

FIELD STUDY ON THE MULTIDIMENSIONAL FACTORS OF VULNERABILITY
AND RISKS IN THE AREAS OF THE VOLTA RIVER BASIN EXPOSED TO
VARIOUS HYDRO-METEOROLOGICAL HAZARDS
(FLOODS AND DROUGHTS)

Attachment Four

Implemented activities and main findings GHANA

April 2021

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Executive Summary

This report was drafted in the frame of the project: "Integration of Management Floods and drought and early warning for climate change adaptation in the Volta Basin (VFDM)", financed by the Adaptation Fund and implemented and implemented by the World Meteorological Organization (WMO), the Volta Basin Authority (VBA) and the Global Water Partnership West Africa (GWP-WA). It is aimed at understand vulnerabilities, exposure and capacities in 15 sites in Ghana, based on the available local information (including historical memory also for mapping flooded areas in each site). There are similar reports for the other five countries of the Volta Basin (Benin, Burkina Faso, Cote d'Ivoire, Mali, and Togo).

For each site, a specific two-page sheet was drafted including, beyond geographical and demographic data, information on the main factors related to exposure, vulnerabilities, and capacities. Specific indexes are also pointed out:

- An exposure index entailing exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc.), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)
- A vulnerability index including risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration
- A capacity index including assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, and human/institutional capacities.

Last but not least, each two-page sheet includes a map of flood (frequent and worst) in the site (reporting also the major structures/infrastructures affected).

All these sheets are included in Chapter 2, while Chapter 1 is devoted to the presentation of the main characteristics on the study and Chapter 3 to an overall analysis of the main findings of this study in Ghana.

Resumé

Ce rapport a été rédigé dans le cadre du projet: "Intégration de la gestion des crues et de la sécheresse et de l'alerte rapide pour l'adaptation au changement climatique dans le bassin de la Volta (VFDM)", financé par le Fonds pour l'adaptation et mis en œuvre et mis en œuvre par l'Organisation météorologique mondiale (OMM), l'Autorité du bassin de la Volta (ABV) et le Partenariat mondial pour l'eau en Afrique de l'Ouest (GWP-AO). Il vise à comprendre l'état de la vulnérabilité, l'exposition et les capacités dans 15 sites au Ghana, sur la base des informations locales disponibles (y compris la mémoire historique, fonctionnelle également à la cartographie des zones inondées dans chaque site). Des rapports similaires sont rédigés pour les cinq autres pays du bassin de la Volta (Bénin, Burkina Faso, Côte d'Ivoire, Mali et Togo).

Pour chaque site, une fiche spécifique de deux pages a été rédigée comprenant, au-delà des données géographiques et démographiques, des informations sur les principaux facteurs liés à l'exposition, aux vulnérabilités et aux capacités. Des index spécifiques sont également indiqués :

- l'indice d'exposition comprenant l'exposition aux inondations (fréquence, effets, etc.), l'exposition à la sécheresse (fréquence, effets, etc.) et l'exposition à d'autres aléas (tremblements de terre, incendies de forêt, glissements de terrain, tempêtes ou vents violents) ;
- l'indice de vulnérabilité comprend les facteurs de risque liés au logement/à l'habitat/aux services d'approvisionnement en eau et assainissement, à la santé, à l'éducation/à l'analphabétisme, aux conditions de travail et aux revenus, aux migrations, à la criminalité/sécurité, aux conflits (ethniques, religieux, politiques, entre agriculteurs et éleveurs), à la fragilité de la famille, aux disparités de genre, à la faiblesse de l'administration publique ;
- l'indice de capacité comprend les ressources liées à l'accès aux opportunités économiques et financières, les TIC, la société civile, les ressources humaines qualifiées, les institutions sociales, les capacités humaines et institutionnelles.

Chaque fiche comprend une carte des inondations (fréquentes et pires) relatives au site (indiquant également les principales structures / infrastructures affectées).

Toutes ces fiches constituent le chapitre 2 de ce Rapport, tandis que le chapitre 1 est consacré à la présentation des principales caractéristiques de l'étude et le chapitre 3 à une analyse globale des principaux résultats de cette étude au Ghana.

Chapter One

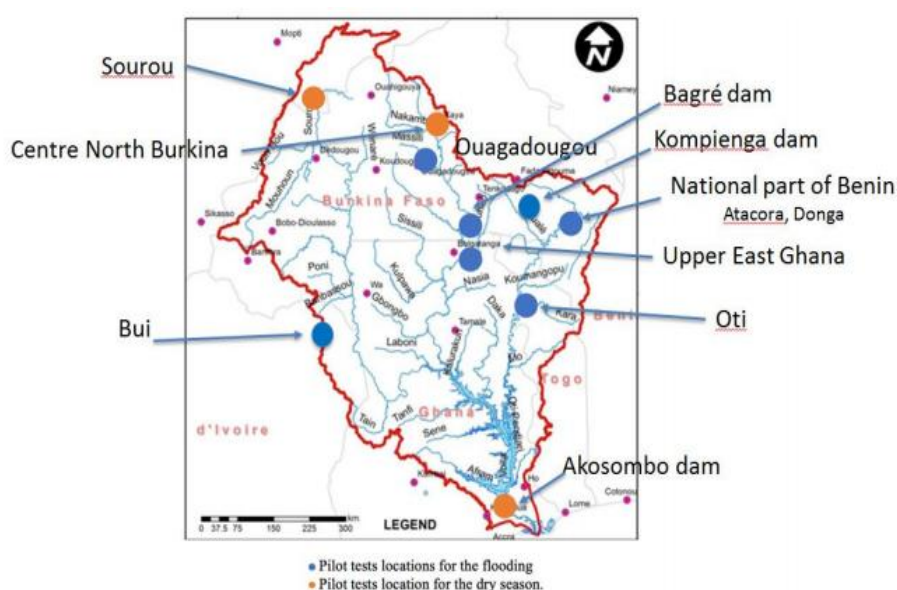
General characteristics of the study

1. Context

The World Meteorological Organization (WMO), the Volta Basin Authority (VBA) and the Global Water Partnership West Africa (GWP-WA) are implementing the project: "**Integration of Management Floods and drought and early warning for climate change adaptation in the Volta Basin (VFDM)**", financed by the Adaptation Fund. The three cited organizations are part of the Project Management Unit (PMU).

The activities of VFDM project began in June 2019 and will last until mid-2023. The implementation of VFDM involves the active participation of national agencies (meteorological and national hydrological, water resources, water protection, civil protection, etc.) and WMO partners such as CIMA Foundation and CERFE.

One of the activities planned under the VFDM project is to conduct a "Study on the multi-dimensional factors of vulnerability (social, economic, ecological, cultural, political and infrastructural vulnerability) in areas of the Volta Basin highly exposed to hydro-meteorological hazards, such as floods and drought¹"; including 60 sites in the Volta Basin located in 10 areas already identified in accordance with this map:



- Burkina Faso-15 sites
- Ghana-15 sites
- Benin-8 sites
- Cote d'Ivoire-8 sites
- Mali-7 sites
- Togo-8 sites.

The 60 sites were identified in strict collaboration between the PMU and the national and local authorities of the countries concerned. More specifically, in Ghana the study was implemented in the following 15 sites.

¹ This is the official/administrative denomination of the study. As we'll see later, this study takes into account, beyond the vulnerability factors, also some issues related to the exposure to the hazards, and to the capacities in the areas of the Volta basin.

TABLE 1 – The selected sites surveyed in Ghana by Sub-Basin and location

Sub Basin	Location	Selected Site
Black Volta	Bole Bamboi District	Chache
Black Volta	Central Gonja District	Buipe
Black Volta	Lawra District	Birifor
Black Volta	Wa West District	Jambusier
Oti	Tatali-Sanguli District	Sanguli
Oti	Saboba District	Kpalba
Oti	Saboba District	Wapuli
White Volta	Bawku Municipal	Djentiga
	Asugyaman district	Akwamufie
White Volta	Bawku Municipal	Tampizua
White Volta	Binduri District	Yarigungu
White Volta	Binduri District	Azumsapeliga
White Volta	Bongo District	Kunkua
White Volta	West Mamprusi District	Nasia
White Volta	Savelugu Municipal	Kukobilla

The study in Ghana was implemented by Frederick Logah, GWP-WA consultant, who was assisted, in few sites, by Mr Ben Ampomah (GWP-WA).

This report was prepared by Andrea Declich, Federico L. Marta and Gabriele Quinti and includes beyond this chapter (describing the general characteristics of the study), a second chapter including 15 sheets, each one with the main important information on the investigated sites; and a third chapter presenting an overall analysis of the main findings of this study related to Ghana.

2. Objectives and contents

The activities were aimed at achieving two objectives:

- a) Understand hazards, vulnerabilities, exposure and capacities at each site based on the available local information
- b) Collect information on flooded areas in each site based on local knowledge, investigating, more specifically, the most frequent and worst flood events according to the communities' historical memory.

The activities were based on the assumption that local actors know their territory well, specifically in relation to natural weather-induced hazards (e.g. flood and drought). The study considers three aspects related to disaster risk management:

- The exposure to the hazards affecting the community,
- The community's vulnerability, and
- The adaptive capacity².

² <https://doi.org/10.3390/hydrology3040042>

The study, therefore, concerns, first, the exposure to floods and drought, but also to other hazards such as fires, earthquakes, coastal erosion, strong winds and landslides. Particular attention was paid to floods, which were "mapped" on the basis of the historical memory of local communities (flood frequency/intensity; flood effects/impacts; time passed from the worst flood; houses built in inappropriate places, such as banks of rivers, hillsides presenting risks of landslides; systems for detection, monitoring and prevention of flood and alarm system in case of possible flooding; infrastructure in watercourses). In few cases drought was also "mapped" based on the historical memory of local communities and, anyway, in all the sites concerned by this hazard information was collected on its effects/impacts and on systems for prevention and monitoring.

Second, the study provides a better understanding of vulnerability and capacities in the selected communities.

In this study, vulnerability³ is defined according to the UN terminology⁴ as *the conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards*.

Regarding local vulnerability in the strict sense, the following elements are considered:

- Poor housing, habitat, infrastructures (roads, WSS, power)
- Health (malnutrition, illness, health services presence/quality, drugs availability)
- Education (illiteracy, education services presence/quality, children not attending school to work)
- Unemployment/inadequate employment; farmers without land; lack of income; migration
- Criminality/lack of security
- Conflicts (ethnic, religious, political, among farmers and breeders)
- Family fragility (e.g., large households, elderly living alone, etc.)
- Gender gaps
- Poor public administration.

As for capabilities, the following elements are considered:

- Presence of qualified human resources
- Civil society presence and activities
- Development projects (with specific attention to those having a focus on issues related to DRM)
- ICT
- Finance, trade, enterprises, livestock
- Environmental protection (e.g., Systems for detection, monitoring and prevention of hazards; Presence of a Disaster Management Committee; community awareness on hazards; community participation in DRM; etc.)
- Services such as civil protection, fire-fighters, police, forest guards
- Social institutions (e.g., village development committee, presence of a traditional/religious leadership).

