulent Gas Clouds and Respiratory Pathogen Emissions: Potential Implications for Reducing Transmission of COVID-19. JAMA. 2020;323(18):1837–1838. doi:10.1001/jama.2020.4756.

Somsen GA, van Rijn C, Kooij S, Bem RA, Bonn D. Small droplet aerosols in poorly ventilated spaces and SARS-CoV-2 transmission. Lancet Respir Med 2020; published online May 27. https://doi.org/10.1016/S2213-2600(20)30245-9.

Handwashing Stations and Supplies for the COVID-19 response, UNICEF, World Health Organization; 2020. https://www.unicef.org/media/75706/file/Handwashing%20Facility%20Worksheet.pdf

World Health Organization. (19, 06, 2019). 1 in 3 people globally do not have access to safe drinking water: https://www.who.int/news/item/18-06-2019-1-in-3-people-globally-do-not-have-access-to-safe-drinking-water-unicef-who.

Development of a Disaster-Resilient Toilet: lessons from the States of Assam and Gujarat, India , UNICEF; 2020. https://www.unicef.org/rosa/media/11801/file

International Federation of Red Cross and Red Crescent Societies (2006), What is VCA? An introduction to vulnerability and capacity assessment, 2006. Available from: https://www.dsm-consulting.ch/images/imagesite/CBDRM/CBDRM_31.pdf

International Federation of Red Cross and Red Crescent Societies (2007), VCA toolbox with reference sheets, 2007. https://www.humanitarianlibrary.org/sites/default/files/2014/02/vca-toolbox-en.pdf

Plan International (2010), Child Centred DRR Toolkit, 2010. https://resourcecentre.savethechildren.net/pdf/5146.pdf/

Sphere Association. The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response, fourth edition, Geneva, Switzerland, 2018.

Cameroon Red Cross, IFRC, Swedish Red Cross (06, 2020) ,rapport d'evaluation des vulnerabilites et capacites
mayo-sava, mayo-tsanaga, diamare , extreme nord du cameroun, octobre-novembre 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/rapport_evc_extreme_nord_crc-ficr-crs_nov_2019.pdf

Antonio-Nkondjio, C., Ndo, C., Njiokou, F., Bigoga, J. D., Awono-Ambene, P., Etang, J., Ekobo, A. S., & Wondji, C. S. (2019). Review of malaria situation in Cameroon: technical viewpoint on challenges and prospects for disease elimination. Parasites & vectors, 12(1), 501. https://doi.org/10.1186/s13071-019-3753-8

World Data, Climate in Far North Cameroon, 2021

World H24, CAMEROON: The bridge connecting Maroua to Mora has collapsed (Far North), 08- 2020