FLOOD VULNERABILITY and CONTINGENCY PLAN

Warrap State, South Sudan

Mapping and Assessment Report

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ShelterCluster.org
Coordinating Humanitarian Shelter

CHF
The Common Humanitarian Fund
South Sudan

REACH
An initiative of IMPACT Initiatives ACTED and UNOSAT

CONTENTS

List of Tables, Maps & Figures

Acronyms

ACTED	Agency for Technical Cooperation and Development
CGI	Corrugated Galvanized Iron
FVI	Flood Vulnerability Index
GHACOF	Greater Horn of Africa Climate Outlook Forum
IOM	International Organization for Migration
NFI	Non-food Item
NGO	Non-governmental Organization
SPOT	Satellite Pour l'Observation de la Terre (*translation: Satellite for Observation of Earth*)
SSRRC	South Sudan Relief and Rehabilitation Commission
UNOCHA	United Nations Organization for the Coordination of Humanitarian Affairs
UNOSAT	United Nations Operational Satellite Applications Program

Geographic Classifications

Boma	Lowest level of local government administration
Payam	Intermediate administrative level including several Bomas
County	Primary administrative level below the State including several Payams
State	Administration of local government including several Counties

SUMMARY

In South Sudan, Warrap State was rated as the most flood-affected state in 2013 and has historically been a critically challenging state in which to provide relief during floods due to inaccessibility. Inaccessibility has also led to a lack of quality data on the location of the most flood-affected communities, needs and vulnerability.

In response to these challenges, the Shelter and Non-food Items Cluster in South Sudan, in partnership with REACH, conducted a flood vulnerability mapping exercise June-August 2013 across Warrap State. This flood vulnerability research in Warrap aims to strengthen the coordination between aid actors during flood emergency responses; to provide information to the South Sudanese government and aid actors and to inform the development of a disaster risk reduction strategy for Warrap State.

The methodology used for this study employed three interrelated steps: (1) identification of inundation areas using remote sensing technology; (2) sampling of flood-prone villages; and (3) primary data collection on the living conditions, flood mitigation and preparedness methods and perceptions of communities in flood prone areas in Warrap State. Descriptive statistics and statistical regressions were run along variables of access to services, displacement, shelter damage, casualties, community perception of impact, and community mitigation and preparedness.

Additionally, a Flood Vulnerability Index (FVI) was created using data on community mitigation and preparedness, leading to a contingency plan for use by the Shelter/NFI Cluster.

The **main findings** from this flood vulnerability mapping exercise are the following:

- The majority of potentially flood-prone villages were located across northern parts of Warrap State, primarily in Twic and Gogrial West counties. Overall, communities reported an increase in both the frequency and the severity of flooding between 2008 and 2012.

- The typology of housing is reported as highly dependent on the local materials available locally, and the availability of building materials is reported as variable according to seasons. The majority of communities use grass (96.6%) and wood (86.2%) for the roofs of their housing, while the vast majority of villages use mud (97.4%) for the walls of their house. Floors are mainly made of mud (93.1%) as well. The source of shelter materials varied across villages, but the main sources were the bush or in the vicinity of the compound (grass, wood, soil, rope, brick and bamboo).

- Surveyed communities report engaging in different housing repair, reinforcement and reconstruction activities at different time periods throughout the year. The seasonality of these activities are important for aid actors to understand in order to provide appropriate mitigation and preparedness responses at appropriate times of the year. At the time of the study, the highest numbers of housing units damaged by flooding were found in Twic and Gogrial West counties.

- With regard to the impact of flooding among the surveyed communities, the average percentage of households displaced outside their boma of origin as a consequence of the floods in 2012 was highest in Twic, Tonj North and Gogrial West Counties. Although most displaced households were reported to have returned, a gap was observed in all counties, with the highest proportion of displaced that never returned seen in Twic County.