³ Vulnerability is an ambiguous concept. There are many definitions, some of which consider only negative aspects, while others balance these negative aspects on the one hand with resources on the other (both included in the notion of vulnerability). We take into account the two aspects in this study by considering the "negative" factors as part of local vulnerability (in the strict sense) and "positive" factors as part of capacities.

⁴ https://www.preventionweb.net/files/50683_oiewgreportenglish.pdf

3. Methodology and tools

Sources of information

For each site, information was collected through:

- Consultation with key informants (for example community leaders, leaders of civil society organizations, government officials, elders, highly educated people). This consultation was done through either individual interviews or discussion groups at each site (involving from 8 to 20 people such as key informants but also entrepreneurs, farmers, shopkeepers, breeders and including women and youth)
- Direct observation (also through maps, a GPS device, a Smartphone with camera or equivalent)
- Consultation of data/documents at the national, regional and local level (if available and accessible).

Tools

A technical tool for gathering information in each site was prepared and a procedure to map the flood (extended in few sites also to drought mapping) was developed. Both the technical tool and the procedure have been tested in 3 pilot sites (among them, 1 in Ghana) and finalized thereafter.

The collection of information was implemented also thanks to further tools provided to the national consultants. More specifically:

- Guidelines for applying tool in the communities and for mapping
- Details on the operations to implement before, during and after the visit in each site
- Some suggestions to overcome possible problems during the implementation of the field visits
- Interactive “e-learning space” for flood mapping.

Indexes

For each site, the following five indexes were calculated.

- a) **Index of exposure to drought**, considering (among other) the following elements:
 - i. intensity of drought
 - ii. effects/impacts of drought
 - iii. systems for detection, monitoring and prevention of drought
- b) **Index of exposure to flood**, considering (among other) the following elements:
 - i. intensity of flood
 - ii. effects/impacts of flood
 - iii. time passed from the worst flood
 - iv. houses built in inappropriate places (e.g., banks of rivers, hillsides presenting risks of landslides)
 - v. systems for detection, monitoring and prevention of flood
 - vi. alarm system in case of possible flooding
 - vii. infrastructure in watercourses
- c) **Overall index of exposure**, considering the following elements:

- i. index of exposure to drought (point a above)
 - ii. index of exposure to flood (point b above)
 - iii. exposure to other hazards, such as fires, strong winds, landslides, coastal erosion, heat waves, earthquake, pandemics, crop pest, livestock disease, pollution
- d) **Index of vulnerability**, considering the following elements:
- i. Poor housing and habitat (e.g., houses built in inappropriate places , Informal settlements) infrastructures (roads, water, latrines and drainage system, power)
 - ii. Health (malnutrition; illness such as diseases linked to unhealthy environment or psychosocial conditions post disaster; health services presence/quality; drugs availability)
 - iii. Education (illiteracy, children not attending school to work; schools and vocational training presence/quality, teaching equipment/materials quality and availability)
 - iv. Unemployment/inadequate employment; farmers without land; lack of income; migration
 - v. Criminality/lack of security
 - vi. Conflicts (ethnic, religious, political, among farmers and breeders)
 - vii. Family fragility (e.g., large households, elderly living alone, etc.)
 - viii. Gender gaps (e.g., local women in local public administration at all levels and in Committees, tendency not to enrol little girls in school, women's level of access to land, financial services, quality agricultural seeds, etc.)
 - ix. Poor public administration (e.g. poor accessibility to local administrative offices)
- e) **Index of capacity**, considering the following elements:
- i. Presence of qualified human resources (e.g., health workers, persons with a higher or university degree, etc.)
 - ii. Civil society presence and activities (NGOs, mutual aid groups and micro-credit groups, women associations, religious groups, farmers' or stockbreeders' cooperatives or associations, associations for the protection and assistance to vulnerable groups, etc.)
 - iii. Development projects (with specific attention to those having a focus on issues related to DRM)
 - iv. ICT (mobile phones, internet mobile connections, PC, etc.)
 - v. Finance (e.g., bank counters or micro-finance institutions), trade (e.g. markets, petty shops, shops for retail sale) , enterprises, livestock
 - vi. Environmental protection (e.g., Systems for detection, monitoring and prevention of hazards; Presence of a Disaster Management Committee; community awareness on hazards; community participation in DRM; etc.)
 - vii. Services such as civil protection, fire-fighters, police, forest guards
 - viii. Social institutions (e.g., village development committee, presence of a traditional/religious leadership)

Each index can range from 0 to 10. For the indexes a), b), c) and d) 0 corresponds to the best theoretical situation; and 10 to the worst theoretical situation. Conversely, for the index e), 0 corresponds to the worst theoretical situation; and 10 to the best theoretical situation.

In the reality of the 60 investigated in the whole Volta Basin (see the Ghana's values in Chapter 3):

- a) The index of exposure to drought range from 0.00 to 9.00
- b) The index of exposure to flood range from 0.00 to 7.45
- c) The overall index of exposure range from 1.20 to 6.90

- d) The index of vulnerability range from 2.50 to 6.75
- e) The index of capacity range from 1.27 to 6.87.

Correlation indexes

In the overall analysis (chapter 3) an attempt was made to calculate the correlations between the trends of the indices in the 15 sites. This is a partially arbitrary exercise, given the limited number of cases ($n = 15$) and the partial uncertainty of the phenomena considered, functional only to identify possible trends. The “numbers”, therefore, must be considered as a mere rhetorical expedient to represent such hypothetical trends and not as the exact calculation of a correlation (correlation indexes).

4. Activities implemented

Before the field work in the 15 sites, the following activities were implemented

- Preparation, discussion and finalization of data and information collection tools, guidelines and other supporting tools for fieldwork
- "Distance" training of national consultants (many meetings from July to October; interactive “e-learning space” for flood mapping)
- Selection of the 15 sites in Ghana (in agreement among the GWP-WA, The VBA and the WMO, with the consultation of Frederick Logah)
- Logistic arrangements (thanks to the assistance of Ben Ampomah from GWP-WA).

The fieldwork was implemented in the sites mentioned in Para. 1 from the beginning of November to mid-December 2020.

Chapter Two

Exposure, vulnerability and capacities in the 15 sites in Ghana

As already stated in Chapter One, in Ghana the study was implemented in 15 sites listed below.

1. Akwamufie
2. Azumsapeliga
3. Birifor
4. Buipe
5. Chache
6. Djentiga
7. Jambusier
8. Kpalba
9. Kukobilla
10. Kunkua
11. Nasia
12. Sanguli
13. Tampizua
14. Wapuli
15. Yarigungu

While Chapter Three will be devoted to an overall analysis on data and information recorded in these 15 sites, this chapter include 15 two-page sheet, one for each of the 15 investigated sites, which briefly report the following information.

GEOGRAPHIC DATA

- Name of the site
- Region and district
- Specification about the eventual existence of hamlets
- Ecosystems

DEMOGRAPHIC DATA

- Total population
- % of women
- % of children
- % of youth
- % of elderly population

MAP OF FLOOD (frequent and worst) *IN THE SITE* (reporting also the major structures/infrastructures affected)

EXPOSURE

- Overall index (value of the index and related colour⁵)
- Exposure to floods (value of the index)
- Exposure to drought (value of the index)
- Date of reported worst flood
- Other reported hazards (e.g., fires, strong winds, landslides, coastal erosion, heat waves, earthquake, pandemics, crop pest, livestock disease, pollution)
- Deforestation

VULNERABILITY

- Value of the index and related colour⁶
- Main reported risk factors (e.g., informal settlements, malnutrition, absence of health services, illiteracy, criminality, conflicts, etc.)

CAPACITY

- Value of the index and related colour⁷
- Main reported community assets (e.g., CSOs, presence of a Disaster Management Committee, presence of qualified human resources, ICT, Infrastructure in watercourses such as dams, banks, reservoirs, etc.)
- Specification on the presence of alarm system in case of flooding
- Specification on the presence of systems for detection, monitoring and prevention of hazards

The 15 two-page sheet follow, alphabetically sorted.

⁵ Blue = absent/very low; light blue = low; light green = medium; yellow/bright sun = high; orange = very high

⁶ Blue = absent/very low; light blue = low; light green = medium; yellow/bright sun = high; orange = very high

⁷ Blue = very high; light blue = high; light green = medium; yellow/bright sun = low; orange = absent/very low



Ghana

Akwamufie

Eastern Region

Asuogy Aman District

Hamlet: Yes (reported n°: several)

Ecosystems: Grassland, mountains, sacred place, riparian forest, river

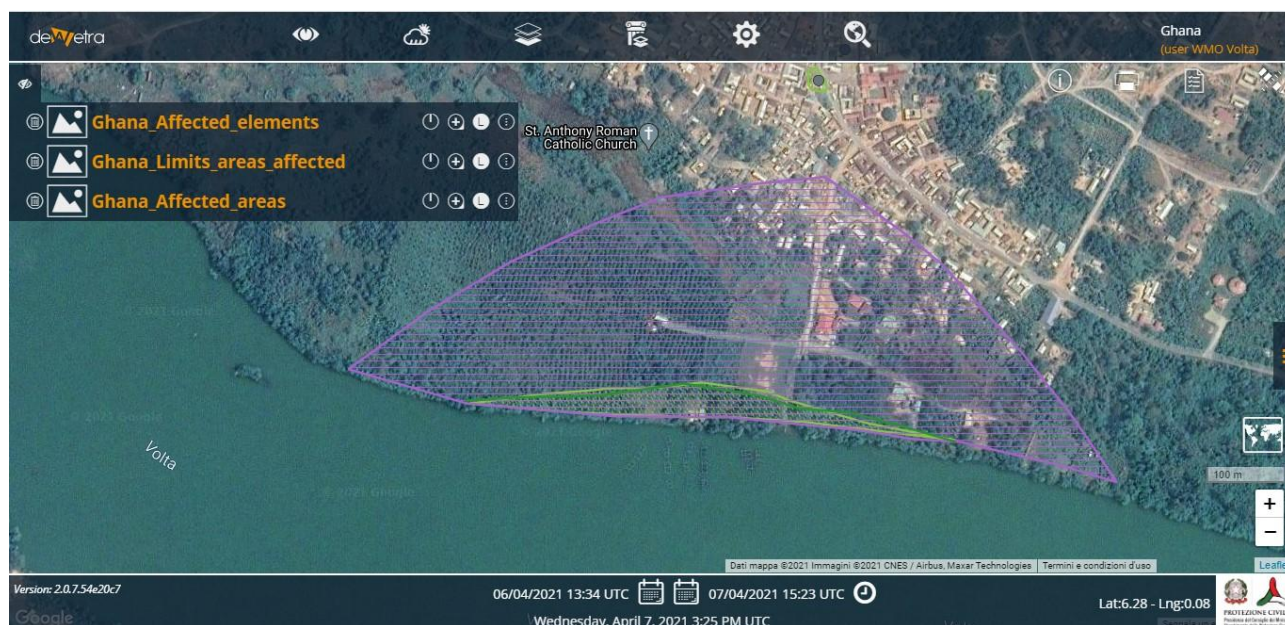
Total Population: 4600

% of women: 60%

% of children: 15%

% of youths: 20%

% of elderly population: 30%



Exposure (overall): 2.99

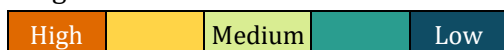


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 3.35

Exposure to drought: 3.75

Legend:



Date of reported worst flood: 1968

Other reported hazards: Fires; Strong wind

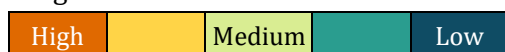
Deforestation: Absent

Vulnerability: 3.55



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

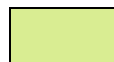
Legend:



Main reported risk factors:

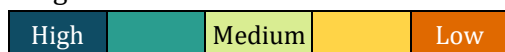
1. Illiteracy
2. Unemployment
3. Large households

Capacity: 4.07



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. Presence of Disaster Management Committee
2. Qualified human resources
3. CSOs

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No



Ghana

Azumsapeliga

Upper East Region

Binduri District

Hamlet: Yes (reported n°: 2)

Ecosystems: River, sacred place, riparian forest

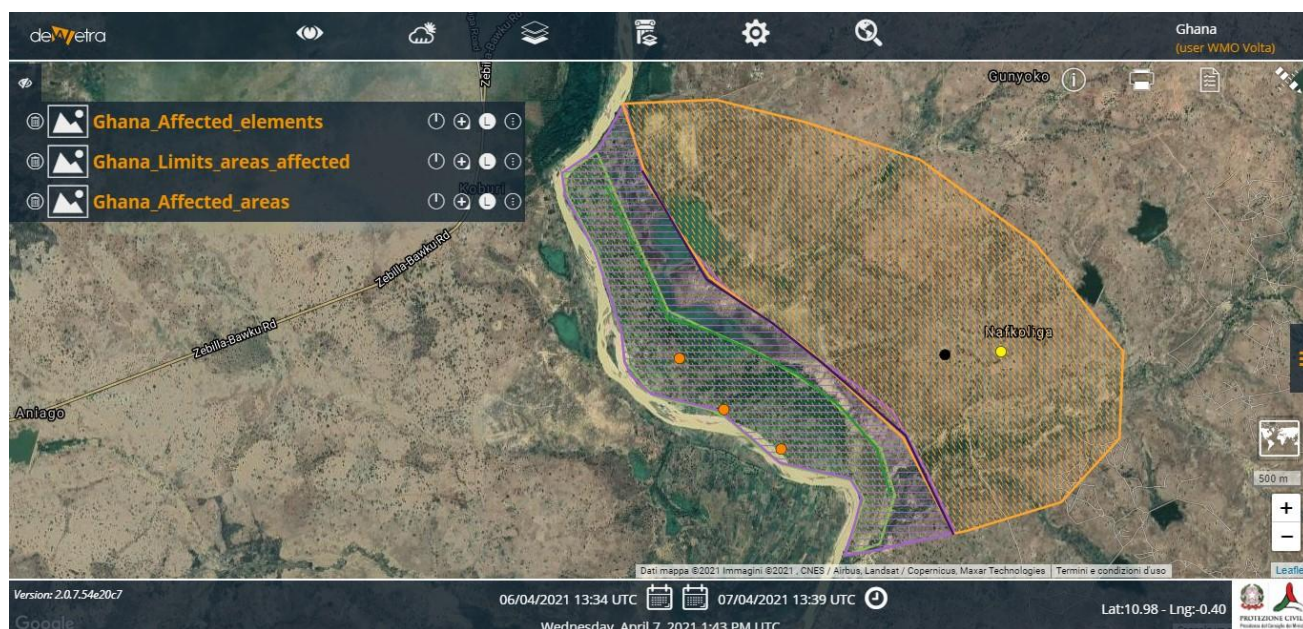
Total Population: 1250

% of women: 68%

% of children: 17%

% of youths: 25%

% of elderly population: 3%



Exposure (overall): 4.20

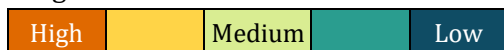


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 3.82

Exposure to drought: 4.50

Legend:



Date of reported worst flood: 2020

Other reported hazards: Crop pest; Livestock disease; Fires; Coastal erosion

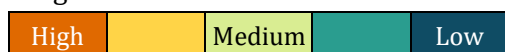
Deforestation: Very widespread

Vulnerability: 4.64



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

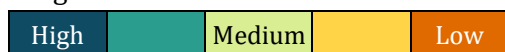
1. Illiteracy
2. WSS inadequate
3. Informal settlements

Capacity: 4.60



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. CSOs
2. Presence of Disaster Management Committee
3. ICT

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No

Upper West Region

Lawra District

Hamlet: No

Ecosystems: Spring water, sacred places, riparian forest, river, tourist site

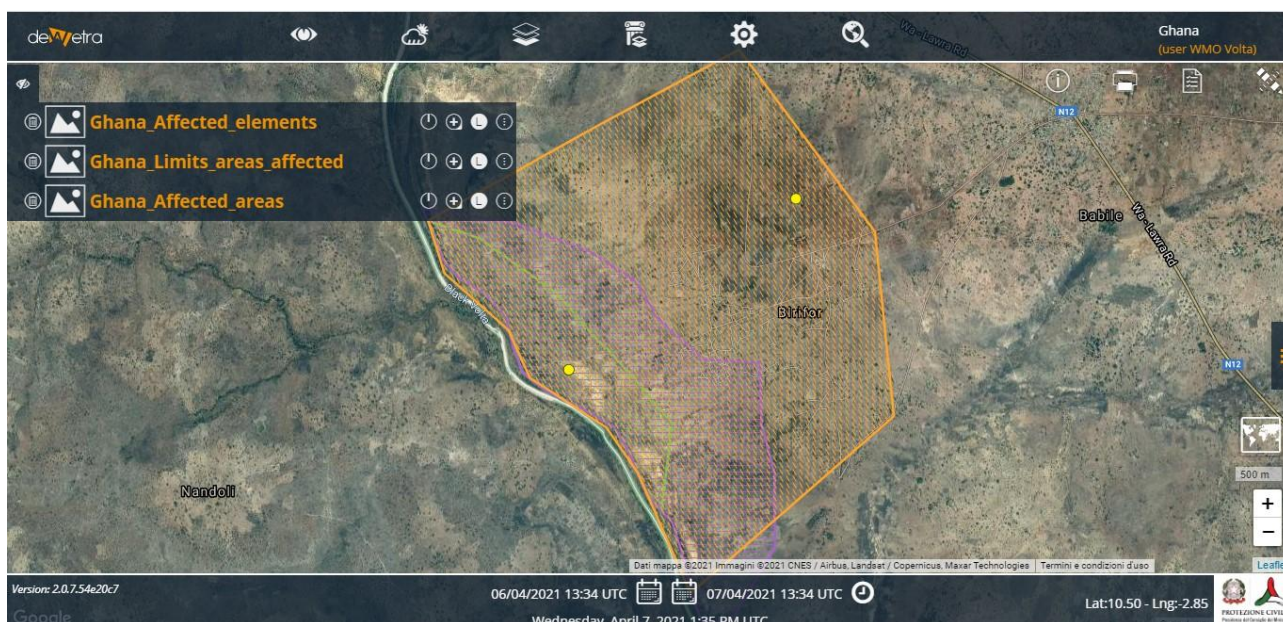
Total Population: 1876

% of women: 60%

% of children: 10%

% of youths: 25%

% of elderly population: 15%



Exposure (overall): 4.92

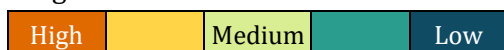


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 6.04

Exposure to drought: 4.50

Legend:



Date of reported worst flood: 2007

Other reported hazards: Crop pest; Heat waves; Livestock disease; Strong wind; Coastal erosion

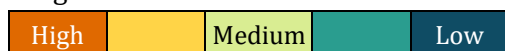
Deforestation: Absent

Vulnerability: 3.95



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

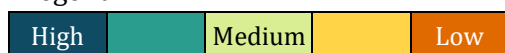
1. Large households
2. Illiteracy
3. Migration

Capacity: 4.00



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. CSOs
2. ICT

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No

Savannah Region

Central Gonja District

Hamlet: No

Ecosystems: River, sacred place, forest, grassland

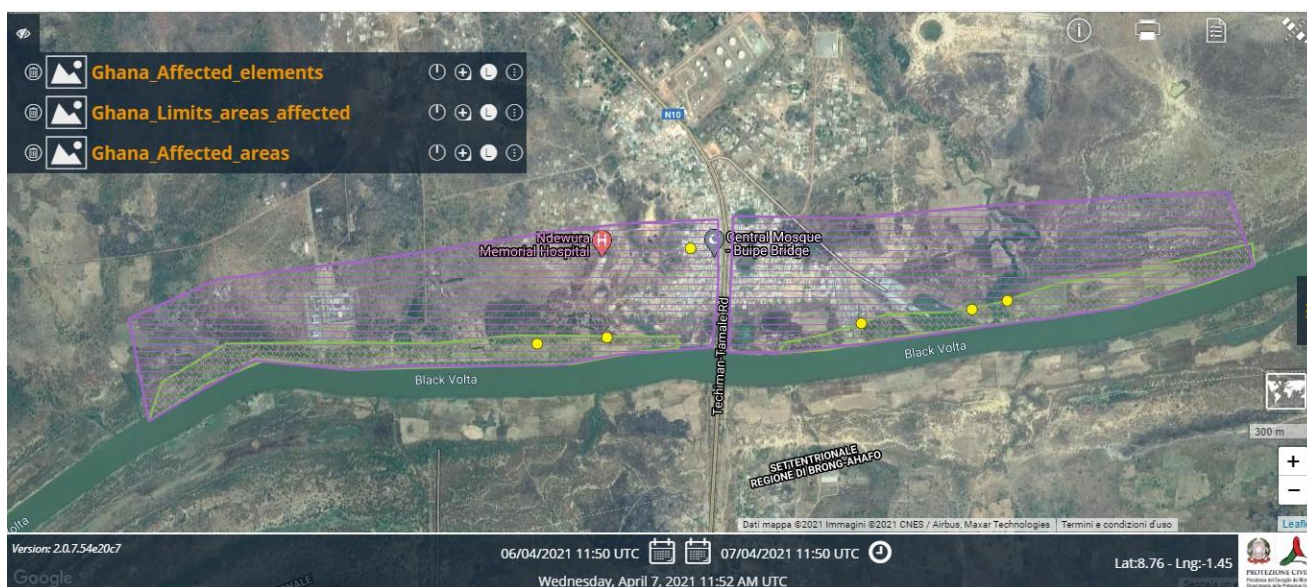
Total Population: 12000

% of women: 70%

% of children: 15%

% of youths: 15%

% of elderly population: 10%



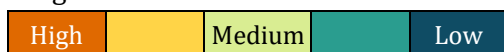
Exposure (overall): 3.98

Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 3.96

Exposure to drought: 4.00

Legend:



Date of reported worst flood: 2010

Other reported hazards: Fires; Livestock disease; Pollution

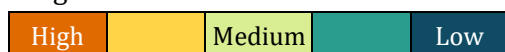
Deforestation: Widespread

Vulnerability: 4.35



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

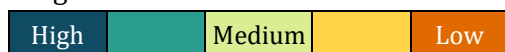
1. Lack of jobs
2. Criminality
3. Conflicts

Capacity: 6.40



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. Presence of a Disaster Management Committee
2. Qualified human resources
3. CSOs
4. ICT

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No

Savannah Region

Bole Bamboi District

Hamlet: No

Ecosystems: Savannah, river, sacred place

Total Population: 800

% of women: 60%

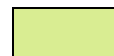
% of children: 5%

% of youths: 10%

% of elderly population: 10%



Exposure (overall): 3.68

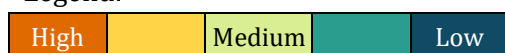


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 3.41

Exposure to drought: 4.00

Legend:



Date of reported worst flood: 1999

Other reported hazards: Fires; Livestock disease; Crop pest; Strong wind; Coastal erosion; Heat waves

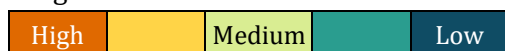
Deforestation: Very widespreas

Vulnerability: 4.85



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

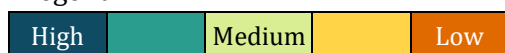
1. Informal settlements
2. WSS inadequate
3. Illiteracy

Capacity: 3.20



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. ICT
2. Infrastructure in watercourses (dams, banks, etc.)

