



**2021 Geneva
Challenge**

Ecofeminist GIS

Lake Chad Lens:

**A Geospatial Tool To Monitor Crisis Levels,
Environmental Change, And Social Threats
To Women In The Lake Chad Basin**

CRISIS MANAGEMENT THEME

**EUROPE CATEGORY
GLASGOW CALEDONIAN
UNIVERSITY**



UNESCO, 2020



Michigan State University, 2019



UN News, 2018

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ABSTRACT

This 2021 Geneva Challenge proposal is submitted by five international Erasmus students pursuing their master's degrees in Urban Climate and Sustainability. The team consists of Jonathan Lieber, an environmental planner from Canada; Newsha Modjrian, an urban designer and planner from Iran; Samson Ogunfuyi, a meteorologist and climate scientist from Nigeria; Saloni Paudel, a civil engineer from Nepal, and Nerxhana Tallushi, an urban planner from Albania. The submission is for the Europe category, as the team's base university is Glasgow Caledonian University.

Lake Chad is among the most urgent complex crises in the world. The underlying environmental change caused by human development, agriculture, and climate change has destabilised Lake Chad, a life source for 30 million people (United Nations, 2020).

Although each demographic segmentation faces its challenges, the specific conditions occurring in Lake Chad have led to the rise of what is being called "ecofeminism". Ecofeminism recognises the intersectional challenges women face by applying feminist principles to ecological issues.

Through exhaustive research and consultations, gaps in data were identified as a major barrier for effectively addressing the crisis. With technology being inaccessible and rarely used by the residents of Lake Chad, it was determined any innovative technological solution must be aimed at the policymaker level.

The proposal consists of creating an ecofeminist geospatial tool called "Lake Chad Lens". This tool utilises ArcGIS application builder to tailor services to women's needs in the region by feeding data to broader spatial and temporal scales at considerably finer resolutions for far more extended periods. The benefit is the access to real-time data collected in a standardised way that decision-makers will have on crisis levels, environmental change, and social threats to women of Lake Chad. The expected results involve improving women's lives by enabling more holistic, informed, and effective data-driven crisis management initiatives.

Ultimately, the proposal demonstrates the value of tailoring existing technological solutions to regional demographics and cultures. Crisis managers can adopt the same philosophy globally to capture the intersectional and nuanced challenges of demographic subsets in the face of conflict and climate change.

Meet our Team

Jonathan Lieber, Team Lead



Jonathan Lieber is an Erasmus Mundus Joint Master student pursuing his MSc in Urban Climate & Sustainability. He holds a certificate in Urban Forestry and a Diploma in Ecosystem Management. He has several years of environmental planning work experience, four of which were with the City of Toronto.

Newsha Modjrian



Newsha Modjrian is an Erasmus Mundus Joint Master student pursuing her MSc in Urban Climate & Sustainability. Her professional profile includes working on several development plans and projects in different scales over the past three years.

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Samson Oluwafemi Ogunfuyi is a graduate student of Urban Climate and Sustainability in Glasgow Caledonian University as part of his Erasmus Mundus Joint Masters program. His first degree was in Meteorology and Climate Science. In addition, he has relevant experience in the space sector and an interest in geospatial solutions.

Saloni Paudel



Saloni Paudel is currently pursuing her masters degree in Urban Climate and Sustainability which is a part of joint Erasmus Masters program. Prior from that she had a bachelors degree in Civil Engineering and has worked as a civil engineer.

Nerxhana Tallushi



Nerxhana Tallushi is an MSc in Urban Climate & Sustainability student part of the Erasmus Joint Master program. Born and raised in Albania, she holds a MSc degree in Urbanism followed by a Spatial Planning and GIS application specialisation. Her work experience includes territorial governmental and tangible cultural heritage development programs in the public sector.

A photograph of two women in a rice field. They are wearing colorful saris and are bent over, harvesting rice plants. The field is filled with tall green rice stalks. In the background, there are some trees and a clear sky.

01

ISSUE BACKGROUND

Issue Background

01. Lake Chad

Lake Chad is located in the Sahel region of Africa between four countries: Chad, Cameroon, Niger, and Nigeria. This freshwater lake is one of the largest lakes in Africa and directly supports the livelihood of 30 million people. It is the third-largest enclosed lake on the planet, with a very shallow depth and a surface area that varies by season and year. Due to the lake's shallowness, hundreds of small islands are created, which expand and contract with water levels. The rising and falling water levels create abundant floodplain and wetland areas around the lake. Several tributaries fed the lake, including Logone, Chari, and Komadugu-Yobe (UNESCO, 2019).

The surrounding area of land where surface water drains into the lake, known as the Lake Chad Basin, is extensive, around 2381635 sq km². The basin represents approximately 8% of the African continent and reaches Algeria in the north and the Central Africa Republic in the south. The majority of it lies in the nation of Chad (43%); hence it is named Lake Chad. 20% is known as the "conventional basin", which falls under the authority of the Lake Chad Basin Commission. (FAO, 2021).

02. Environmental Challenges

Lake Chad is surrounded by vast arid deserts, making it a haven for both humans and wildlife. It is situated in an interior basin that once held an ancient sea called "Mega-Chad". The current extent of the Lake Chad Basin features three major climatic zones: the Saharan desert climate in the north, the Sahel in central Chad with its wet and dry seasons, and the Sudan zone in the south with a hot, wet-dry tropical climate (GIZ, 2021). Three ecoregions exist in the lake area: the Lake Chad Flooded Savannah Ecoregion, the Sahelian Acacia Savannah Ecoregion, and the Western Sudanese Savannah Ecoregion (UNESCO, 2021).

This flooded savannah ecosystem provides vital habitat for migrating birds and resident species. For example, up to one million birds of 17 waterfowl species and 49 wetland species congregate on the lake during the winter period. It is also a refuge for all West African vulture species. In this area, three documented bird species are classified as near-threatened in the IUCN Red List (2018), and one species is considered vulnerable (UNESCO, 2021).

Regarding mammal species, there are at least 44 large to medium size mammal species and the central savannah area of the lake hosts species like the African savannah elephant and sitatunga (UNESCO,2021). Other animals such as hippopotamus, otters, and up to 179 different fish species are present in the various parts of the lake. The degrading state of habitat in Lake Chad has led to a significant decline in mammal populations (World Wildlife Fund, 2021).

Between 1960 and 2000, Lake Chad shrunk significantly. Since the 1960's the lake has shrunk by almost 90% due to unplanned expansion of irrigation and water infrastructure, desertification, drought, and climate change. The lake surface area of the lake was 25,000 km² in 1963 but now extends only 2,500 km². The shrinking caused the lake to split into a northern pool and a southern pool. At the beginning of the 1990s, the mean annual precipitation began increasing and during the past two decades, the lake has stabilised. Studies indicate the lake is no longer shrinking and recovers its surface water extent and volume seasonally, although this is an extremely sensitive claim which is contested. Climate change still influences the instability of Lake Chad's environment, with higher interannual variability affecting the amount of precipitation during rainy seasons. This variability can significantly impact traditional agro-pastoral activities, aggravating the region's social challenges (Pham-Duc, B. et al., 2020).



Cecile Brugere, 2015

03. Social Challenges

The result of the environmental, political, and economic issues has been increased social pressure on women. The impacts on women, and adolescent women, in particular, are unique in comparison to men and must be examined to understand the social and cultural landscape of the region. Women face insecurity at every level. These women are subject to physical violence, sexual violence, early childhood and forced marriage, food and water insecurity, family separation, and limited access to education.

There are widespread reports and evidence of conflict-related violence, community violence, and domestic violence across the region. A culture of fear endures among the women due to armed gangs and lack of police or military protection. They are most vulnerable to violence at night, in some geographic regions when stability deteriorates and displaced. Women without parents, and most especially a father, have the highest exposure to violence. Remaining with the family, especially with a present father, is among the top indicators for a women's safety and stability in the region.

Sexual violence is one of the most prominent types of violence inflicted on women. Kidnapping and rape are commonly committed by armed gangs throughout the Lake Chad Basin. Women are often forced to serve as domestic workers from their attackers. Survival due to economic conditions is also a stimulant factor of sexual violence (Plan International, 2018).

Anecdotal reports suggest early childhood and forced marriage is increasing in the region. The already commonplace practice amplifies social challenges like health risks associated with early pregnancy and limiting women's chances of securing education or other opportunities. Risks also include poverty, education drop out, and contracting HIV/AIDS (Government of Canada, 2020).

7.2 million people are food insecure in the Lake Chad Basin. The insecurity has increased as armed groups attack farming and transportation operations, causing women to participate in informal and unregulated labour markets to support themselves and their families. Plan International's survey found out that over 60% of women went to bed hungry at a point in the past month. The prevalent water scarcity issue causes similar aggravations.

The burden of household chores and caretaking make access to education a major challenge for women in the Lake Chad region. In addition, the insecurity of the region makes travel to school an often high-risk task. Displacement, family separation, and early childhood or forced marriage often null any opportunity to attend the offered education. (PI, 2018).

Although most women in the region can partially access healthcare, the quality is low or unaffordable. Disease and injury are rampant among women in the region, most common in the form of Malaria and HIV. Sexual health is also a major challenge as access to information is rare and sometimes taboo, making contraception rarely used. With 773.4 maternal deaths for every 100,000, the Lake Chad Basin has some of the highest maternal death rates anywhere in the world.

One of the main drivers of conflict in the region stems from the Boko Haram insurgency. Boko haram (known as Maiduguri before 2009) is “an Islamic sectarian movement which gradually transformed into a radical jihadist armed rebellion”. The conflict began in 2009 when Nigerian authorities launched a brutal military offensive into the organisation’s headquarters. Since then, this conflict has persisted and expanded out from the Maiduguri, capital of Borno, into Lake Chad and along the Cameroonian border (Akpa, J.I. 2015).