- The average number of displaced households was found to vary depending on severity of flooding (since 2008) – where the number of displaced households was higher among communities with a Very High flood severity rating (75-100) compared to those with a High (50-75) and Medium (25-50) rating. The highest average number of displaced households was found among communities with a Low flood severity rating (0-25), suggesting that communities with larger populations tend to be located in areas that were less affected by flooding, or that households in less affected areas found it easier to migrate temporarily as surrounding areas may have been easier to access.

- The preparedness strategy most commonly rated as most effective by the communities was dyke construction (considered the most effective by 68% of communities). The second most efficient preparedness strategy according to communities was water channel construction (considered as the second most efficient by 50% of communities assessed).

- Reconstruction of dykes was most commonly considered as the most effective mitigation method, cited by 36% of communities. Change in mode of livelihood was the second most commonly cited mitigation method (20%) followed by shelter reconstruction and reconstruction of canals.

- With regard to the Flood Vulnerability Index, Twic County has the highest concentration of High and Moderate vulnerability classified villages along the index while Gogrial East and West have higher concentrations at the Low and Moderate ends of the index. Overall, there are 24 villages considered to be highly vulnerable, 68 moderately vulnerable and 43 with low vulnerability classification.

The resulting strategic response and contingency plan outlines specific activities for humanitarian actors and the government to implement both before and during a flood event for each classification of the FVI. Combined with detailed information about location of agencies and supplies/materials available, a full contingency plan can be developed by the Shelter/NFI Cluster.

INTRODUCTION

Climate change poses a particular threat to developing countries due to greater challenges in adapting to an increase in natural disasters compared to countries with higher levels of resources. Given its geographic location, South Sudan has been dramatically affected by an increase in flooding over recent years, posing a challenge to this new country. Most recently, the Greater Horn of Africa Climate Outlook Forum (GHACOF) reported that South Sudan experienced above-normal rains during the 2012 rainy season, which led to flooding that in some parts of the country prompted displacement of thousands of households.

Warrap State in particular has experienced a high level of precipitation in recent years. In September 2013, UN Office for the Coordination of Humanitarian Affairs (UNOCHA) reported that Warrap was affected by flooding in its entirety, making it the most flood affected state in South Sudan in 2013. Interagency rapid assessments, conducted in August 2013, reported that 16,880 people were directly affected. The impact of floods on the population in Warrap remains largely unknown, given that most of the flooded area in the state has been inaccessible at the time of the assessments. The interagency assessments hence relied on figures collected by the South Sudan Relief and Rehabilitation Commission (SSRRC) and Payam authorities.

Lack of accessibility creates significant challenges to an effective humanitarian response in the event of flooding, including ability to identify gaps in the emergency flood response and to determine vulnerability and needs of affected communities affected. In response to these challenges, the Shelter and Non-food Item (Shelter/NFI) Cluster in South Sudan partnered with REACH to conduct a flood vulnerability mapping exercise across Warrap State between June and August 2013.

In South Sudan, the Shelter/NFI Cluster is led by the International Organization for Migration (IOM) and works closely with national and local authorities. REACH facilitated this research as part of its overall standing partnership with the global Shelter Cluster, and with funding from the Common Humanitarian Fund. The REACH team on the ground used technical expertise from IMPACT Initiatives, a Swiss-based organization and operational support from the Agency for Technical Cooperation and Development (ACTED), a French humanitarian and development organization.

The flood vulnerability mapping in Warrap aims to strengthen the coordination between aid actors during flood emergency responses; to provide information to the South Sudanese government and aid actors; and to inform the development of a disaster risk reduction strategy for Warrap State.

This report presents the results of this study, using the analysis to directly inform a contingency plan for humanitarian actors in Warrap State. The following **structure of the report** allows each section to build upon the next:

(1) Review of findings across key variables to inform the creation of a Flood Vulnerability Index;

(2) Consolidation of key variables and presentation of FVI; and

(3) Contingency plan based on the FVI.