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No



Ghana

Djentiga

Upper East Region

Bawku District

Hamlet: Yes (reported n°: 7)

Ecosystems: River, savannah, riparian forest

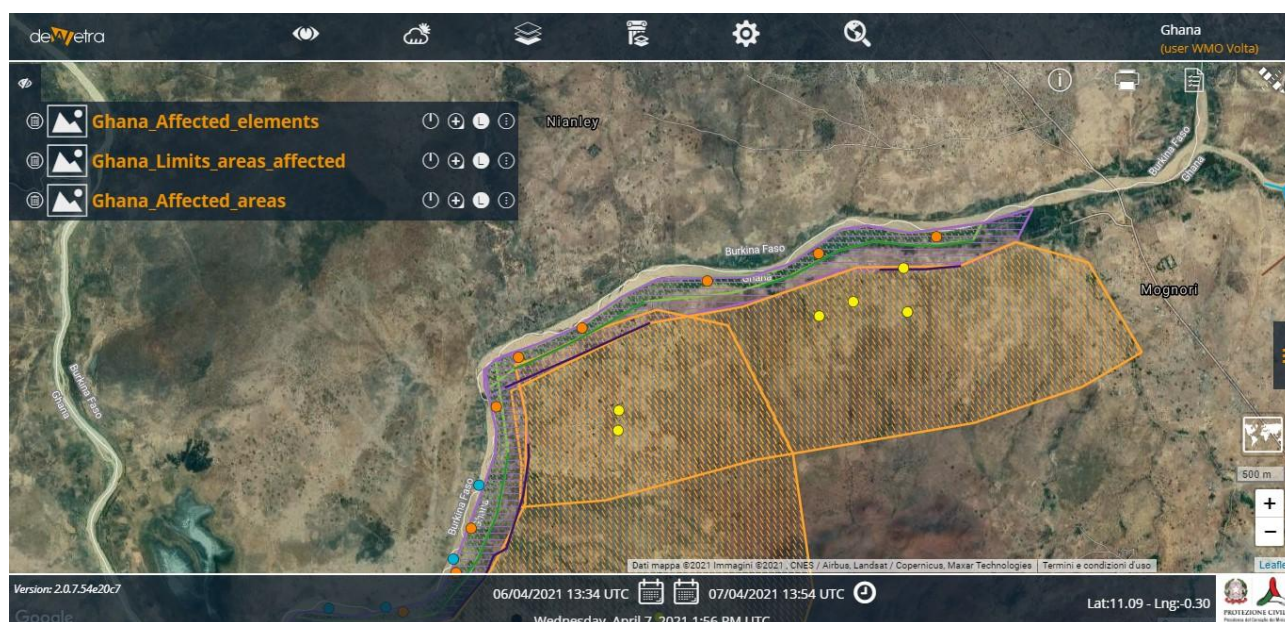
Total Population: 3000

% of women: 60%

% of children: 23%

% of youths: 20%

% of elderly population: 3%



Exposure (overall): 5.00

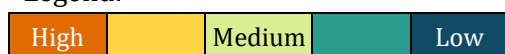


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 5.82

Exposure to drought: 4.50

Legend:



Date of reported worst flood: 2020

Other reported hazards: Fires; Strong wind; Crop pest; Livestock disease; Heat waves; Coastal erosion

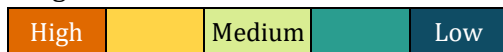
Deforestation: Not very widespread

Vulnerability: 4.45



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

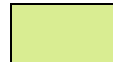
Legend:



Main reported risk factors:

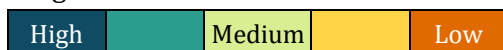
1. WSS inadequate
2. Informal settlements
3. Health services inadequate

Capacity: 4.53



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. CSOs
2. ICT

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No

Upper West Region

Wa West District

Hamlet: No

Ecosystems: River, sacred places, open savannah

Total Population: 890

% of women: 65%

% of children: 35%

% of youths: 10%

% of elderly population: 15%



Exposure (overall): 4.10

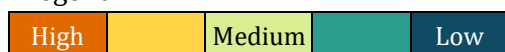


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 4.18

Exposure to drought: 5.00

Legend:



Date of reported worst flood: 2014

Other reported hazards: Fires; Crop pest; Livestock disease; Strong wind; Coastal erosion

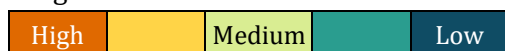
Deforestation: Not very widespread

Vulnerability: 4.50



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

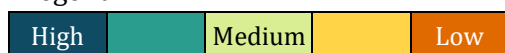
1. Informal settlements
2. WSS inadequate
3. Unemployment

Capacity: 4.07



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. Presence of a Disaster Management Committee
2. ICT

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No

Oti Region

Saboba District

Hamlet: Yes (reported n°: >8)

Ecosystems: River, dam, sacred place,
savannah grassland, forest

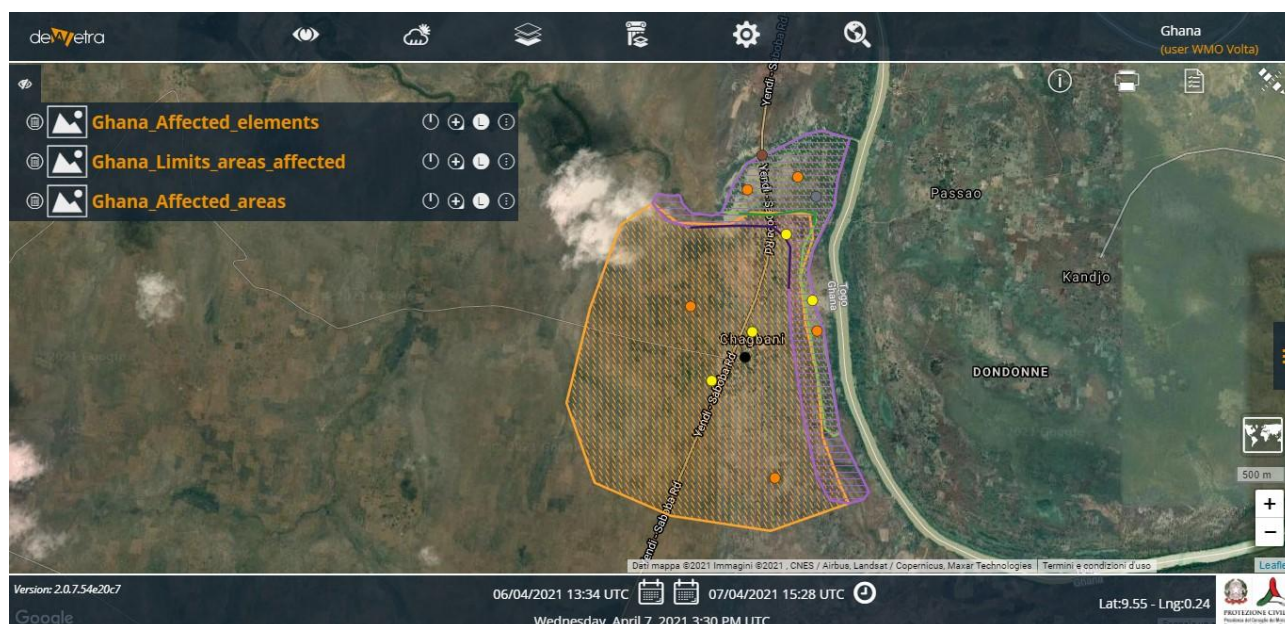
Total Population: 3442

% of women: 65%

% of children: 15%

% of youths: 22%

% of elderly population: 10%



Exposure (overall): 4.58

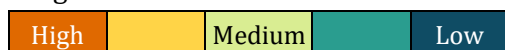


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 3.96

Exposure to drought: 5.50

Legend:



Date of reported worst flood: 2008

Other reported hazards: Fires; Strong wind; Crop pest; Livestock disease

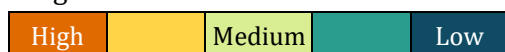
Deforestation: Not very widespread

Vulnerability: 4.35



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

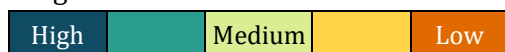
1. Informal settlements
2. Education services inadequate
3. Unemployment

Capacity: 4.73



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. Infrastructure in watercourses (dams, banks, etc.)
2. CSOs
3. ICT

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No



Kukobilla

North East Region

Savelugu District

Hamlet: No

Ecosystems: River, savannah grassland,
hills, dams, sacred place

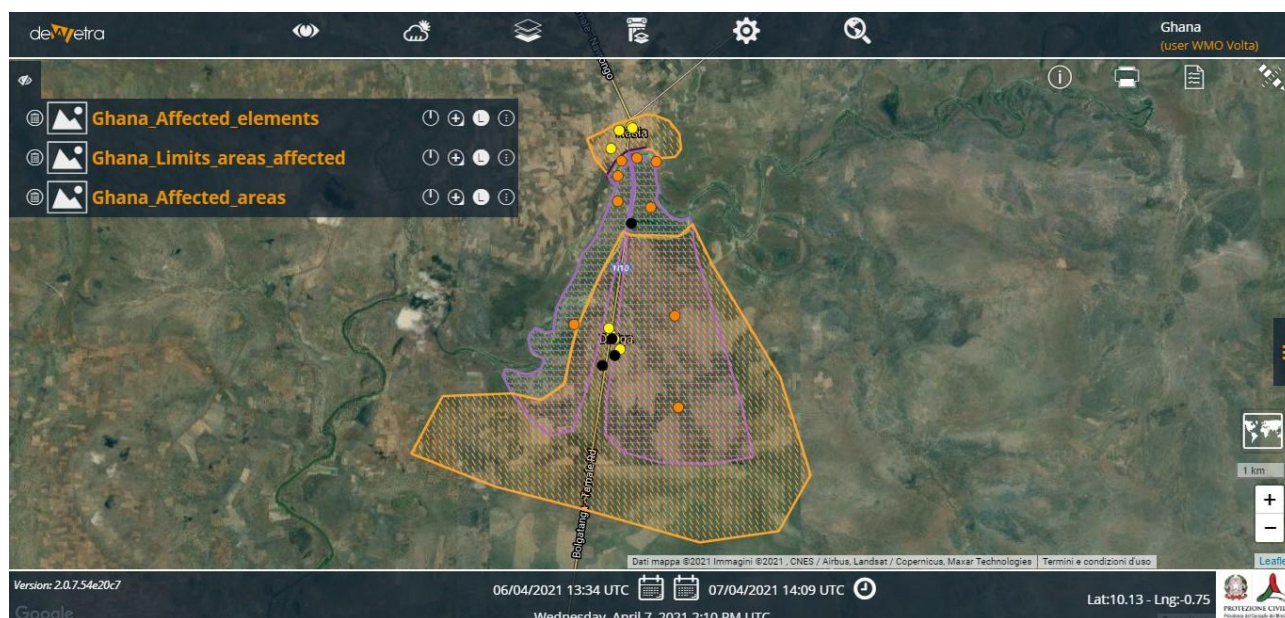
Total Population: 2141

% of women: 60%

% of children: 18%

% of youths: 20%

% of elderly population: 2%



Exposure (overall): 4.40

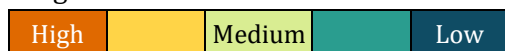


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 4.00

Exposure to drought: 5.00

Legend:



Date of reported worst flood: 2020

Other reported hazards: Fires; Strong wind; Crop pest; Livestock disease

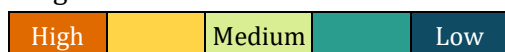
Deforestation: Widespread

Vulnerability: 3.90



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

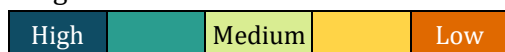
1. WSS inadequate
2. Informal settlements
3. Gender gap

Capacity: 3.73



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. ICT
2. Infrastructure in watercourses (dams, banks, etc.)

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No

Upper East Region

Bongo District

Hamlet: Yes (reported n°: n.a.)

Ecosystems: Dam, rocks, stream, savannah
grassland, scared places

Total Population: 1939

% of women: 60%

% of children: 28%

% of youths: 18%

% of elderly population: 3%



Exposure (overall): 6.06

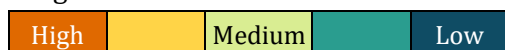


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 6.84

Exposure to drought: 7.00

Legend:



Date of reported worst flood: 2007

Other reported hazards: Crop pest; Livestock disease; Heat waves; Strong wind; Coastal erosion

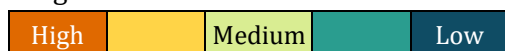
Deforestation: Absent

Vulnerability: 4.90



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

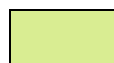
Legend:



Main reported risk factors:

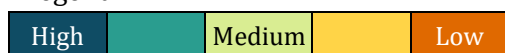
1. Absence of health services
2. Informal settlements
3. WSS inadequate

Capacity: 4.93



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. ICT
2. CSOs
3. Infrastructure in watercourses (dams, banks, etc.)

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No

North East Region

West Mamprusi District

Hamlet: No

Ecosystems: River, savannah grassland,
sacred place

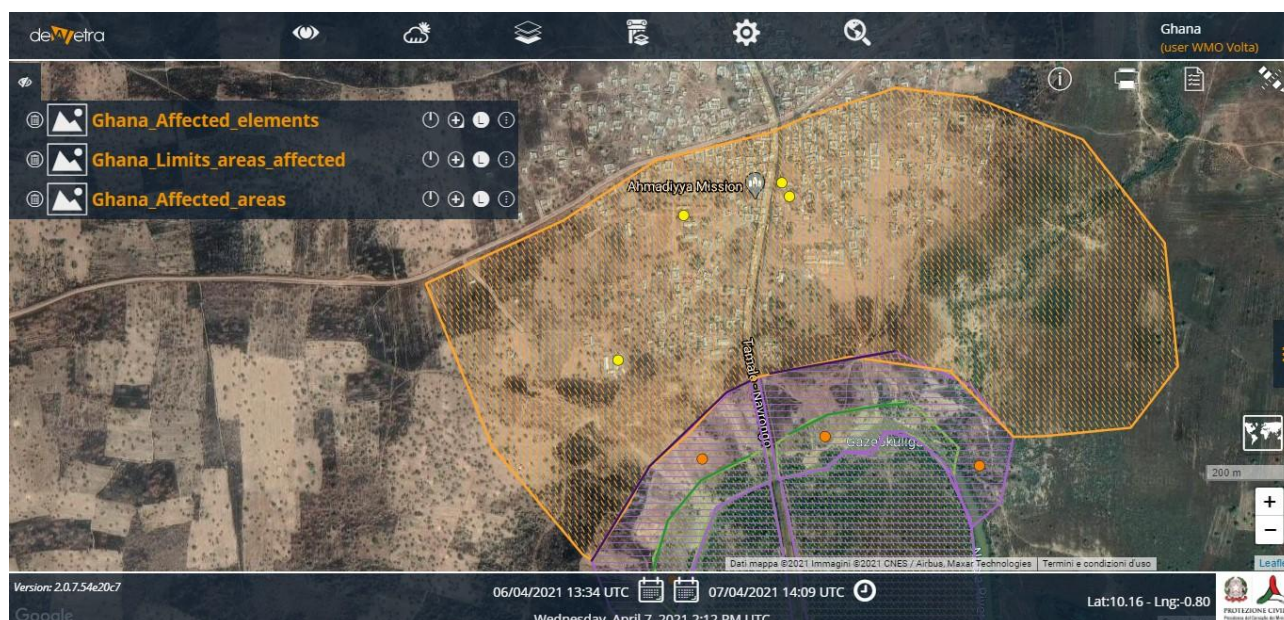
Total Population: 2634

% of women: 60%

% of children: n.a.

% of youths: 30%

% of elderly population: 7%



Exposure (overall): 4.70

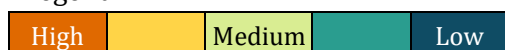


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 4.91

Exposure to drought: 4.00

Legend:



Date of reported worst flood: 2020

Other reported hazards: Fires; Livestock disease; Crop pest; Strong wind

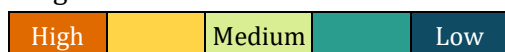
Deforestation: Widespread

Vulnerability: 4.95



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

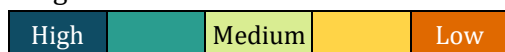
1. WSS inadequate
2. Informal settlements
3. Health services inadequate

Capacity: 5.87



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. CSOs
2. Presence of Disaster Management Committee
3. ICT
4. Qualified human resources

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No

Oti Region

Tatali-Sanguli District

Hamlet: Yes (reported n°: 6)

Ecosystems: River, riparian forest, sacred place

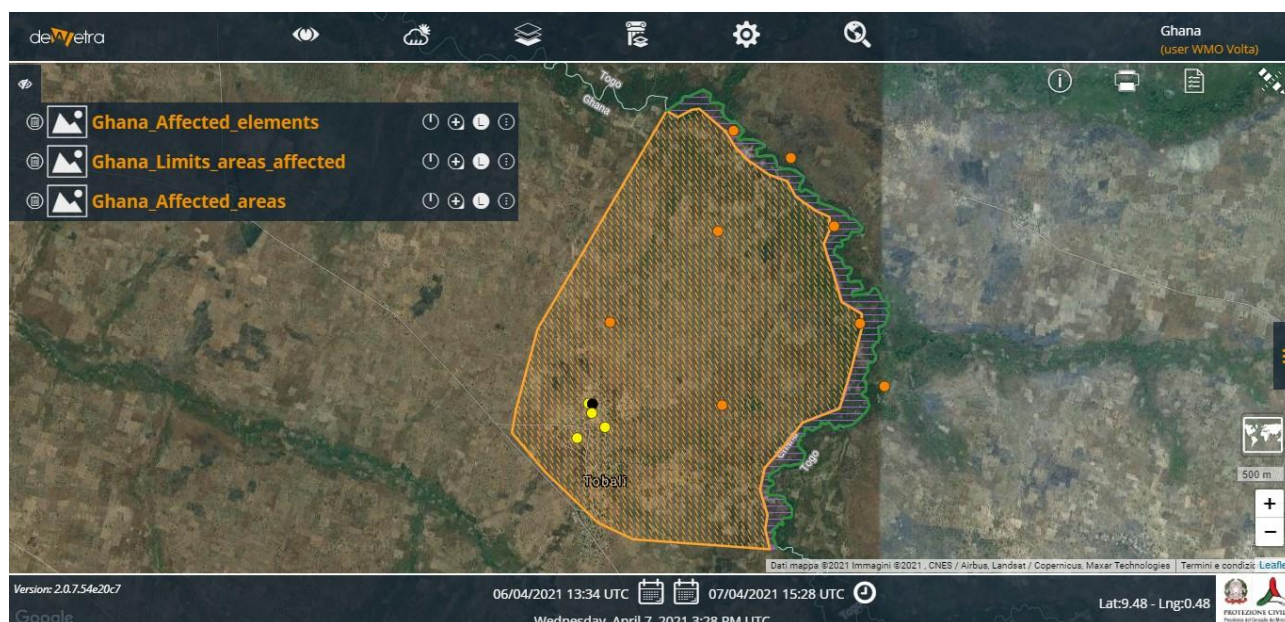
Total Population: 2940

% of women: 58%

% of children: 20%

% of youths: 18%

% of elderly population: 5%



Exposure (overall): 3.10

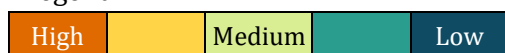


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 2.36

Exposure to drought: 4.00

Legend:



Date of reported worst flood: 2020

Other reported hazards: Fires; Strong wind; Livestock disease; Crop pest; Heat waves

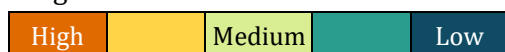
Deforestation: Widespread

Vulnerability: 3.80



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

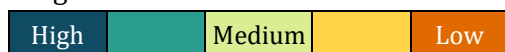
1. Informal settlements
2. Unemployment
3. WSS inadequate

Capacity: 4.47



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. CSOs
2. ICT
3. Qualified human resources

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No



Ghana

Tampizua

Upper East Region

Bawku District

Hamlet: Yes (reported n°: 3)