The cause of the Boko Haram insurgency is complex and unclear. It appears to be a connection between the social element and environmental dynamics of the area. It has had devastating impacts on women in the region. Most notably are the instances of mass kidnappings of schoolgirls. In 2014, Boko Haram kidnapped 276 schoolgirls in the northeastern town of Chibok. Although some girls escaped and some major releases were negotiated, 112 are still missing (National Geographic, 2020). These incidents, along with the name of Boko Haram, which translates to “western education is forbidden”, has instilled a widespread fear of participating in education in the region. Additionally, the conflict “adversely affects women’s agency and exacerbates behaviours that are often precursors to intimate partner violence” (World Bank, 2020).

One of the contributing factors is that Lake Chad holds large oil reserves that hold the interests of the Lake Chad countries, Western countries like France and America, and Boko Haram. Taking control of the main economic drivers such as the oil and gas reserves and “cross-cutting fishing, all-season farming, water, and control of cross-border trade routes” appears to be the primary strategy of Boko Haram to gain regional influence. Niger, Chad, and Cameroon act as major

havens for Boko Haram due to government indifference (Omenma, J. T. 2020). The complexity and unclear nature of the Boko Haram insurgency are articulated in the African Studies Centre document “Boko Haram: Islamism, politics, security and the state in Nigeria” by stating:

“For a movement such as Boko Haram to mutate from a sectarian group splitting away from the Izala movement to a full-grown rebellion threatening the integrity of the most powerful state in West Africa, you need more than religious fanatics, violent Salafist ideology, and intolerance” (Akpa, J.I.,2015)

These extensive and ingrained social challenges are dynamic and complex. Climate change amplifies and aggravates the situation by further deteriorating the stability of the region. However, unfortunately, there is also a lack of ground data and information to inform solutions as the problems unfold and change.



Gulland, A. 2019

04. Literature Review

Approaches such as gender mainstreaming, ecofeminism, political ecology that study the relationship between political, economic, social and environmental issues are relatively introduced lately, around the 1980s. For gender mainstreaming only in 1998 Council of Europe reached a definition of this concept:

“The (re)organisation, improvement, development and evaluation of policy processes, so that a gender equality perspective is incorporated in all policies at all levels and all stages, by the actors normally involved in policy-making.”

However, these concepts until 2010 were not much studied, as all the research lacked a gender perspective in correlation to climate change and recommendations for future climate policies. Also, international organisation reports like the UN mostly were neutral to gender perspective except one of the studied documents.

In the recent ten years, however, some studies support such a correlation and women's capacity to adapt to climate-related problems (Tanny & Rahman, 2016; Arora-Jonsson, 2011; and Solomon, & Angular, 2017). The discussion appears to be more visible among poor societies highly dependent on environment-based livelihoods like agriculture.

Moreover, in some study cases, indicators were used to quantify the gender gap due to climate change (Tanny & Rahman, 2016). During our literature review, it appeared that Nigeria had been a study case for few researchers studying the relation between women and climate change, taking into consideration the actual political, economical, social situation of the area and environmental issues that Nigeria is facing nowadays (Egbue, 2010; Nigerian Environmental Study Team, 2011; Fabiyi & Yesuf, 2013).

Nowadays, these approaches are set as a goal in the UN 2030 Agenda for Sustainable Development-SDG 5, by recognising that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests (UN, 2021).

05. Sustainable Development Goals

The 17 Sustainable Development Goals (SDG) created by the United Nations have been core to the development of this proposal. The United Nations defines the SDGs' as "an urgent call for action by all countries – developed and developing – in a global partnership (United Nations, 2021). The crisis women face in the Lake Chad Basin strikes to the core of several sustainable development goals. This proposal does not aim to solve these complex and deep-rooted challenges in wholesale but rather to create a tool that can help inform action to ultimately relieve some of the sufferings of women in the region.

Table 1. Sustainable Development Goals (SDG)



Alleviating poverty is one of the main objectives of the proposal. The staggering poverty rates in the region demonstrate an urgent need for action.

One of the major challenges is understanding how the range of threats in the region are experienced by different demographics and how they change over time. This tool will allow for updated data collection that can be used to target the root of poverty in particular areas. Updated, granular, and nuanced data will be the foundation for informed actions to end poverty in a holistic manner.



7 million are food insecure and 515,000 children suffer from severe acute malnutrition in the Lake Chad region (Borgen Project, 2018). The tool will provide essential data that can inform agricultural opportunities on appropriate lands based on their environmental suitability and social context. It also informs where aid sites can be built based on the highest need.



The data provided by the tool will facilitate good health and well-being, specifically for women. By monitoring environmental changes, regional planning can be conducted in a more informed and coordinated way. This is essential for good health and well-being because environmental degradation is aggravating women's health by creating food shortages and extending distances to water sources. The tool may also provide data to assess current and future locations of healthcare services.



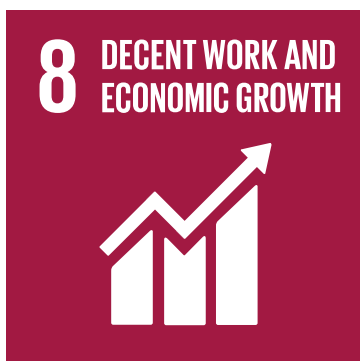
With almost 1,000 schools closed or non-functional due to violence and unrest in northeast Nigeria, Chad, Cameroon, and Niger, and 3.5 million children at risk of having their education being disrupted from conflict, quality education is critical for the region's stabilisation (UNICEF, 2018). Among other services, the data collected from the tool can inform quality education services throughout the region by informing the safest and more effective areas to invest in.



The proposal is explicitly tailored to the needs of women. Our team recognises the value of creating demographic-specific tools to contextualise the needs and solutions to specific communities. The 2021 UN Migration document "Gendered Dimensions of and in the Lake Chad Basin Region: DDDR" specifically recommends integrating gender analysis into policy and project cycles.



Lake Chad and its tributaries are the sole source of drinking water for millions of residents in the area. The fluctuating lake levels deplete aquifers, causing major water shortages that fuel conflict and many social challenges. The lack of sanitation also risks cholera, diarrheal diseases, and hepatitis E outbreaks (Global Citizen, 2017). The tool will monitor and report hydrological changes in the watershed and provide critical data to identify sites for sustainable water infrastructure investment.



Conflict and degrading natural resources hamper the economic prospects of the Lake Chad Region severely. The informal and disrupted economy drives many of the social challenges, such as poverty and conflict. The proposal aims to deliver data that can inform economic recovery actions, identify geographic areas for investment, and contribute to stabilising the region.



The proposal aims to reduce both gender and economic inequalities in the Lake Chad Basin by gathering contextual data that inform actions that relieve social challenges and improve economic prospects.



The Lake Chad Basin is highly vulnerable to Climate Change. Chad, where the majority of the basin is located, is ranked as the most vulnerable country in the world to the impacts of Climate Change according to the University of Notre Dame's Global Adaptation Index (University of Notre Dame, 2018). The geospatial tool is specifically tailored to monitor environmental changes caused by climate change. The tool will provide data to inform climate action.



The geospatial tool holds the interests of regional governments, business leaders, tribes, women, and other stakeholders. The data collected and presented can enable improved decision-making and regional cooperation. As noted by Machine Learning Researcher and Consultant Srujana Merugu “data science has the potential to make immense contributions to the pursuit of peace. Providing macro-level insights to policymakers, curating personalised content on peaceful conflict resolution, guiding educators in moulding the behaviour of their wards and automated agents for arbitration are some of the many ways that data science can assist in promoting peace” (United Nations, 2021).

06. Governance

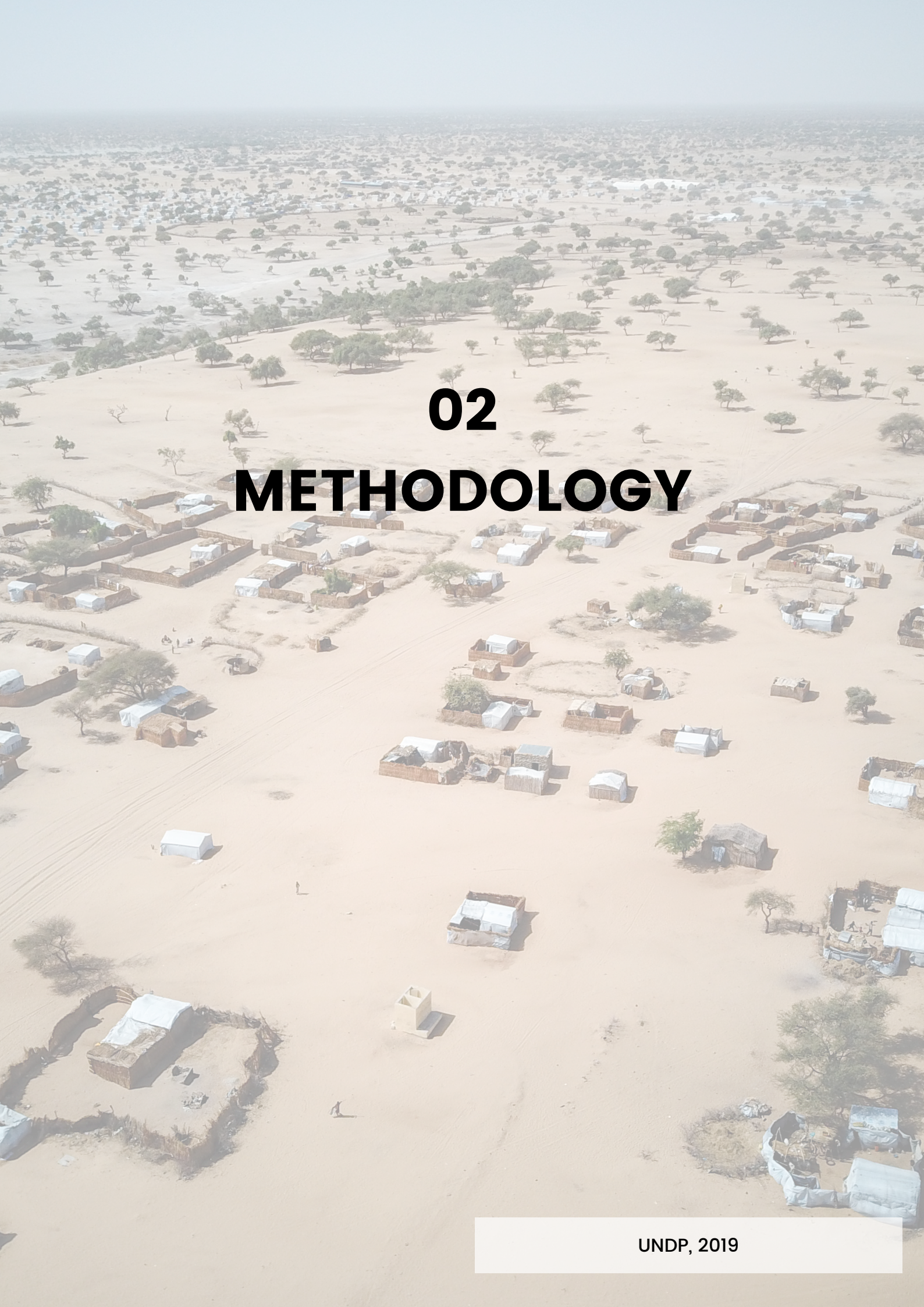
The Lake Chad Basin Commission (LCBC) is the authority responsible for regulating water use and basin development. Formed on the 22nd of May 1964 by the Heads of State of Cameroon, Chad, Nigeria, and Niger, it is one of Africa's oldest basin organisations. The Republic of Central Africa joined the organisation in 1996, while Libya joined in 2008. In addition, countries like Sudan, Egypt, the Republic of Congo, and the Democratic Republic of Congo have observer status in the organisation. The mandates of LCBC aim for sustainability and equitability management and the basin's natural resources conservation by promoting economic integration, cooperation, peace, and security (Commision, 2008).