METHODOLOGY

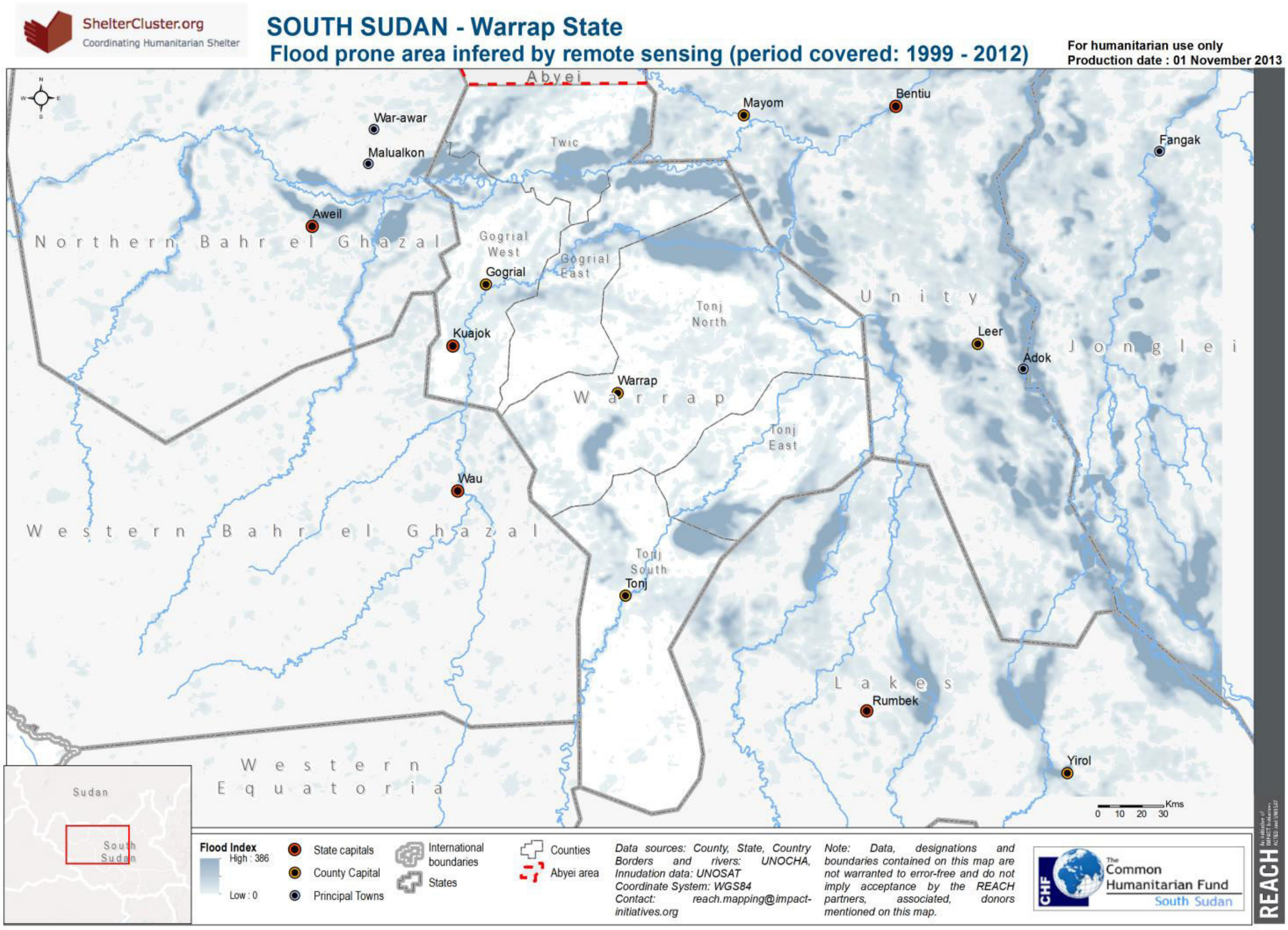
Remote Sensing

The first step in the flood mapping methodology deployed here was the identification of inundation areas in Warrap State using remote sensing technology. Water inundation maps produced by the United Nations Institute for Training and Research (UNITAR) Operational Satellite Applications Programme (UNOSAT) were used to identify flood prone villages.