Ecosystems: Sacred place, riparian forest, river, dam

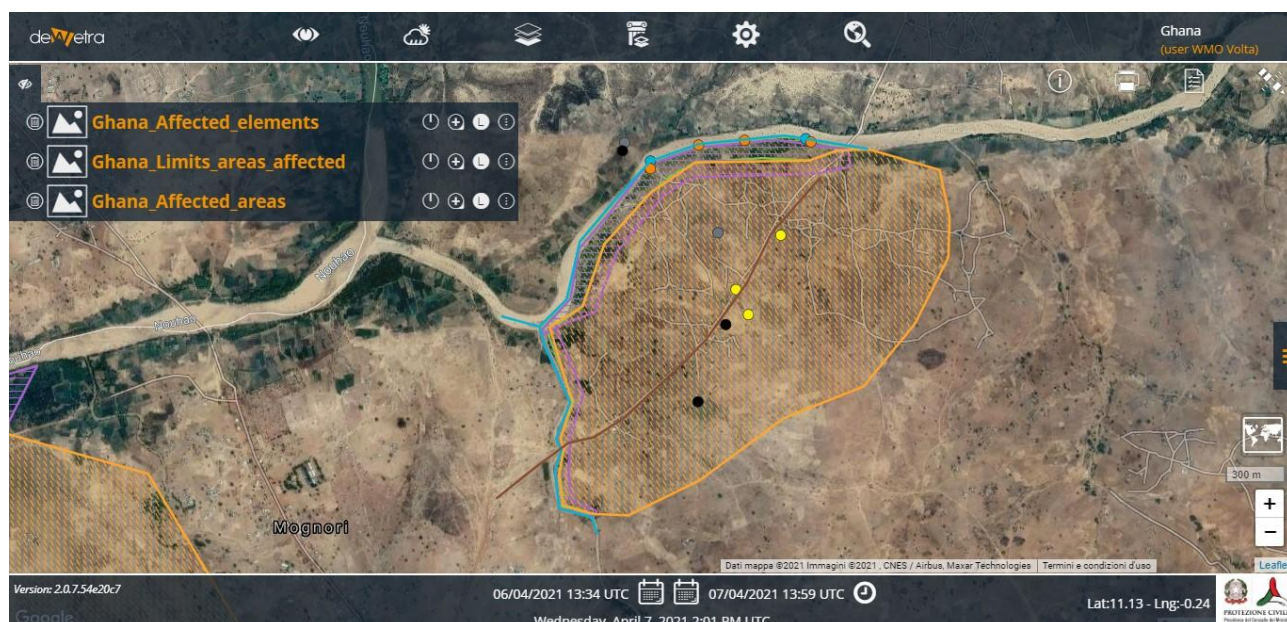
Total Population: 1800

% of women: 65%

% of children: 10%

% of youths: 30%

% of elderly population: 5%



Exposure (overall): 3.58

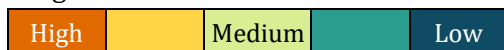


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 3.77

Exposure to drought: 3.50

Legend:



Date of reported worst flood: 2020

Other reported hazards: Fires; Strong wind; Livestock disease; Coastal erosion

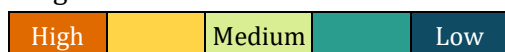
Deforestation: Not very widespread

Vulnerability: 4.50



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

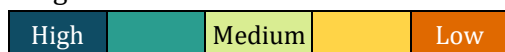
1. Health services inadequate
2. Education services inadequate
3. Illiteracy

Capacity: 3.80



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. ICT
2. CSOs

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No

Oti Region

Saboba District

Hamlet: Yes (reported n°: 4)

Ecosystems: Forest, river, tourist centre (not yet developed), sacred place, dam

Total Population: 2500

% of women: 60%

% of children: 25%

% of youths: 14%

% of elderly population: 6%



Exposure (overall): 5.00

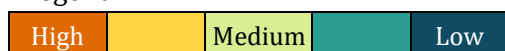


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 5.64

Exposure to drought: 4.00

Legend:



Date of reported worst flood: 2020

Other reported hazards: Fires; Heat waves; Strong winds; Crop pest; Livestock disease

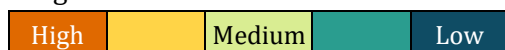
Deforestation: Very Widespread

Vulnerability: 4.50



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

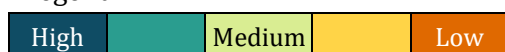
1. Unemployment
2. Informal settlements
3. Illiteracy

Capacity: 5.33



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. CSOs
2. ICT

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No



Ghana

Yarigungu

Upper East Region

Binduri District

Hamlet: Yes (reported n°: 12)

Ecosystems: Mountain, river, savannah
grassland

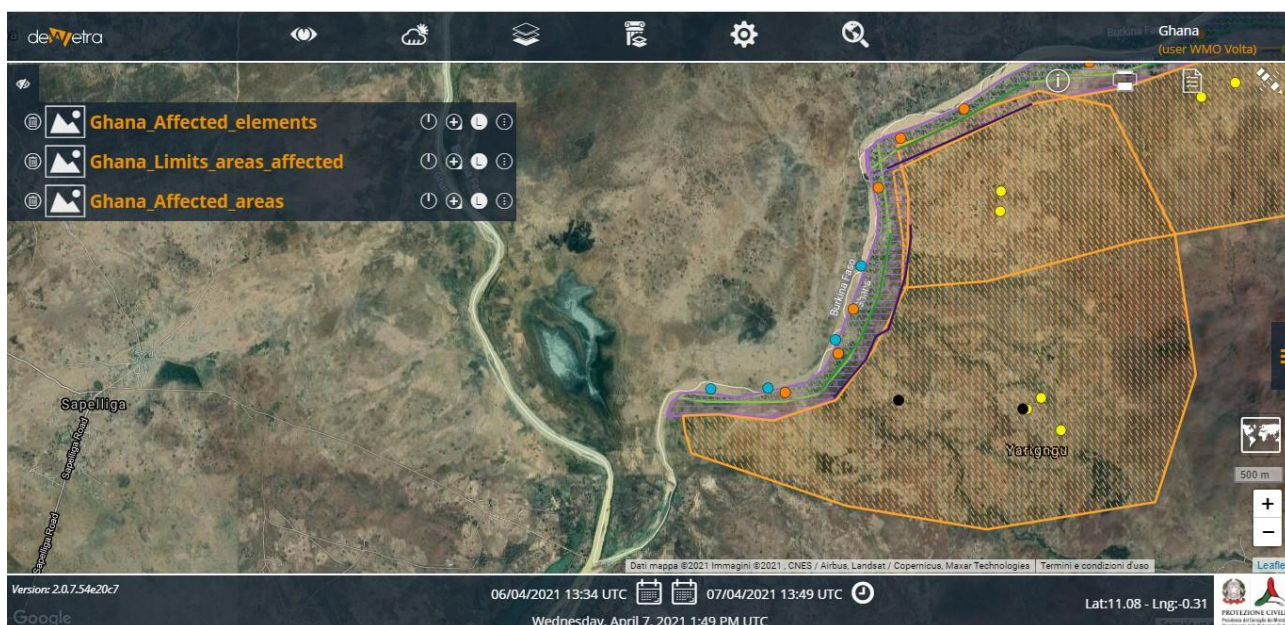
Total Population: 1088

% of women: 60%

% of children: 16%

% of youths: 20%

% of elderly population: 13%



Exposure (overall): 5.80

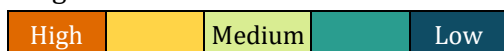


Exposure index entails exposure to flood (frequency, effects, etc.), exposure to drought (frequency, effects, etc), exposure to other hazards (earthquakes, forest fires, landslides, storms/strong wind)

Exposure to floods: 6.55

Exposure to drought: 4.00

Legend:



Date of reported worst flood: 2020

Other reported hazards: Heat waves; Strong wind; Fires; Livestock disease; Crop pest

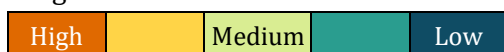
Deforestation: Widespread

Vulnerability: 4.25



Vulnerability index includes risk factors related to housing/habitat/WSS services, health, education/illiteracy, labour conditions and income, migrations, criminality/security, conflicts (ethnic, religious, political, among farmers and breeders), family fragility, gender, public administration

Legend:



Main reported risk factors:

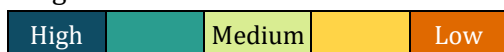
1. WSS inadequate
2. Informal settlements
3. Illiteracy

Capacity: 3.80



Capacity index includes assets related to access to economic and financial opportunities, ICT, civil society, qualified human resources, social institutions, risk management (e.g., Presence of a Disaster Management Committee, Infrastructure in watercourses, etc.), human/institutional capacities

Legend:



Main reported community assets:

1. CSOs
2. ICT

- Alarm system in case of flooding: No
- Systems for detection, monitoring and prevention of hazards: No

Chapter Three

Ghana – Overall analysis

The study in Ghana has been carried out in 15 sites, listed in the first chapter and sintetically presented in the second Chapter of this report.

Following the theoretical and methodological approach presented in the Chapter One, as already stated, it was possible the measure for each site specific indexes of exposure to natural hazards (overall), of vulnerability and capacities.

The Table 2 reports the main results of this measurement exercise. The main indexes are reported, together with other information: the indexes of exposure (to flood and to drought, informing, as already stated, the overall index of exposure) and the main three factors contributing to the indexes of vulnerability and capacity.

Based on the figures reported in Table 2 it is possible to provide some general comments about the ways in which exposure, vulnerability and capacity appear in the sites.

- Kunkua (Bongo district) is the site with the reported highest exposure both to drought and to flood and, therefore, also with the highest overall exposure; in Kunkua we find also the second index of vulnerability; so Kunkua appears as the most fragile site among the 15 investigated in Ghana.
- Nasia (West Mamprusi district) is the site with the highest reported vulnerability, slightly higher than that of Kunkua; this high vulnerability depends mainly on the intensive presence of informal settlements and the inadequacy of health services and water and sanitation facilities. In Nasia, exposure (overall, related to drought, related to flood is far below the one recorded in Kunkua.
- Chache (Bole Bamboi district) is the site with the lowest index of capacity (low presence of both CSOs and qualified human resources).
- Conversely, Buipe (Central Gonja District) is the site with the highest index of capacity thanks to an intensive presence of CSOs and qualified human resources, the existence of a Disaster Management Committee and of a good ICT network.

Beyond these general comments, it is possible to provide some more specific comments concerning the specific ways in which the specific exposure to natural hazards, vulnerability and capacity occurs in the sites.