The three mandates of the LCBC have the following responsibilities:

- Managing Lake Chad water use and the other transboundary water resources in the Lake Chad basin sustainably and equitably.
- Conserving the basin ecosystem.
- Promoting regional integration and safeguard peace and security in the conventional basin. (NUHU, 2018).

The LCBC has in the past had to carry out three projects financed in cooperation with various donors: (i) MEGA-CHAD financed with Belgian bilateral resources; (ii) IPM financed by the Bank for UA 1.4 million, and (iii) HYDRO CHAD financed by the Arab Bank for Economic Development in Africa (ABEDA). Currently, there are six ongoing projects for an amount of CFAF 6 billion within the LCBC. The most recent are those financed by the GEF / the World Bank, the first phase almost completed; the German Cooperation (GTZ and BGR projects); the ADB (HIV/AIDS project) still ongoing; and the European Union project, engaged in the Programme Coordination bodies' reinforcement, communication, strengthening the legal framework of water sharing, risk analysis, the study on the interactions between ground and surface waters, small pilot projects as well as pre-feasibility studies on river transport (African Development Bank Group, 2008).

Another proposal related to Lake Chad management is the Transaqua project, firstly pitched in the 1970s. This plan proposes channelling the water from the Congo river, Oubangui, to the Lake. The Transaqua Project consists of taking water from the right tributar[ies] of River Congo, conveying the 2,400 km channel to Chari River, which is the preferred feasible option (Celani, 2020).



02 METHODOLOGY

Methodology

There has been a growing “ecofeminist” narrative building out of Lake Chad due to the intersectional crisis women in the region face. This movement has largely been led by Oladosu Adenike, a young Nigerian advocate named by the BBC as a key African activist who has also spoken on Lake Chad’s challenges at COP25. This proposal objective was to contribute to this crisis relief by tailoring a solution to the specific challenges of women in Lake Chad.

For developing a solution, qualitative and quantitative data sets were collected by conducting literature reviews, internet scans, and consultations with experts who had practical experience working on the Lake Chad crisis. Although an extensive list of references is provided in the bibliography section, the below chart outlines the primary sources of data that informed the proposal.

Table 2. Qualitative and quantitative data

Data Information	Source	Outcome
<p>Gender, Poverty and the Conservation of Biodiversity: A Review of Issues and Opportunities.</p> <p>White Paper</p> <p>Qualitative/ Quantitative</p>	McArthur Foundation	The paper contextualised the link on a global scale between gender, poverty and conservation of biodiversity with qualitative information. Specific statistics related to the participation of women in agricultural sectors and women in poverty used as supporting quantitative data.
<p>Cultural and Natural Landscapes of Lake Chad</p> <p>Web Page</p> <p>Qualitative/ Quantitative</p>	UNESCO	The web page provides detailed qualitative data of the natural features of Lake Chad. Quantitative data related to the number of species and surface area of the lake is used as supporting information.
<p>Lake Chad Flooded Savanna</p> <p>Web Page</p> <p>Qualitative/ Quantitative</p>	World Wildlife Fund	Qualitative and quantitative data regarding the ecoregions, biodiversity features, protection status, threats and delineations of the Lake Chad flooded savanna.

Data Information	Source	Outcome
<p>Cultural and Natural Landscapes of Lake Chad</p> <p>Web Page</p> <p>Qualitative/ Quantitative</p>	UNESCO	<p>The web page provides detailed qualitative data of the natural features of Lake Chad. Quantitative data related to the number of species and surface area of the lake is used as supporting information.</p>
<p>Promoting Peace: How Data Science Can Assist?</p> <p>Opinion Piece</p> <p>Qualitative</p>	UNESCO	<p>Qualitative data linking the value of data science in crisis management and peace agreements.</p>
<p>The Lake Chad hydrology under current climate change</p> <p>Research Paper</p> <p>Qualitative/ Quantitative</p>	<p>Journal: Scientific Reports</p> <p>Authors: Pham-Duc, B., Sylvestre, F., Papa, F., Frappart, F., Bouchez, C. and Crétaux, J.-F</p>	<p>Qualitative and quantitative data regarding the hydrology and current understanding of the fluctuating water levels. Although water levels receded by up to 90% from the mid-century levels, in the 21st century, water levels appear to have stabilized. Increased rainfall intensity, drought, and extreme weather events exacerbated by climate change still threaten the environmental stability of the region.</p>
<p>Untold Story of Boko Haram Insurgency: The Lake Chad Oil and Gas Connection.</p>	University of Johannesburg	<p>Qualitative data emphasizing the natural resource exploitation undertone of the region and its link to conflict. Quantitative data of the quantity of oil reserves and make up of natural resources industries in each country.</p>
<p>Drying Lakes: A Review on the Applied Restoration Strategies and Health Conditions in Contiguous Areas</p> <p>Research Paper</p> <p>Qualitative</p>	Lund University	<p>Qualitative data of case study of Lake Urmia and Aral Sea regarding receding lake levels and restoration approaches.</p>

Data Information	Source	Outcome
<p>Gendered Dimensions of and in the Lake Chad Basin Region: Disengagement, Disassociation, Reintegration Reconciliation.</p> <p>Publication</p> <p>Qualitative</p>	<p>UN Migration</p>	<p>Qualitative data of the nuances of the gendered dimensions in the Lake Chad Basin Region.</p>
<p>Boko Haram: Islamism, politics, security and the state in Nigeria</p> <p>Publication</p> <p>Qualitative/ Quantitative</p>	<p>Journal: African Security Review</p> <p>Author: Akpa, J.I.</p>	<p>Qualitative data of the history and causes of the Boko Haram insurgency. Quantitative data of the percentage of the Muslim population in each Nigerian state.</p>
<p>Adolescent Girls in Crisis: Voices from the Lake Chad Basin</p> <p>Publication</p> <p>Qualitative</p>	<p>PLAN International</p>	<p>Qualitative data from detailed accounts of women expressing the challenges they face in the region.</p>
<p>Consultation with Peter Ikyapa, Independent Environmental Consultant</p> <p>Audio Interview</p> <p>Qualitative</p>	<p>Interviewee</p>	<p>Qualitative data of women's health issues and migration patterns in the region stemming from Peter's experience surveying vulnerable women at Lake Chad on behalf of the Nigerian Ministry of Health.</p>
<p>Consultation with Oladosu Adenike, Eco-Feminist Advocate</p> <p>Video Interview</p> <p>Qualitative</p>	<p>Interviewee</p>	<p>Qualitative data of cultural sensitivities, regional challenges, and verification of eco-feminism philosophy.</p>
<p>Consultation with Raphael William, Environmental Consultant</p> <p>Audio Interview</p> <p>Qualitative</p>	<p>Interviewee</p>	<p>Qualitative data of environmental challenges such as extreme weather, agricultural yield loss and lake fluctuations.</p>

Through the literature review, research, and consultation process, three major factors were identified to be considered for the proposed solution:

- Gaps in demographic and environmental data constitute a significant challenge to making informed decisions
- There is a multitude of stakeholders with a diversity of competing regional interests
- Use and access to technology among the population is low

These factors helped identify how advancing a proposal that could empower decision-makers with data collected in a standardized way would be decisive for delivering more holistic and informed crisis management initiatives. Access to updated, nuanced data has a wide range of uses in crisis management, constantly evolving as technological capacities advance. Recognizing that residents of Lake Chad themselves have little access to technology, the solution focused on providing the data collection and analysis at the decision-maker level. It was also important to consider that a significant percentage of the population of the Lake Chad basin is Muslim, and therefore the proposal must be sensitive to religious practices and teachings.