The UNOSAT water inundation maps were based on satellite imagery collected for the African continent by *Satellite Pour l'Observation de la Terre* (SPOT) satellites from 1999 until 2013. The SPOT images were first processed by the Geoland2 research project to identify areas of water coverage in a one kilometer pixel during 10 day sample periods for each year. To produce the water inundation maps, UNOSAT then analyzed the 10 day sample periods for each year across the entire range of imagery from 1999 until January 2013. Pixels with the 'maximum' (100%) level of flooding indicated that water was present within the km^2 pixel during each of the10 day periods recorded from 1999 until 2013. Correspondingly, pixels with the 'minimum' (1%) level of flooding indicated that water was present within the km^2 pixel during 1% of the 10 days periods.

The inundation dataset thus provided information about the frequency of flooding, from 1999 until 2013. Assuming that areas that were frequently flooded during this period are also likely to be flooded in the future, the inundation dataset indicates which areas are likely to be flooded during the coming years. Map 1 highlights flood prone areas that were identified in Warrap State using the water inundation maps.

Map 1: Flood Prone Area Inferred by Remote Sensing



Sampling

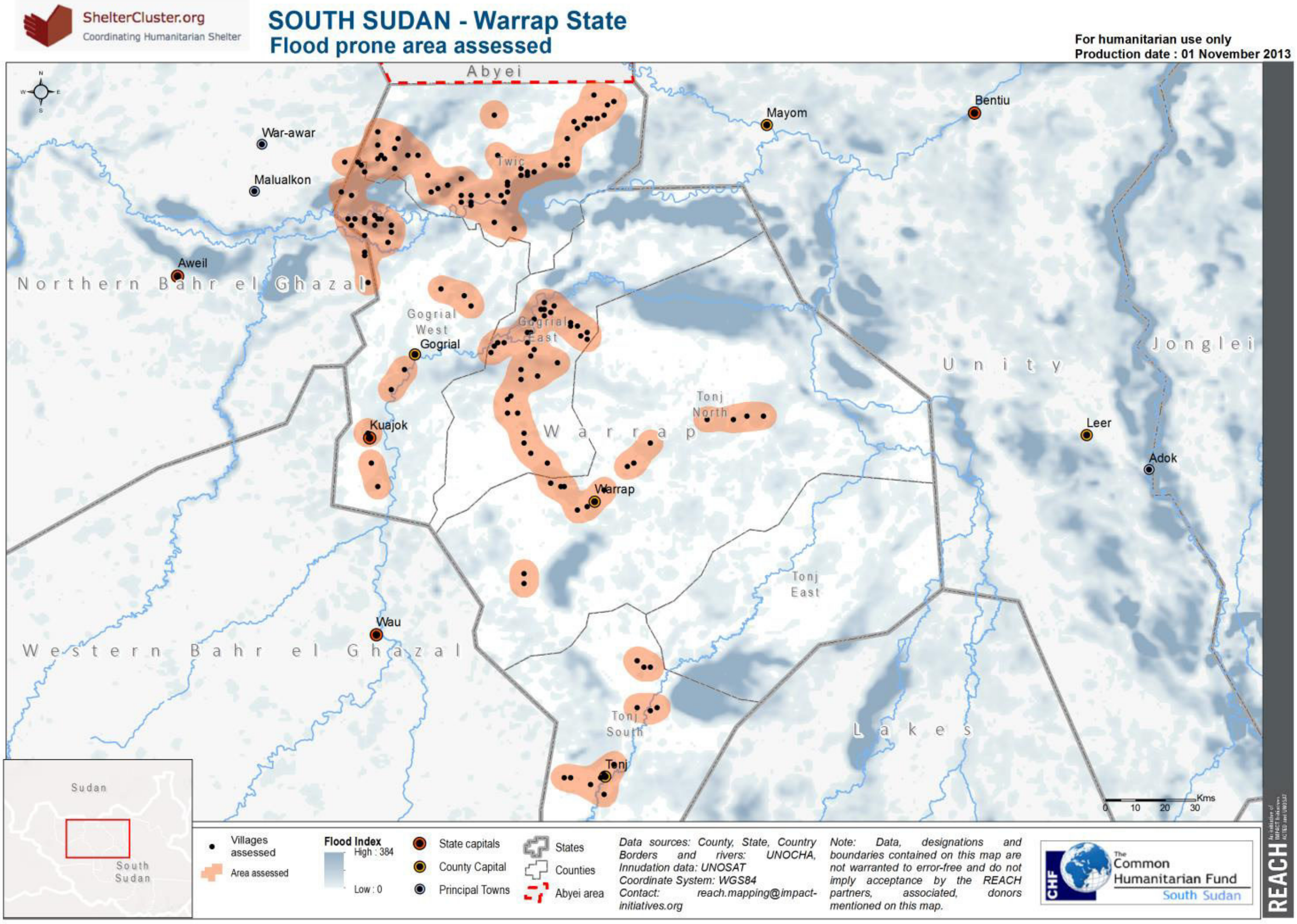
The sampling for primary data collection during the present study was based on: (1) the water inundation data provided by UNOSAT and (2) the UNOCHA data on the geographic location of settlements in Warrap State. By combining the two data sets, 135 villages in flood-prone areas were identified. Areas that had been flooded at least once for 10 consecutive days during the last decade were considered as flood prone.