TABLE 2 – The selected sites according to the indexes of exposition, vulnerability and capacity and the main components and factors that compose them

Site	Exposition	Drought	Flood	Vulnerability	Vul Factor1	Vul Factor2	Vul Factor3	Capacity	Cap Factor1	Cap Factor2	Cap Factor3
Akwamufie	2.99	3.75	3.35	3.55	Illiteracy	Lack of jobs	Large households	4.07	Presence of a DMC	Qualified HR	CSOs
Birifor	4.92	4.50	6.04	3.95	Large households	Illiteracy	Migration	4.00	CSOs	ICT	//
Jambusier	4.10	5.00	4.18	4.50	Informal settlements	inadequate WSS	Lack of jobs	4.07	Presence of a DMC	ICT	//
Chache	3.68	4.00	3.41	4.85	informal settlements	inadequate WSS	Illiteracy	3.20	ICT	Infrastr. in watercour	//
Buipe	3.98	4.00	3.96	4.35	lack of jobs	Criminality	Conflicts	6.40	Presence of a DMC	Qualified HR	CSOs
Azumsapeliga	4.20	4.50	3.82	4.65	Illiteracy	inadequate WSS	Informal settlements	4.60	CSOs	Presence of a DMC	ICT
Tampizua	3.58	3.50	3.77	4.50	inadequate Health services	inadequate Education services	Illiteracy	3.80	ICT	CSOs	//
Djentiga	5.00	4.50	5.82	4.45	inadequate WSS	Informal settlements	inadequate Health services	4.53	CSOs	ICT	//
Yarigungu	5.80	4.00	6.55	4.25	inadequate WSS	Informal settlements	Illiteracy	3.80	CSOs	ICT	//
Kunkua	6.06	7.00	6.84	4.90	Absence of health services	Informal settlements	inadequate WSS	4.93	ICT	CSOs	Infrastr. in watercour
Nasia	4.70	4.00	4.91	4.95	inadequate WSS	Informal settlements	inadequate Health services	5.87	CSOs	Presence of a DMC	ICT
Kukobilla	4.40	5.00	4.00	3.90	inadequate WSS	Informal settlements	Gender gap	3.73	ICT	Infrastr. in watercour	//
Kpalba	4.58	5.50	3.96	4.35	Informal settlements	inadequate Education services	Lack of jobs	4.73	Infrastr. in watercour	CSOs	ICT
Wapuli	5.00	4.00	5.64	4.50	Lack of jobs	Informal settlements	Illiteracy	5.33	CSOs	ICT	//
Sanguli	3.10	4.00	2.36	3.80	Informal settlements	Unemployment	inadequate WSS	4.47	CSOs	ICT	Qualified HR

Legend: Figures in red represent the worst results while figures in green represent the best ones

1. Exposure to Natural Hazards

One of the objectives of the study was mapping how the 15 sites were exposed to natural hazards. The main focus was flood, but during the visits we were able to survey also the exposure to drought and also to other environmental hazards. In general, with exposure we meant both the intensity with which certain hazards hit the sites and of the factors that potentially increase the impacts of the hazards (for example, the lack of an alarm system is going to worsen the impact of a flood; the same could be said if there are houses built in flood-prone areas). It was also measured an overall exposure index, considering the composition of the three.

Floods

All the indexes could, in principle range from 0 (no hazard) to 10 (highest intensity). As for exposure to flood, it emerges that, out of 15 sites, just 6 seemed to be hit by the problem of flood more than the others (i.e., above the average value of the index, that was 4.57). It also emerges that there is a certain degree of variability in the exposure to floods in different sites. As a matter of fact, index ranges from 2.36 of Sanguli to 6.84 recorded in Kunkua.

The effects on the local communities are, in general, very relevant since it is reported in almost all the cases that floods produce damages on farmland, on crops and consequently on the livelihood of people through reduction of income and food. The damages reported are mostly referred to as a private type. Nevertheless, damages to local civil infrastructures, for example, schools, are mentioned and references are also done to impediments to public life such as mobility, problems in sanitation systems and pollution that indicate that impacts are produced by floods to a variety of common goods. In one case, Kunkua, mention is done to a death tolls caused by floods. In this site the frequency of floods is not different from the other places but in the collective memory the damages brought about are recorded as particularly serious.

It is important to stress that floods are events that are heavily actual in the life of the communities. In 8 out of 15 sites it is reported that the worst floods – according to the memory of the people interviewed - occurred in the year of the survey, but located only in the White Volta and Oti Sub-basins (in the studied sites in Black Volta the worst flood were reported between 1999 and 2014 and in Akwamufie in 1968, see below, Table 5 at the end of this chapter).

In 5 sites, in the last year were reported more than 1 flood. From the interviews emerges that more than one flood in a year is a common experience of the communities living in the sites. Particularly, in 11 out of 15 sites it was reported that floods occur up to 2 times a year. In one site, it was reported that floods are even more frequent, while in three sites floods are considered as extraordinary events. Nevertheless, these three sites (Sanguli Kukobilla and Chache) last year experienced a flood. In any case, in 2 of these three cases, in the last five years floods occurred more than once.

Droughts

The survey considered also droughts, even if not as in-depth as it was for floods. The harshness of droughts seems to be more evenly distributed in the area, at least compared to the case of floods, since there is less variability among the sites (11 out of 15 are plus/minus 0.5 points from the average value of the index, that varied between 3.5 and 7.0). The difference between the least and most hit sites are mainly in the frequency of the occurrence of drought. In less-hit sites, the damage consisted mainly of

decreased production, while phenomena such as starvation were also reported in the most affected sites. It is to be stressed that the measurement of exposure has made it possible also to consider the associations between different hazards in different places. It is to be noted, indeed, that the site that resulted as the most exposed to floods was also the most exposed to drought. While it is not possible to single out, based on the available data, any form of connection between the two phenomena/types of exposure (to flood and drought), it is possible to observe the possibility that they are associated – i.e. they occur in an extreme form in the same place. In this case, such an association may produce particularly adverse effects on the population, the economy and so on, also considering that the two hazards hit the population in different ways (for example on how they are located in the affected areas) and requires different prevention practices. The possibility that the two phenomena occur together in the sites has, therefore, to be considered once policies and interventions are designed (considering the limitations of the data collected, it is somehow useful to observe that the indexes of exposition to droughts and floods measured in the 15 sites are partly correlated⁸).

Other hazards and overall exposure

The possible association within each site of the environmental risks makes it relevant the measurement of the overall exposure to them. It was measured considering not just the exposure to floods and droughts but also other environmental risks that were surveyed on the site such as fires, strong winds, landslides, coastal erosion, heat waves, earthquake, pandemics, crop pest, livestock disease, pollution. Of course, the nature of these possible hazards is diverse as it is the exposure. From the survey, it resulted that not all the sites are exposed to all these hazards. In general, we can say that the situation is varied among the sites – the range of variation of exposure indexes is wider than in the cases of exposure to drought and floods. Probably, the exposure to these “residual” types (residual, because it is not the object of the Volta Flood and Drought Management program; and not because we consider not important these further hazards) of hazards is particularly connected to the specific place in which they occur: this is suggested by the diversity registered among the various types of hazards and by a scarce correlation between these hazards and the other two “main” types.

We thought that this “residual” form of exposure to hazard has to be considered in order to understand the ways in which local population are challenged by the environment. For this reason, we combined the three indexes of exposure in a “total index”, or Exposure Index (EI). The EI is the highest in the place site where exposure to drought and floods is higher (6.06/10, Kunkua), and it is the lowest where all the three components are under the average or at minimum level (2.99/10 Akwamufie, 3.10/10 Sanguli).

The exposure of all the sites to environmental risks seems to be relevant for the social life. In almost all the sites there are migration that are considered by the people we interviewed as one of the results of climate change and of the hardship connected to environmental hazards. This is also confirmed by the fact that in all the sites the interviewees said that there are significant negative impacts on agricultural production and in the dimension of the livestock of floods and droughts. In 11 sites the interviewees said there were a reduction of agricultural production comprised between 20 and 50% and in 3 sites even higher. In 7 out of 15 sites there was a reduction of the livestock between 20 and 50%, in 2 sites it was higher. In 4 sites such a reduction was of less than 20% and just in 2 places the livestock did not reduce. A part from the exact estimates of the quantitative impacts – that was out of the scope of this study, it can be said that the exposition to natural hazards such as floods and droughts impact significantly on local human capital, on production activities and on the endowment of livestock.

⁸ Correlation index = +0,41

2. Vulnerability

Vulnerability, as explained above, concerns those social, economic and infrastructural conditions that compound the effect of natural hazards. Therefore, the vulnerability has to do more with how local communities are organized than directly with the hazards as such (however, natural hazards increase vulnerability on one hand and, on the other, the effects/impacts of hazards are increased by vulnerability). Based on this, we can say that vulnerability index is fully social since, in principle, very similar hazards could cause differently nearing communities that are organized in different ways. For this reason, the index of vulnerability is informed by the situation related to housing, infrastructures, health, education, working conditions, poverty, family conditions, gender gaps, criminality, conflicts, and effectiveness of public administration. In general, vulnerability index considers not just very localized phenomena but also processes that characterize the society (of Ghana, in this case) as a whole. This is the case, for example, of the organization of public administration and the supply of basic services, or phenomena such as economic poverty or cultural and political phenomena, ranging from gender gaps to conflicts. The nature of vulnerability helps explain why there is a relatively smaller differentiation among the sites: the range of variability is smaller than that of the indexes of exposure and, as will be seen later, of capacity (1.40 compared to 3.07 of exposure and 3.40 of capacity).

The least vulnerable community is Akwamufie. It is important to stress that this site is also the one that is the least exposed to environmental hazards. This coincidence occurs also in the reverse case, where the most exposed site, Kunkua records the second-highest score in the vulnerability index. The most vulnerable site is Nastasia (which scores also a quite high exposure index but certainly is not among the most exposed to hazards, with an exposure index of 4.70). It can also be noted that, more in general, it was noted that in the 15 sites some positive association has been identified between exposure and vulnerability⁹. Because of the little number of observation (15 sites), we cannot state that this is a relation that we can expect as valid in general, neither we can assume any kind of causal relation between the level of vulnerability and the level of exposure. We can just say that the intensity of the two phenomena registered through the two indexes is, in some of our cases, associated. This fact indicates that there is the possibility of association and, also, that this implies some consequences once policies for the management of environmental hazards are being figured out. When these two processes are associated, we have a certain degree of disrepair: a dangerous situation caused by environmental degradation is not properly coped with through the use of adequate social and infrastructural capital. Therefore, it is possible to say that it is important to control if the overall state of disrepair is made worse by societal action and not just by adverse environmental conditions.

The factors composing vulnerability

Of course, the generally low degree of variance of vulnerability (if compared to the other indexes) means that some differences do exist, anyhow, among the factors affecting each site. In Table 2, for each site, the three most intense risk factors composing the Vulnerability index are reported. It emerges that the main important reported risk factors are:

- Intensive presence of informal settlements in 9 sites
- Inadequate water supply and sanitation (WSS) in 9 sites
- Illiteracy in 7 sites
- Unemployment/lack of jobs in 6 sites

⁹ Correlation index = +0,42

- Inadequate/absents Health services in 4 sites.

It is interesting to note that vulnerability has also some constant characteristics. In two sites (Djemtoga and Nasia) there were the same triplet of most intense risk factors: inadequate WSS, Informal settlements, inadequate Health services. We can also note that the association between inadequate WSS and the diffusion of informal settlements is present in other 7 sites (Jambusier, Chache, Azumsapeliga, Yarigugu, Kunkua, Kokubilla, Sanguli). The 9 sites who have among the three most important risk factors inadequate WSS, Informal settlements in general have an average index of vulnerability higher than the average of all the 15 sites.

More in general, in 11 out of 15 places, at least one of the most relevant three risk factors is the presence of informal settlements. We could say that a bad management of land and settlements and a, probably related, scarce attention to how primary services are distributed over those informally settled areas are among the most frequent factors that compose vulnerability. In the remaining 4 sites in which the problem of informal settlements is not reported as one of the three most important risks, also inadequate WSS is not reported. This confirms that the two issues are deeply related. This connection could become a theme of reflection for the policy makers at the local level.

The sites in which these two leading factors (Informal Settlements and Inadequate WSS) are not reported, have in three cases (Tampizoua, Birifor and Akwamufie) as a constant, the presence of the issue of illiteracy. In two of these three cases, the problem of the presence of "large households" was mentioned, while the third factor was in one case "Migration" and in the other "lack of jobs" (that probably have to do with a similar economic difficulty). This would indicate a bad economic situation. A third site in which illiteracy was mentioned, the other risk factors were the inadequacy of health services and of education services. Therefore, a general inadequacy of social policies.