Crowdsourcing using the ArcGIS application builder was selected as the foundational tool to operate with. ArcGIS application builder is an existing and widely adopted technology with proven abilities to collect and analyze real-time data that can be refined for use in Lake Chad.

Through the use of field surveys, dashboards, interactive maps, and story maps using applications of the ArcGIS application builder such as: Survey123 connect; ArcGIS Online; ArcGIS Dashboard, and ArcGIS Story map that focuses on the overlap of women and environmental change, the proposal create a new tool to help feed data at broader spatial and temporal scales at considerably more satisfactory resolution far more extended periods.

Due to the nature of multi-stakeholder and regional interests in Lake Chad, no sole decision-making body was identified as a user of the tool. The tool aims to share open-source technological infrastructure among all parties involved in the management and intervention of Lake Chad initiatives. The website shares the information collected, and analysis conducted easily to access and interpret format for others to use.



03 CONSULTATIONS

Consultations

The proposal was shaped through consultation with three local Lake Chad experts. These three experts come from various technical backgrounds and have a range of academic and practical experiences. The goal of the consultation was to ensure the geospatial tool proposal was feasible and to improve the mechanics of the proposal by embedding local knowledge. Below is a summary of the three interviews.

#1. Nyetiobong William

Nyetiobong William is a Nigerian geologist and environmental scientist. He notes that the principles of environmental determinism are very strong in the region. The weather is always extreme. Any weather of relief is the exception. This extreme weather, generally in the form of heat and prolonged dry seasons, has become the foundation of the culture. From his perspective, these climatic factors are still causing the lake and aquifers to deplete. He does not accept the notion that the lake has stabilized, citing a clear reduction in 2012 to 2021 aerial imagery.

He explained that the geology of the region makes the situation worse, as the area has very soft rocks that do not hold water in aquifers well. He confirmed that Lake Chad is connected to the Niger River by several tributaries, which bring migrants from upstream countries. When asked to rank the crisis from the options of low, moderate, high, and extreme he selected extremely high. Nyetiobong confirmed there are large gaps in data. For example, the geological map is outdated. Many data sets are low resolution or outdated.

Nyetiobong outlined that the challenges the women of the region face and the hydrology of Lake Chad are strongly linked, calling it a “hydro-social” situation. Nyetiobong noted the breadth of challenges women face due to the shrinking lake and drying aquifers. Nyetiobong suggested that the proposal take on a “gender mainstreaming” approach where a gender equity lens is applied at every level of the proposal.

**“The Project Should Take On A
“Gender Mainstreaming”
Approach Where A Gender
Equity Lens Is Applied At Every
Level Of The Proposal”**



#2. Oladuso Adenike

Oladuso Adenike is a youth activist and agricultural economist from Nigeria who describes herself as an Ecofeminist. Consultation with Oladosu was core to the development of the proposal. Oladosu agreed that aiming an innovation at the policymaker level is a good approach because it avoids direct interventions that may be unfeasible due to the low access women have to technology. She also helped articulate the intensity and urgency of the crisis. From a ranking of low, moderate, high, and extremely high in crisis level intensity, she selected extremely high. She noted that the clashes between farmers and nomads, ethnic tensions, and political divisions are all reaching a boiling point and she worries that war is very possible. She noted Nigeria has the highest crisis levels, Niger 2nd, Cameroon 3rd, Chad 4th.



"The Women of Lake Chad Are A Resource. Ask Them What Solutions They Think Could Help Relieve The Crisis"

As a further description of the crisis conditions, she points out that migration was once a core adaption strategy but there is now nowhere to go that is environmentally and socially stable in the region. This has cascading impacts. For example, her local school has been taken over by internally displaced peoples and no longer operates. There are also many external migrants from neighbouring countries. Nigeria is downstream from nine countries, meaning many migrants come from upstream. She further described how the desperate economic situation is causing violence. Kidnapping and then demanding ransom for example is becoming a staple business.

The psychological trauma was also touched on by Oladosu, noting how devastating the loss of culture can be on top of the physical and economic trauma. She also highlighted how these women are the experts in this very subject as they are loving through the intersectional crisis, and therefore should be viewed as a resource for finding solutions. She suggested the survey directly asks them what solutions they think could help relieve their challenges.

#3. Peter Ikyapa

Peter Tertese Ikyapa is an environmental consultant from North-Central Nigeria. Aside from living in the Lake Chad Basin, Peter has conducted work at Lake Chad. As part of his duties as a corps member, he administered a structured questionnaire for the National Reproductive Health Project (NRH) through the National Youth Service Corps (NYSC). After which he was sent back for medical outreach to carry out HIV/AIDS counseling & testing for the locals. Through this project, he spoke with many of the local Lake Chad women and developed an initial understanding of the challenges they face, and the cultural sensitivities of the region.



“Although Residents are Open to New Innovations, Initiatives Must Be Sensitive To Islamic Religious Teachings And Cultural Sensitivities”

Peter offered a window into the lives of women in the region and the challenges they face. Peter noted the most common diseases that women struggle with are typhoid in the north and malaria in the south. He noted that sleeping sickness (African Trypanosomiasis) is also common, but HIV rates are low. Women have trouble accessing healthcare for these diseases because Boko Haram has destroyed many health facilities in the region, along with schools.

Peter emphasized how active women are in agricultural production and selling agricultural, fishing, and wood products. He suggested we seek their counsel on climate changes as they related to agricultural yields. He noted that rainfall reduction, illegal logging, and drought have all had devastating impacts on women's agricultural activities. Peter made the correlation between areas with rich natural resources and areas of conflict. He pointed out that the north area along the Chad border is relatively safe whereas the southwestern area where resources are rich is high risk.

The background image shows a rural landscape. On the left, there is a thatched hut. In the foreground, a young girl is walking, carrying a baby on her back. She is wearing a yellow and green striped shirt and a blue cloth around her waist. The ground is dry and sandy, with some sparse vegetation. The sky is hazy.

04

PROJECT PROPOSAL

Ecofeminist GIS

**Lake Chad Lens: A Geospatial Tool To Monitor
Crisis Levels, Environmental Change, And Social
Threats To Women In The Lake Chad Basin**

PROJECT PROPOSAL

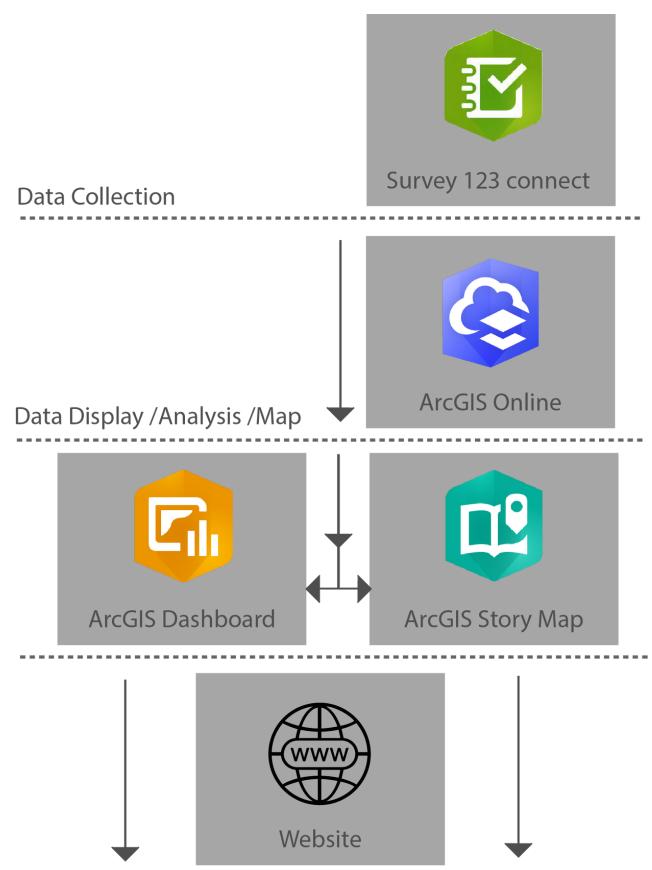
01. Ecofeminist GIS: Lake Chad Lens

The unstable situation around Lake Chad can be attributed to terrorism, climate change and fluctuating water levels. Habitants around this region have a story to tell how this crisis has impeded their progress, leaving them in a state of physical, mental, emotional damage. Though this crisis might be location-specific, the global community and several NGO's have constantly been supporting the Lake Chad region with humanitarian aid. The question is, how effective are these supports? The most vulnerable gender, which happens to be the female, remains helpless.

In summary, the crisis impact on humans is yet to be effectively measured since there is a lack of socio-demographic, environmental and health-related data to measure the crisis impact on location judiciously. Thus, an innovative approach that can provide real-time data, analyse and interpret the obtained data is needed to understand crisis trends, patterns and effects. Having such a system will help adopt an effective policy that is solution-driven. For this reason, this project focuses on Crowdsourcing using ArcGIS application builders such as Survey123 connect, ArcGIS Online, ArcGIS Dashboard and ArcGIS Story map.

Crowdsourcing allows for the collecting of data on considerably broader spatial and temporal scales. It also allows considerably finer resolution for more extended periods than would otherwise be achievable. Field surveys, dashboards, interactive maps, and story maps; just four of the aspects listed above that make up part of the modern GIS can assist and encourage spatial thinking, critical thinking, and in-depth use of GIS tools and data. Asking a geographic question, acquiring data, assessing and exploring data, analysing data, presenting the analysis results, and taking action, as shown in figure 1, are all steps in the geographic inquiry process (Kerski, 2020)

Figure 1. Innovative solution process



02. Geoweb data collection tool build-up

The survey form built using XLS Form Survey123 Connect relies on responses from people living in the Lake Chad region. The respondents act like a human sensor that provides a real-time update on environmental situations that define crisis levels.



Calculation column where the Arcade statements for all logic expression leading to the Crisis level calculation is written.