This methodology was chosen to limit the bias introduced by the satellite imagery. Each pixel in the water inundation map covers an area the size of one square kilometer (1 km^2) and each pixel is considered as flooded if 100% of the surface is covered with water. This low resolution leads to a potential bias in the categorization of flooded areas, given that water is not detected by the satellites where the area flooded is less than km^2. Similarly, where the inundated area covers several pixels but neither in full, the water is not detected, leading to categorization of areas as not flooded. In addition, the geographic data on settlements across South Sudan obtained from UNOCHA was outdated; mainly from a map of 1972, where some locations had not been verified for several decades.

To address these potential biases in the sampling methodology, the field team cross-checked available maps with local authorities and elders, to ensure the villages affected by floods were correctly identified and assessed.

The final sample included 151 villages that were identified as particularly flood prone using the above methodology, representing 63,084 households living in flood prone areas. Map 2 shows the location of the assessed villages. It should be noted that areas of high inundation on the map (dark blue) were found to consist of very few or no villages, suggesting that any previously existing villages had likely moved due to repeated flood events.

Map 2: Flood Prone Areas Assessed



The majority of potentially flood-prone villages were located across northern parts of Warrap State, primarily in Twic and Gogrial West counties. The assessment aimed to assess several villages that were potentially flood prone in Tonj East County but data collection was not possible given inaccessibility to the county due to poor road conditions.

Primary Data Collection

The objective of primary data collection method was to gather information on the living conditions, flood mitigation and preparedness methods and perceptions of communities in flood prone areas in Warrap State. Two data collection tools were designed to facilitate two complementary data collection methods – direct observation and community discussion.

The questionnaires were designed to answer the following research questions:

- How can the efficacy of the emergency response to flooding be improved?
- To what level is the population in flood prone areas exposed to flooding?
- What are the impacts of flooding on the population?
- What are the main modes of preparedness used by the population?
- What are the main mitigation techniques used by the population?
- What type of support is needed from governmental and humanitarian actors?
- What strategy can be implemented to reduce the effect of floods in Warrap State?

Data collection was conducted using mobile data collection technology on the Open Data Kit (ODK) platform. Two teams of three enumerators were deployed to the sample areas over a period of 8 weeks June-August 2013. This time period was chosen, as it coincides with the middle-end of the rainy season and, thus allows for access to villages, while also allowing for collection of information on most recent flood events. All completed questionnaires were geo-referenced and stored in an associated geo-database.

Community Discussion Questionnaire

The objective of the community discussion method was to collect information on the perception of people about the effect of floods on their communities. The tool collected information on the living conditions of communities in flood prone areas across several variables such as shelter damage, access to services and demography of the community. Additionally, the participatory ranking methodology integrated the cultural and local context by asking communities about the perception of the main impact of floods and the most efficient preparedness activities they use to mitigate against the impact of flooding.