Interesting enough, the larger site investigated, with 12,000 inhabitants, appeared to be most affected by more cultural dynamics and problems such as, beyond lack of jobs, criminality and conflicts (of different nature, i.e. ethnic, economic and political). In this case too is difficult, from this data, to draft strong conclusions but it would seem that some forms of urbanity begin to emerge with problems more connected to the presence of a relatively high number of people.

Furthermore, it should be stressed that in 6 out of 15 sites employment related risks are reported. In a couple of cases (Sanguli and Jambusier), the three main risk factors reported are almost the same, even if with differences in ranking and in wording (Informal settlements, Unemployment/lack of jobs and inadequate WSS).

3. Capacity

With capacity, in this study, we mean the "positive" factors impacting the susceptibility to environmental hazards. In a certain sense, as stressed in the introduction of this document, these factors offset those composing vulnerability and could be considered as assets of the local communities. For measuring capacity, we have considered the availability of social structures and/or physical infrastructure that contribute to handling and managing environmental hazards. In practice, we have considered *in primis* elements such as the presence in the site of qualified human resources, of civil society organizations and of social institutions (e.g., village development committee, presence of a traditional/religious leadership). In the index are included also factors connected to infrastructures

(such as the existence of local development projects - with specific attention to those having a focus on issues related to Disaster and Risk Management capacities), the availability ICT services or services and economic activities such as finance, trade, enterprises, livestock. The index includes also environmental protection initiatives and awareness (e.g., Systems for detection, monitoring and prevention of hazards; Presence of a Disaster Management Committee; community awareness on hazards; community participation in DRM; etc.), that should allow a better Disaster Risk Management, as well as local territorial services such as civil protection, fire-fighters, police, forest guards. All these factors can contribute in different way to create the capacity of the local communities to cope with environmental hazards.

We can say that these positive factors tend to be very localized and specific to each site. Most of these factors depend on very local dynamics (e.g. the presence of CSO and other local institutions and organizations), the availability of services of a different type. Even in the cases in which the presence of such factors depends on the decisions of authorities supervising larger territorial districts (e.g. civil protection or police services), the actual presence in the specific territory changes depending on the specific sites (and its very particular sets of characteristics).

This is expressed by the fact that the capacity index varies according to the different sites more than the vulnerability one (the range of variation between the maximum and the minimum value of the index is more than double and so it the standard deviation index).

Also in this case, for each site, we singled out the three most relevant assets reported during the survey. The most important reported assets are the following.

Intensive availability of ICT in 13 of the 15 sites. This factor should be properly understood: in general, people in these areas are not very endowed with computers and sometimes electric power represent a problem; nevertheless, through cellular phones in many cases it is possible to be linked to the internet and, in any case, have easy exchanges outside the local communities, and this represents an important positive element. While having this form of connection is an important asset, it does not entail as such any form of active citizenship or agency oriented to the control of natural hazards. ICT, in the specific sense implied in this survey, is a pre-condition of full exploitation of other capacities. As a confirmation of this, the site that has the highest capacity index, Buipe, has not, among the three most important assets ICT. This does not mean that it is not endowed with this asset: on the contrary, it is reported that there is a certain diffusion of TV sets and even personal computers: reported as “moderately frequent” and in 30% of houses, that is remarkable compared to the level of other sites, where PCs are present but very rare just in 5 out of the remaining 14 sites, while in 9 sites they are reported as absent from houses. ICT is more frequent in Buipe than other sites, but it is even more endowed with other assets.

Intensive presence/activities of CSOs in 12 of the 15 sites. It is to be noted that for all the sites who score a value above the average (i.e., 4.50) this asset is mentioned. It should also be noted that presence of a **Disaster Management Committee (DMC)** is registered in 5 sites and in 3 cases such sites are above the average capacity. One particular aspect that could be considered in this qualitative assessment is that for Buipe, the site who has the highest capacity score, the three most important capacity factors are all connected to some form of social agency and professional expertise. Beyond the already quoted “Presence of a DMC” and Intensive presence/activities of CSOs, it should be noted that they are also endowed with a significant pool of Qualified Human Resources such as Medical doctors, health workers (nurses, pharmacists, midwives, etc.), Engineers, Hydrologist, Traditional practitioners

(traditional doctors), Civil protection, Police, Fire-fighters. This pool of professionals includes people with higher or university degree and teaching staff.

The site with the least level of capacity, Chache, has just a few health workers, traditional practitioners, few teachers (3) and people with higher or university degree (1).

Two of the above mentioned assets represent some traits of "quasi" homogeneity regarding the capacities in the 15 sites visited in Ghana. A strong homogeneity can also be seen with regard to the identification of the services and advantages (which, as such, are therefore "assets") relating to the ecosystems characterizing each site. A few services / benefits are mentioned in the vast majority of the 15 sites. Especially:

- Food production in 13 sites
- Spiritual in 13 sites
- Water supply in 11 sites.

A few other services / benefits are, however, less reported:

- Firewood in 10 sites
- Recreational in 3 sites.

4. Some further remarks on the exposure, vulnerability and capacity relations

We did not observe many cases of strong correlation between the indexes beyond those that we have mentioned above that let us to try to formulate, if not conclusions, at least some hypothesis. Two cases in which the not-so-strong correlation was singled out, anyhow, are worth being briefly commented: correlation between population size, on the one hand, and exposure (-0,23) and vulnerability (-0,20) on the other. The interest is connected to the sign of these correlations that could indicate a tendency of exposure and vulnerability to be lower as long as the population size grows. As in other cases, we cannot state any causal relation nor a general value of these few data, but we can observe the fact that exposed areas could tend to be less populated and that larger populations could tend to be associated with less vulnerability (that requires, as stressed above, a higher level of organization). An analysis in depth of all the possible association between some indexes and the related processes were out of the scope of our study. Nevertheless, it is important to highlight that they could become the objects of further research (they should be based on a wider set of observations).

Some further observations could be formulated about the performances of the three main indexes if we look at the three regions of the Volta Basin, the "sub-basin", where the sites are located (see the Table 3 that contains this information). In particular, it seems that the sites within each area are more similar than the entire set of sites as a whole. This is almost clear if an analysis of the standard deviation of each index is calculated for each sub-basin. We can observe that this is generally confirmed for all indexes of general exposure, of vulnerability and capacity, where we find that the standard deviation is always lower for each sub basin compared to the standard deviation as a whole. This change a little when the indexes of exposure are considered: we have more variability in the exposure to drought in the White Volta Sub basin and to flood in the Oti Sub-basin (even if the difference in variability with all the sites as a whole is little).

Black Volta Sub-basin is markedly less variable for the indexes of exposure than the other, vulnerability is also quite low and this, in general, would indicate a certain homogeneity. The situation is different for

the capacity index whose variability changes a lot among the regions. This is in line with what was stated above that this index is the most dependent on local conditions. The index of vulnerability tends to be lower in each sub-basin (and, in general, it is very low). This also tends to be in line with what stated above regarding the “supra-local” nature of the phenomena measured through it.

Table 3 – Sub-Basins according to the Standard deviation of the indexes of the sites

Sub-Basin	General Exposure St. Dev	Exposure to Drought St.Dev	Exposure to Flood St.Dev	Vulnerability St. dev.	Capacity St. dev
White Volta	0.81	1.06	1.03	0.34	0.72
Oti	0.81	0.71	1.13	0.30	0.36
Black volta	0.46	0.41	0.84	0.32	1.19
Akwamufie(just one site)	0.00	0.00	0.00	0.00	0.00
All the site as a whole	0.86	0.85	1.07	0.40	0.83

As for the differences that emerged from the survey among sub-basin, it is interesting to note that in White Volta the worst floods were mostly recorded in 2020 (see Table 4), while the situation is more varied in the other sub-basins. This observation is not conclusive, since other data for better qualifying the phenomenon are needed. Nevertheless, it is worth being mentioned for further possible investigations.

Table 4 – Sites according to the Sub-Basin, Location, Site and Year of the worst flood

Sub Basin	Location	Site	Year of the Worst Flood
White Volta	Binduri District	Azumsapeliga	2020
White Volta	Bawku Municipal	Djentiga	2020
White Volta	Savelugu Municipal	Kukobilla	2020
White Volta	West Mamprusi District	Nasia	2020
White Volta	Bawku Municipal	Tampizua	2020
White Volta	Binduri District	Yarigungu	2020
White Volta	Bongo District	Kunkua	2007
Oti	Tatali-Sanguli District	Sanguli	2020
Oti	Saboba District	Wapuli	2020
Oti	Saboba District	Kpalba	2008
Black Volta	Wa West District	Jambusier	2014
Black Volta	Central Gonja District	Buipe	2010
Black Volta	Lawra District	Birifor	2007
Black Volta	Bole Bamboi District	Chache	1999
	Asugyaman district	Akwamufie	1968

A final consideration can be made by taking into account the number of inhabitants of the sites studied which are, we could say, the “par excellence” resource of each territory. However, the capacity index is not completely influenced by the size of the population of each site. In the following table we can see how capacities vary significantly with the size of the population of each site.

Table 5 – The sites according to the population size and the capacity index

Site	Population (A.V.)	Capacity
Buipe	12,000	6.40
Akwamufie	4,600	4.07
Kpalba	3,442	4.73
Djemtoga	3,000	4.53
Sanguli	2,940	4.47
Nasia	2,634	5.87
Wapuli	2,500	5.33
Kukobilla	2,141	3.73
Kunkua	1,939	4.93
Birifor	1,876	4.00
Tampizua	1,800	3.80
Azumsapeliga	1,250	4.60
Yarigungu	1,088	3.80
Jambusier	890	4.07
Chache	800	3.20

A small hamlet tends to be endowed with fewer assets (those relevant to capacity) than a larger settlement. As said before, Buipe, the site with the highest capacity score (6.40) has also the largest population (12,000 inhabitants). Conversely, Chache, who has the lowest capacity score (3.20) has also the smallest population of 800 inhabitants (the index of capacity is, indeed, positively correlated, +0.67, with the population size). This is in line with the observation that, being capacity a strongly social phenomenon, it is particularly dependent on the specific dynamics of the site, first of all those connected to population size. A large site tends to be a central market, the place where hub services are located and where qualified human resources tend to live (and work). In general, larger sites has a wider variety of economic activities and services. This is very clear in Buipe, the largest site, where there are several shops, petty shops and some enterprises. The relatively high number of people, with a higher level of qualification, tends to bring about the emergence of social subjectivities that are relevant for coping with several social risks and natural hazards (e.g., CSOs, committees that can valorize the existing qualified human resources and so on). Conversely, small settlements tend to be less serviced and less endowed with qualified human resources (in general there are more teachers in larger settlements and we noted, in the 15 sites, also a more relevant presence, even if less evident, of persons with a higher or university degree). Therefore, we could say that the different situation concerning population is likely to produce different local social processes that tend to be less conducive to the effective management of risks and hazards.

In general, the positive effects of the geographic concentration of people are well known. What is important here is to observe that these dynamics seem to be present in the areas object of our study and that they have to be factored in the initiative that will be taken to improve the management of environmental hazard, also considering that some sites are smaller than others and the strategy of hazard management should change accordingly.