Figure 2. Data collection and decision procedure

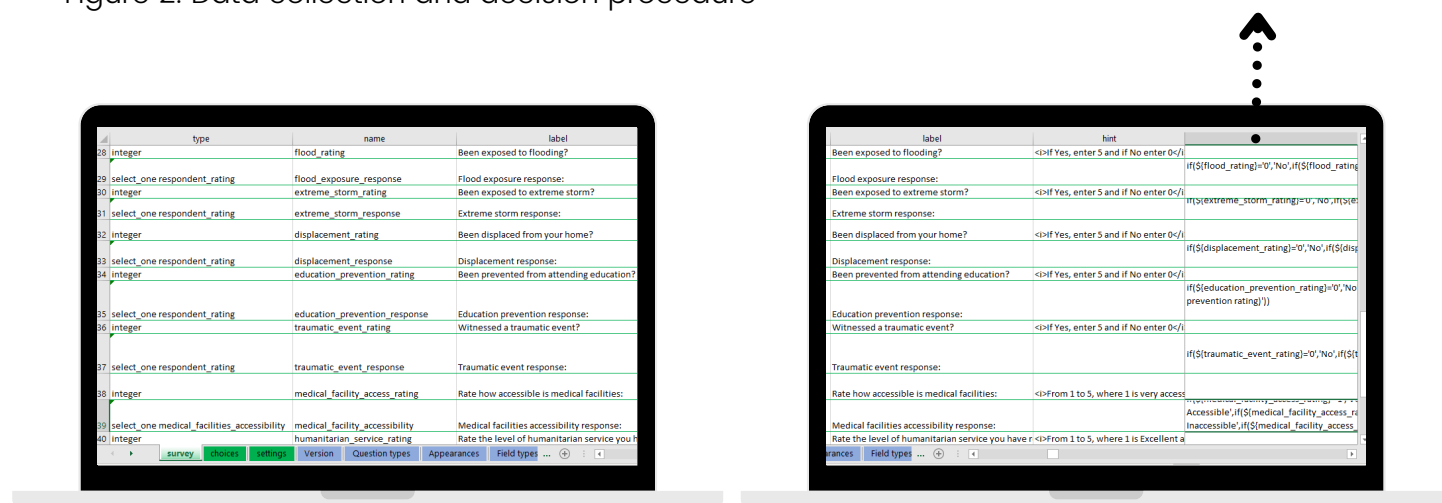


Figure 3. Making of the survey form using XLS-form

The form consists of socio-demographic, environmental and geo-point questions available in multiple languages (English and French) for web and mobile applications that can work offline. Every environmental question was given an appropriate ranking value, summed up to determine each location's crisis level and its impact on women.

The form further provides a unique identification number for every respondent that can be used to monitor data quality and change detection during the routing data collection (quarterly). For instance, a respondent's unique response during the first quarter can be updated in the second quarter using her unique identification number.

The first question section consists of a "Yes" or "No" answer, and "yes" is assigned 5, while "no" is assigned 0. Entering other values aside 0 and 5 will pop up an error message.

In the past 3 months have you:

Table 3. First section question

Q1	Has your source of income been disrupted?	Q7	Been exposed to extreme heat?
Q2	Been a victim of tribal or political conflict?	Q8	Been exposed to flooding?
Q3	Been a victim of domestic violence?	Q9	Been exposed to extreme storms?
Q4	Been a victim of sexual violence or abuse?	Q10	Been displaced from your home?
Q5	Had a health issue related to disease?	Q11	Been prevented from attending education?
Q6	Been exposed to drought?	Q12	Witnessed a traumatic event?

Second question section is based on ranking.

Table 4. Second section question

	Question	Possible answer category	Rank
Q13	Rate how accessible is medical facilities	Very inaccessible	5
		Somewhat inaccessible	4
		Neither accessible nor inaccessible	3
		Somewhat accessible	2
		Very accessible	1
Q15	Rate the level of humanitarian service you have received	Terrible	5
		Not that good	4
		Neutral	3
		Good	2
		Excellent	1

Table 5. Crisis level category

Crisis level criteria:

The survey buildup consists of several arcade expression algorithms that automatically pick every respondent answer, sum them together to give a particular value. This value is assigned a crisis level category, as shown in Table 5.

Crisis Level Calculation	Crisis Level Calculation
2 to 8	Low
9 to 15	Somewhat low
16 to 30	Neutral
31 to 49	High
50 to 65	Extreme

03. Survey form user interface

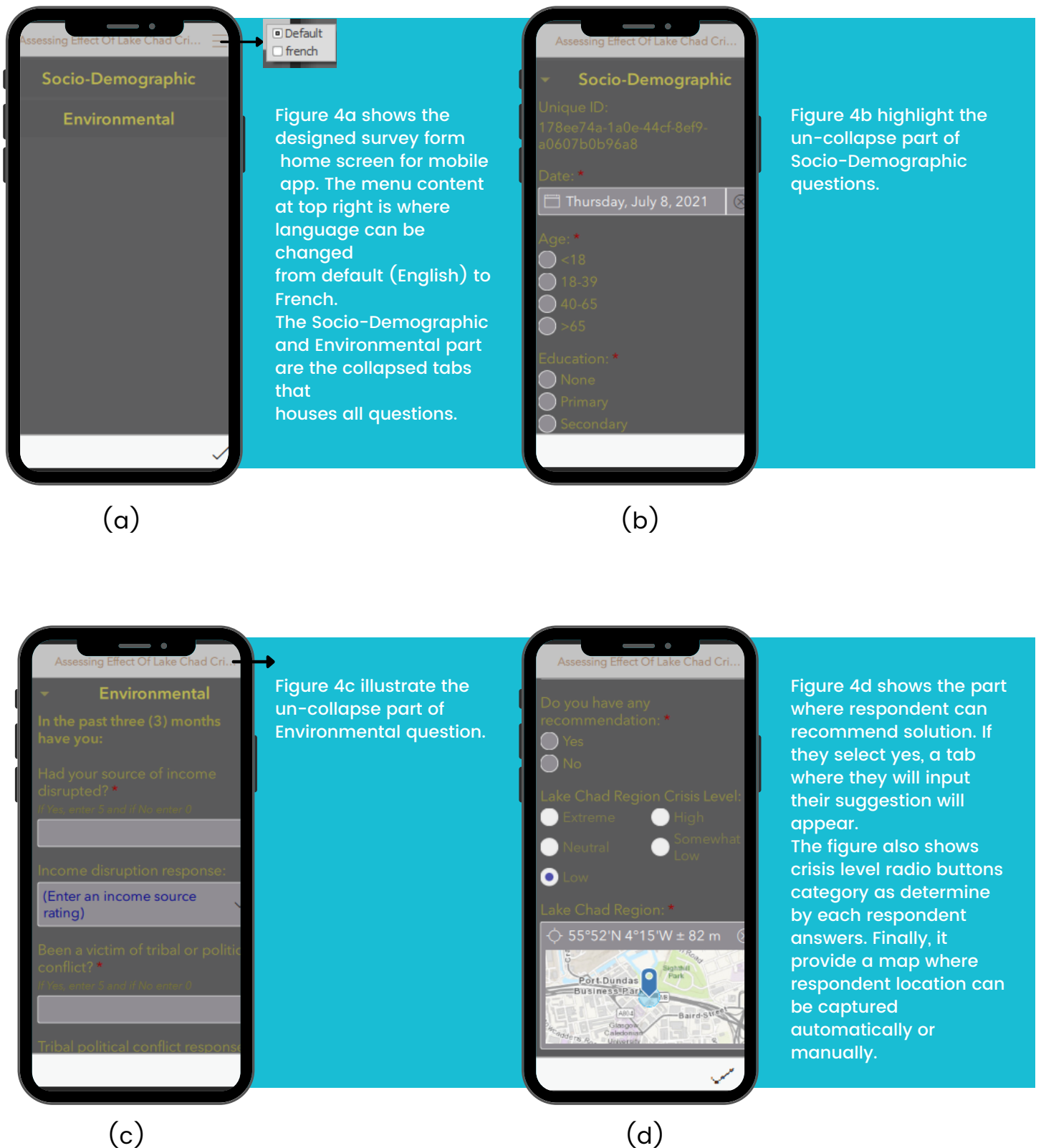


Figure 4. Survey 123 connect user interface: (a) Home screen (b) Socio-demographic question (c) Environmental question (d) Crisis level and geolocation section

04. Field data collection strategy

Simple guidelines have been developed to administer the survey, which is the main mechanism of collecting field data. Questions have been framed in the simplest terms so women with little education or low language confidence levels can understand and respond to the questions. The survey may be administered by any organisation or person and does not rely on any specific technical competence or credential. The administration is flexible, although some recommendations are provided here.

Building trust among the community is essential for accurate and ongoing data collection. It is recommended that surveyors collaborate with religious and community groups. The identity of participants should always be protected and remain anonymous. Sites for the surveying must be representative of the various regions surrounding Lake Chad. Permanent sites should be selected in each country so incoming survey data can be compared to previous results. The tool is designed to intake survey data on a quarterly basis.

A review of the website's past data should be conducted before selecting sites so that new results can build upon past ones. There should be an estimate of the amount of each participant in a given survey location so materials such as printed surveys in each language, pencils, or electronic devices are prepared. The safety of the area must also be considered.

When administering the survey, it should be clear that the survey is targeted to women. The language fluency of each participant should be identified so the appropriate survey language can be administered. The survey may be administered in either a written or oral format depending on the literacy of the participant. An administrator should always be accessible during the survey so any questions from the participant can be answered. Participants should be advised to skip a question if they find it sensitive or do not fully understand it. Each participant may only take the survey once each quarter.

Data can either be immediately entered or saved in an electronic or written format and entered at a later date. It is important that the integrity of the data is upheld, ensuring all responses are accounted for and that collection is conducted with consistent methodology. Budget will range greatly depending on the scope of the data collection strategies imposed by the administrators and the amount of technology utilized. It is suggested that administrators seek institutional review board (IRB) approval for their specific field collection strategy, so ethics and rights are considered and qualified.