Direct Observation Questionnaire

The direct observation questionnaire was used as a way to cross-check information from the community discussion. This tool collected information related to the shelter situation of the communities, including materials used and types of shelter constructed. The tool also elicited information on specific infrastructure constructed to deal with flood hazards. The tool required a recording of the shelter types by photograph, leading to a picture database of shelters that could be used to regroup and verify the main construction materials used by communities.

Flood Vulnerability Index

A flood vulnerability index was designed to assess differences in flood vulnerability across communities included in the present study. The index is based on the hypothesis that communities are more resilient to the effects of flooding if they are prepared and use mitigation techniques to limit the effects. The index includes two components: (1) a mitigation score and (2) a preparedness score. The answers to specific questions in the questionnaires were ranked by the communities from the least efficient to the most efficient. Each community was assigned a cumulative preparedness and mitigation score which were based on the three preparedness and mitigation strategies they had reported using. Ranking of effectiveness of these strategies were supplied by a community ranking exercise.

Communities were asked which preparedness and mitigation techniques they felt were most effective. Based on these responses, mitigation and preparedness techniques were: (1) identified and (2) weighted according to the level of their respective level of efficacy in limiting negative effects of flooding, as determined through ranking by the consulted communities. The preparedness and mitigation scores both ranged from 0 to 9 and were divided into 3 categories: low [0-3]; medium [3-6]; and high [6-9] levels of preparedness/mitigation. An example of the preparedness index is shown below.

Table 1: Preparedness Index

Preparedness	Rank	Weight
Construction of dyke	1	3
Construction of water channel	2	3
Displacement on higher land before the floods	3	3
Preparation of water pond	4	2
Sharing community resources	5	2
Raising the house/compound	6	2
Planting trees to mitigate effect of flood	7	2
Contingency stocks of non-food items	8	2
Protect belonging against floods effect	9	2
Strengthening of the shelter before floods	10	1
Early cultivation	11	1

These two indexes were then combined to create the FVI in order to categorize communities as to their potential vulnerability to flooding. Table 2 shows this matrix.

Table 2: Flood Vulnerability Index

	Mitigation Index		
Preparedness Index	[0,3]	[3,6]	[6,9]
[0,3]			
[3,6]			
[6,9]			

The results can thus be interpreted as follows: a village that has high preparedness and high flood mitigation scores is considered to be more resilient and less vulnerable (highlighted in green in Figure 2) while a village with low preparedness and low mitigation scores would be more vulnerable (highlighted in red in Figure 2).

Housing Design Report

As a complement to this research, a Canadian-based urban planning and design firm – planningAlliance – was commissioned by the Shelter/NFI Cluster and facilitated by REACH and ACTED to conduct a housing design study. This study reviewed current housing construction methods and materials among the same communities covered by this vulnerability study and provided recommendations for flood mitigation construction methods. The resulting report from October 2013 was used to inform the contingency plan contained within this vulnerability study.

Limitations of Methodology

Four main limitations of the methodology for this study were identified:

(1) the remote sensing methodology used only identifies a square kilometer area as flooded if the entire square kilometer area is flooded, hence flood prone areas inside the square kilometer pixels that are not fully flooded are not detected on UNOSAT inundation maps;

(2) Tonj East County was not accessible due to poor road conditions at the time of the assessment;

(3) although the community discussion mode of data collection allows for data to be collected on large populations using limited resources, it restricts the reliability of the information collected as it relies heavily on a select few number of individuals; and