05. Automated data analysis system by ArcGIS

Web Map, Dashboard and Story map

For a location like Lake Chad that continually experiences consistent environmental challenges, a real-time crisis level indicator will play a crucial role in early warning, decision making, real-time monitoring and risk assessment to protect life, properties and curb gender inequality. The availability of crowdsourcing tools by the Environmental Systems Research Institute (ESRI) made it possible for us to build an innovative tool that can provide crisis level indicators among other capabilities to everyone. Complimenting survey123 connect is ArcGIS Web Map, Dashboard and Story Map. These tools were designed and connected with the survey123 connect to automatically analyze and present obtained data once each respondent submits their response.

On ArcGIS Web Map, obtained data is displayed as point features whose attributes are based on the survey question. Each point feature represents the geolocation of the respondent describing the environmental characteristic of that location. For the purpose of understanding the crisis level across the different countries and their community that is bounded by the Lake, obtained data from the survey will be analyzed to show different crisis categories (low, somewhat low, neutral, high and extreme) using point features on the web map.

Also, a different web map that shows the ranking of humanitarian service (terrible, not good enough, neutral, good and excellent) received will also be automatically analyzed and made available for monitoring, assessment and planning purpose. A spatial trend and pattern will be observed. Homogeneity across the different locations with respect to crisis and humanitarian levels will be easily studied to understand hot spots that are not safe for women to live in.

To provide a more in-depth data description and analysis, ArcGIS Dashboard will be utilized (figure 5). It also updates itself automatically when a survey is submitted. In addition to the crisis level map and humanitarian service map displayed on the dashboard with different tabs, the right-hand side panel shows some socio-demographic data such as respondents' country, occupation in the pie chart while age group is given in a serial chart. The dashboard's left-hand side displays the total respondent gauge and a list of points(response) on the map. Each point is further characterized by the respondent's verdict on health issues, traumatic experience and tribal/political conflict. The dashboard will be designed in a user-friendly way and all displayed information is sensitively connected to each other providing a smart and informative user interface that aids understanding.

Finally, ArcGIS Story Map will be used to provide an interactive presentation of web mapping in a story form (as shown by figure 6). The web map will be accompanied by different types of issues rocking Lake Chad, real-life experience of victims with the crisis, multimedia section and the innovative solution result (Web map). It is aimed at educating people with updated Lake Chad situation. It will further give a background context of what is going on in this region, indicating a clear spatial pattern that will aid decision making toward achieving a lasting solution.

06. Automated data analysis system demonstration

Illustrating how the tools will work will require data obtained from Lake Chad female residence. After building a prototype Survey123 connect form, ArcGIS Web map, Dashboard and Story map, we generated some data by filling the survey form using the information we gathered from some field experts during our consultation. Each submitted response was automatically displayed and analysed as modelled by our innovative solution. The following figures (figure 5) give a conceptual view of the end product.

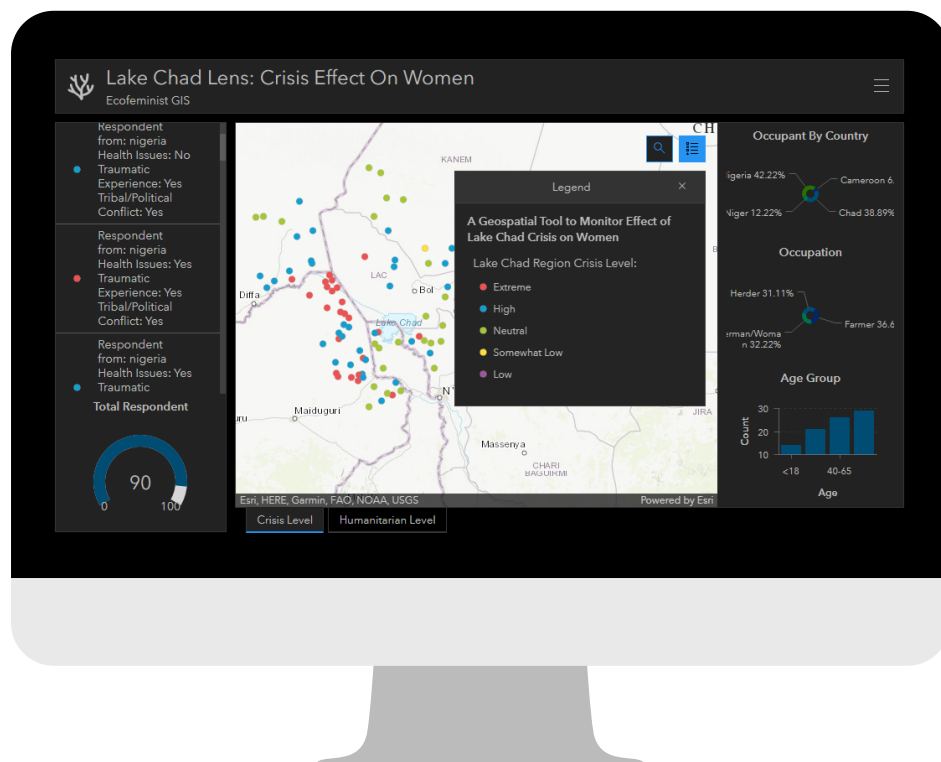
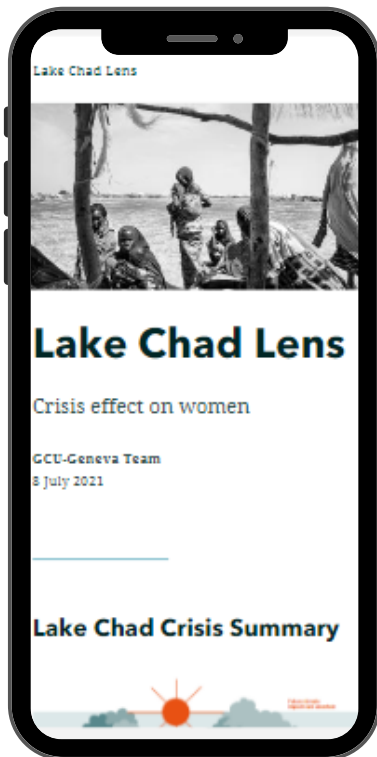


Figure 5. ArcGIS Dashboard interface

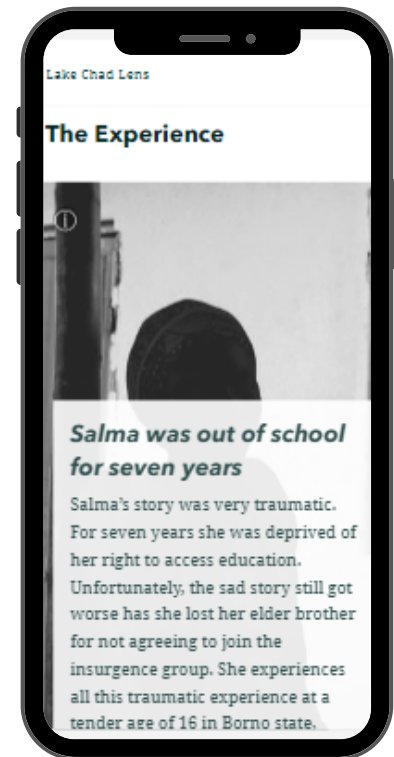
Aside from ArcGIS Dashboard (figure 5) showing a more detailed data description and analysis, it provides a responsive user experience. For instance, clicking on any of the age group serial charts will prompt the occupant by country and occupation pie chart to provide more specific information for the selected age group.



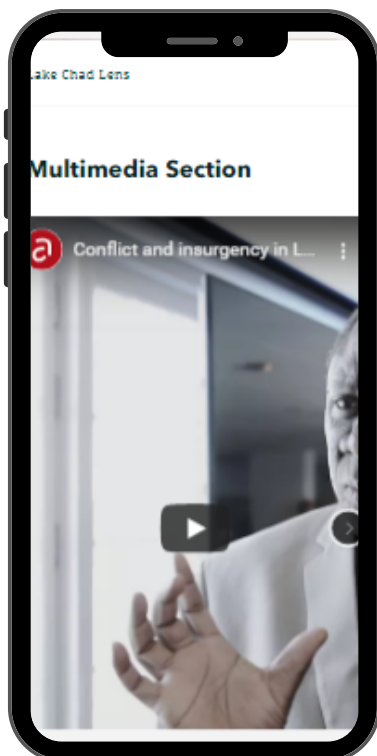
(a)



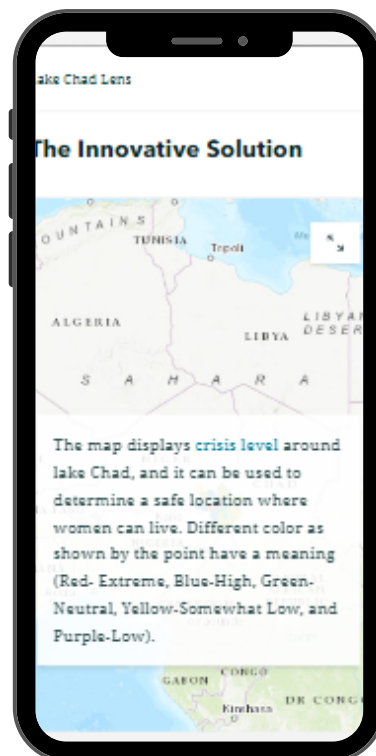
(b)



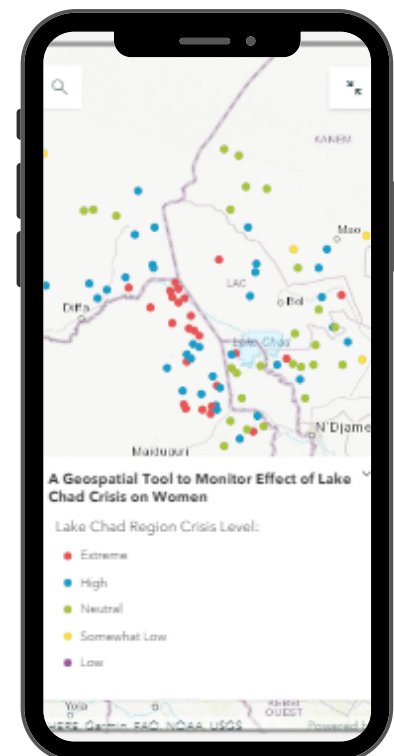
(c)



(d)

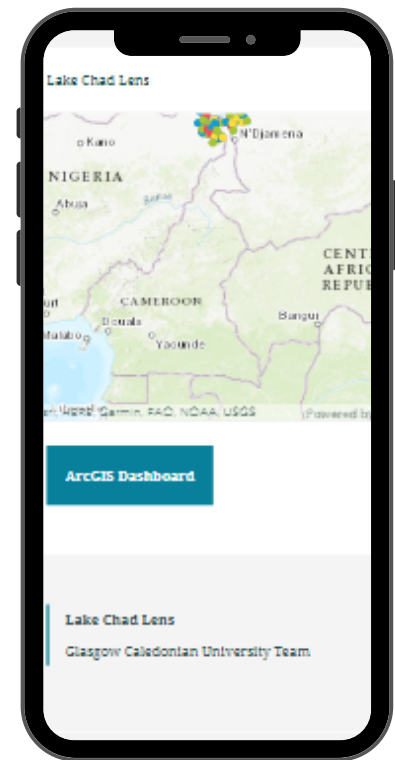


(e)



(f)

Part of the goal of this Story map is to instil alertness, knowledge, information and education to end-users. With the Story map having the ability to work offline, users in remote and infrastructural deprived locations like Lake Chad can still have access to information that will bring them up to speed. With the availability of Lake Chad crisis summary (b), the updated experience of locals (c), podcast or interview section of experts across various filed (d) and the innovative solution (e), every user will have a good knowledge of their location of interest that will guide their decision in whatever they want to do with respect to the location.



(g)

Figure 6. Storymap mobile version illustration: (a) Home page (b) Lake Chad crisis summary (c) The experience (d) Multimedia section (e) and (f) The innovative solution (g) Story map footer also with ArcGIS Dashboard tab

07. Final Website

The primary concept of Lake Chad Lens is to provide the accessibility to real-time data collection in a standardised manner on crisis levels, environmental change, and societal risks by focusing on women in Lake Chad community. The name of this web-based platform demonstrates how to make crisis look larger and clearer. Lake Chad Lens platform achieves its objective of continuing to form policy discussions by providing a variety of technical assessments and communication channels through four main mechanisms: (1) accessibility to data for enhancing collaborative crisis management; (2) engaging several expert opinions with policy makers; (3) assisting in the adoption of an effective, solution-oriented policy; (4) encouraging genuine interactions and dialogues between people and officials.

08. Research and Design Roadmap

1- Research Design: To start the design process, understanding the problem and all the challenges was the main part of this phase. The goal of research design is to determine how people interact with websites, what their requirements are, and what can be done to address their issues.

2- Analysis: Market research to define a target groups created a better understanding of what features and data were needed to add in the final platform in order to meet the needs of the target audiences.

3- Design: The major advantage of prototyping (low-fidelity and high-fidelity prototype) is that it allows for a more efficient and effective design cycle. Because prototypes allow the developers to test their designs in a "real-world" setting, it's simpler to see possible issues and avoid costly mistakes down the line.

4- Funding and Investment: One of the most significant challenges that many enterprises encounter is obtaining enough finance. It's critical to include a large margin for contingencies and the unexpected in the financial projections, even if it is a new product or service to be released.

5- Production and test: With a reliable budget, the final product (website) will be codified into a beta-testable version to be ready to the last testing and analysis process by developers and engineers.

6- Launch the product: The development step is not necessarily ended after your site is launched. Regularly updated content is one technique to attract repeat visitors to your website.

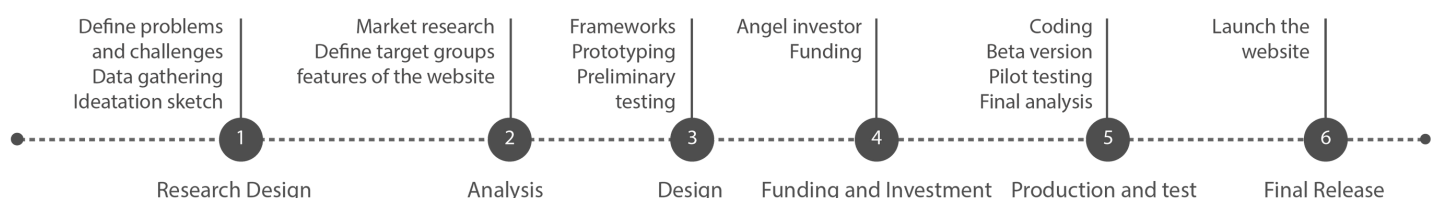


Figure 7. Design roadmap

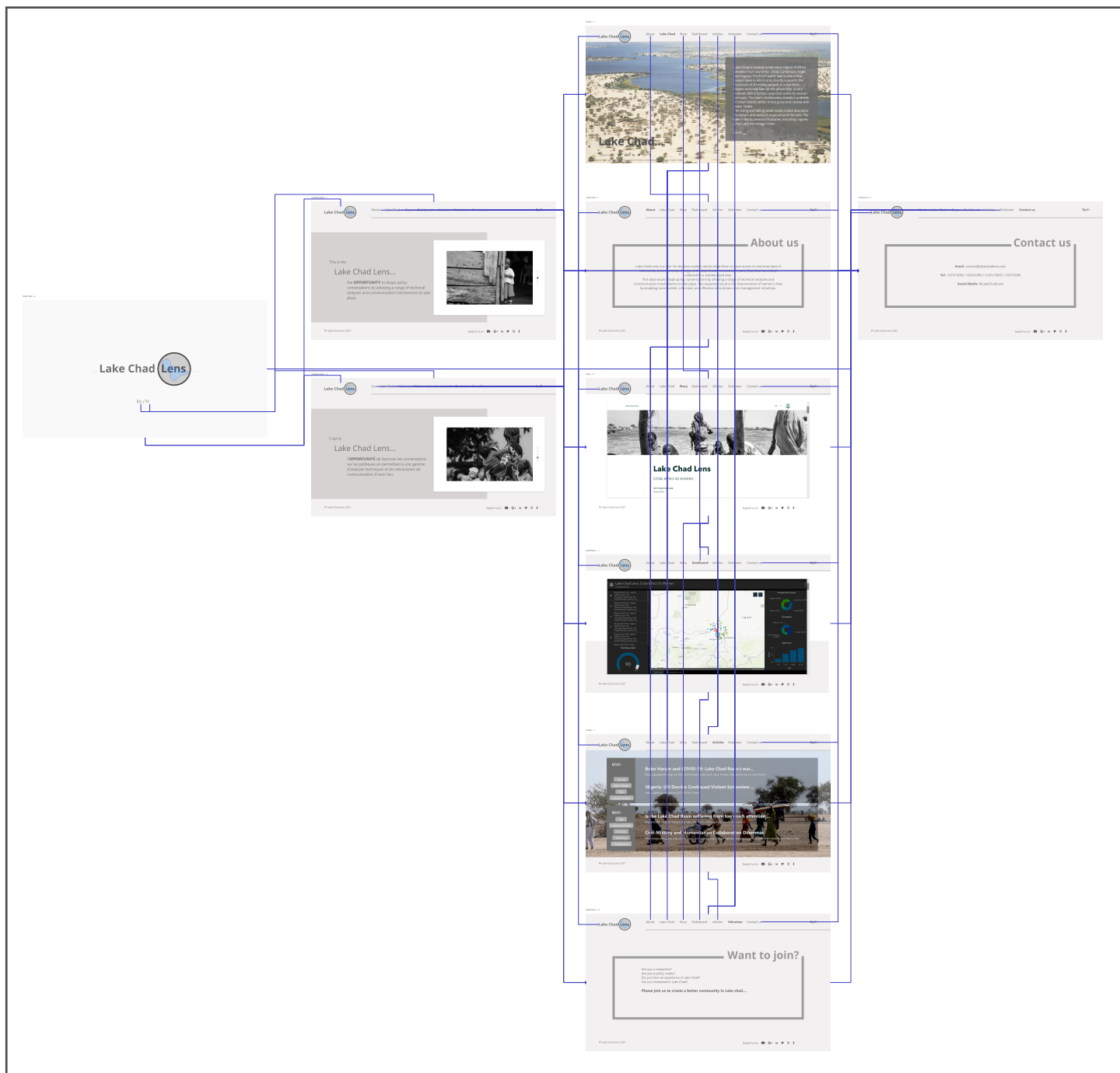


Figure 8. Website user flow diagram

09. Preliminary Testing

Lake Chad Lens team members have put the Lake Chad Lens platform (High-fidelity prototype through Adobe XD application and active link) to the test with their friends in which the excellent feedbacks and comments have been collected. Here is the screenshot of teammate, Jonathan, who wanted to monitor the age group of 18-39 and find the extreme effects of lake chad crisis on women through the Dashboard platform on the website.

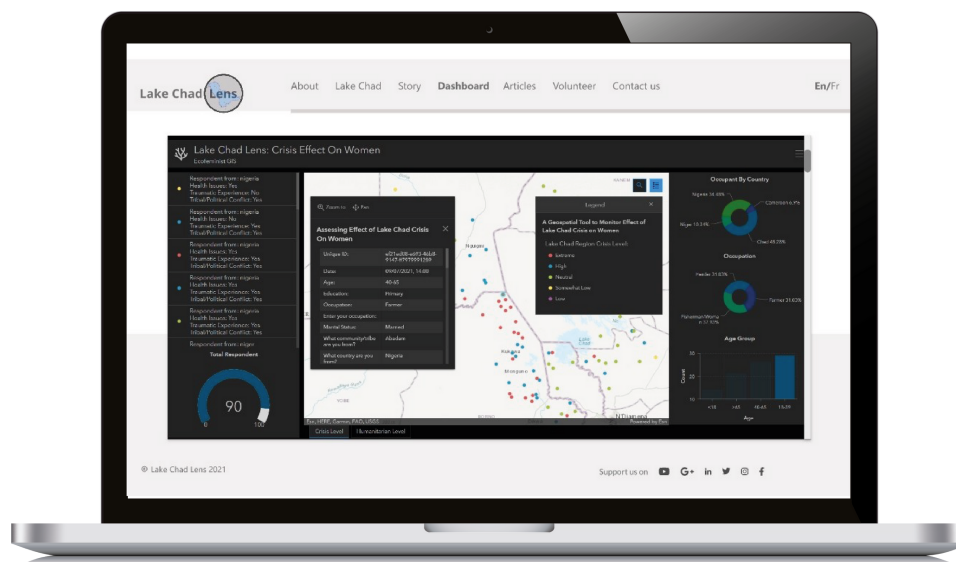


Figure 9. User flow diagram

10. Implementation and Timeline

The workable prototypes have already been produced in Adobe XD and Overflow. The next step is to find the investors and codify the website into a beta version before final release.

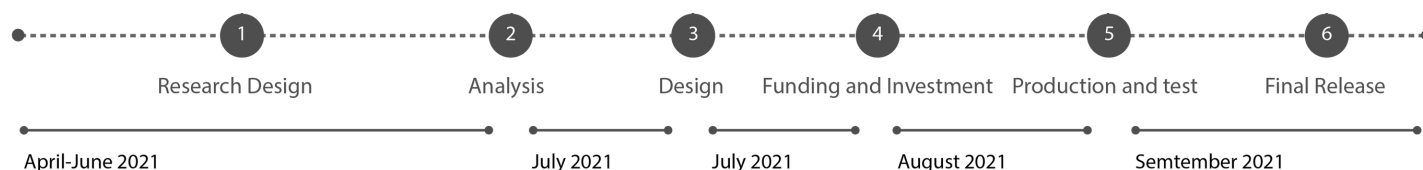



Figure 10. Project Timeline

11. Cost estimation

The overall cost of putting the pilot project into action is projected to be \$103,030.00. The entire cost includes the ESRI Professional Account subscription, data gathering, website development and annual maintenance, as well as training and other expenses.

Table 6. Cost estimation

Project Requirement	Description	Cost
ESRI Account (GIS professional advanced)	A year subscription for 10 quantity	\$ 54,030
Data collection	logistic support for field experts	\$ 10,000
Website/maintanance	Annual website maintenance	\$ 30,000
Training and miscellaneous	Orientation expense for field experts	\$ 9,000
Total	Cost summation	\$ 103,030



05 CONCLUSION

Conclusion

The women of Lake Chad face a complex intersectional humanitarian crisis. Accurate and current data is critical for informing decisions, strategies, and policies for managing the crisis. The proposed “Lake Chad Lens” ecofeminist GIS tool will empower decision makers with spatial patterns of data that will aid in developing sustainable and holistic solutions.

Feasible Solution

Supported by Research and Expert Testimonial

Developed through exhaustive research, literature reviews, application of the team’s technical expertise, and consultations with local experts, “Lake Chad Lens” supports several SDG’s and is practical in its application. Crowdsourcing, surveying, the use of ArcGIS Story Map, and the creation of a website allow data to not only be collected, but analysed and presented in a highly valuable, easy to understand, non-technical manner. The data is provided in both quantitative and qualitative forms allowing for extra analysis to take place in addition to the tool's outputs.

Strong Value Proposition

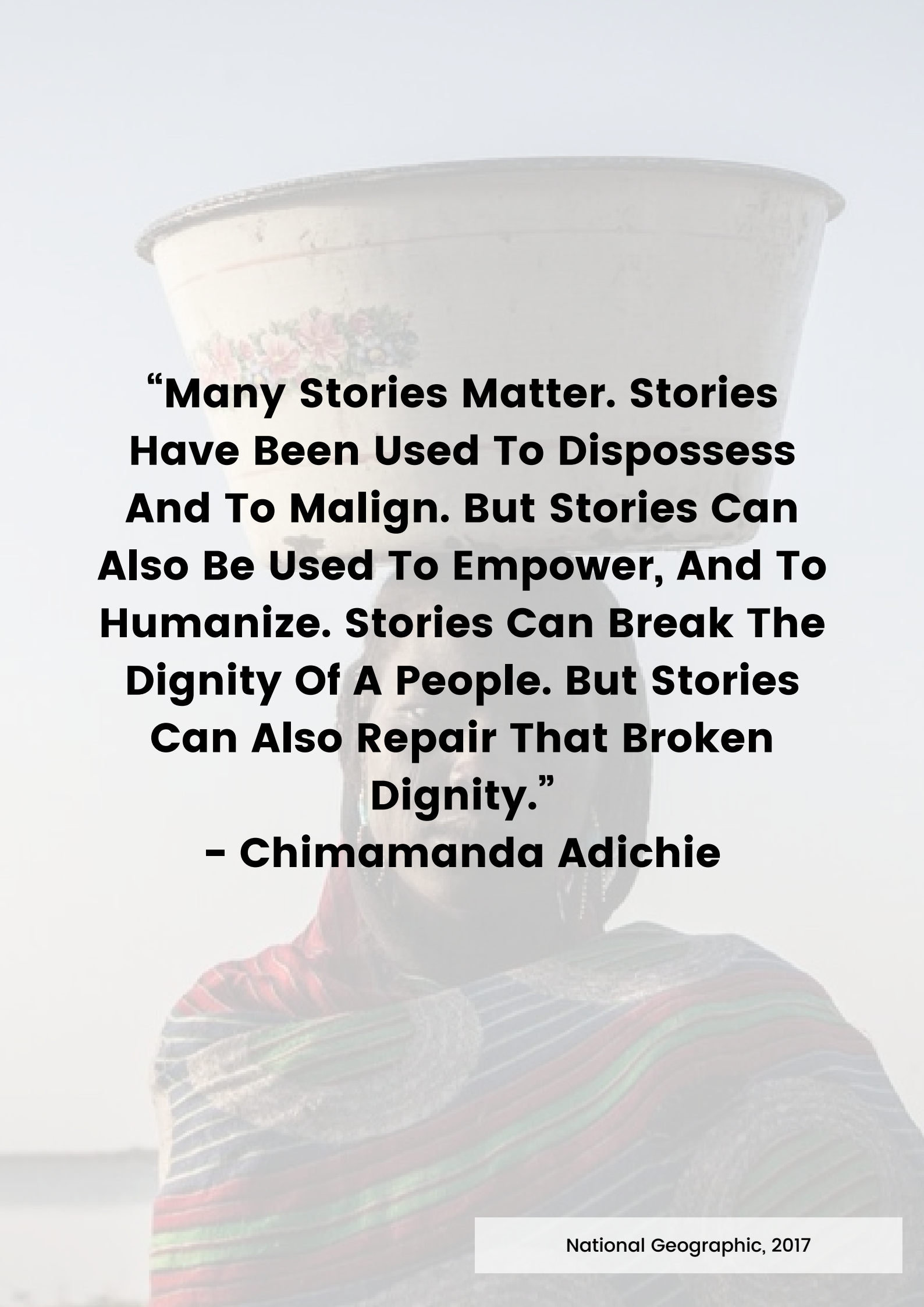
Real-time Update on Environmental and Humanitarian Situations That Define Crisis Levels

“Lake Chad Lens” creates shared technological infrastructure that allows respondents to act like a human sensor providing a real-time update on environmental situations by defining crisis levels. This helps advance the understanding of decision makers and the wider public on what challenges the women of Lake Chad face without being on-site. Most importantly, through the survey and data outputs, the tool allows the women to be part of the solution.

Scalable Approach to Crisis Management

Demographic Specific and Intersectional Approach

General applications have failed to address the challenges in Lake Chad. Nuanced, intersectional data of various demographics are required to fully account for the reality of challenges faced on the ground. Adopting this demographic-specific and intersectional approach as a core tenant of crisis management globally would create more informed and effective actions to relieve the suffering of communities.

A woman is shown from the chest up, wearing a vibrant shawl with horizontal stripes in red, green, and blue. She is carrying a large, white, conical bowl balanced on her head. The bowl has a decorative band of pink and green flowers near its base. The background is a soft, out-of-focus landscape. The text is overlaid on the image in a bold, black, sans-serif font.

“Many Stories Matter. Stories Have Been Used To Dispossess And To Malign. But Stories Can Also Be Used To Empower, And To Humanize. Stories Can Break The Dignity Of A People. But Stories Can Also Repair That Broken Dignity.”

– Chimamanda Adichie

Acknowledgements

The team expresses deep gratitude to the following entities and individuals who supported the development of the proposal:

- Those who participated in the consultations, pro-bono: Peter Ikyapa, Oladuso Adenike, and Nyetiobong William
- Our program Professor, Rohinton Emmanuel
- The Erasmus Program supported by the European Union
- Our host university: Glasgow Caledonian University, and partnering universities: LAB University of Applied Sciences and University of Huelva
- The Graduate Institute for hosting the Geneva Challenge
- Mukta M Dhere for providing helpful guidance of the Geneva Challenge requirements and expectations

**We thank you for your continued support
in our efforts to contribute to the SDGs**

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