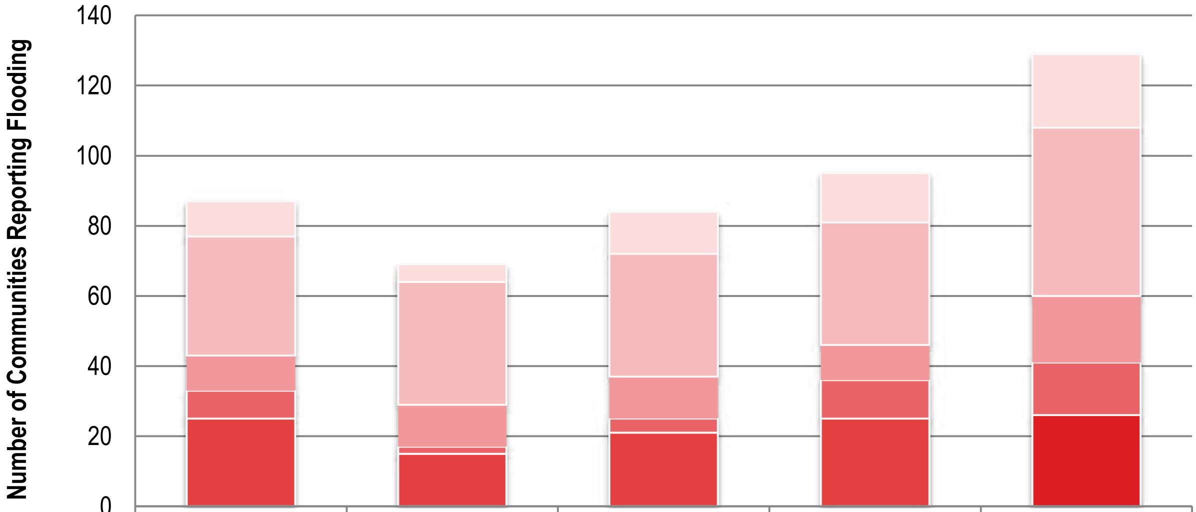
(4) Given limited resources, only 1-2 shelters were assessed in each village, limiting the generalization of observed shelter construction to entire populations (although a Shelter Expert enlisted during the project, concluded that the various types of shelter construction were limited).

FINDINGS

Characteristics and Location of Floods 2008-2012

Overall, communities reported an increase in frequency of flooding between 2008 and 2012[1]. While 87 of 151 assessed communities reported there had been flooding during 2008, this figure rose to 129 during 2012. Figure 1 shows the reported frequency of floods in the assessed communities.

Figure 1: Frequency of Reported Floods (by County)



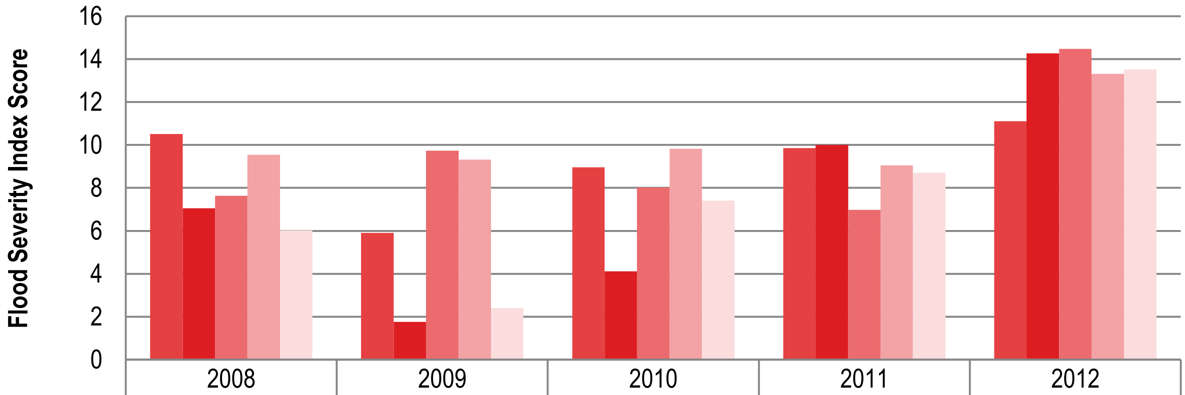
	2008	2009	2010	2011	2012
Gogrial West	10	5	12	14	21
Twic	34	35	35	35	48
Tonj South	10	12	12	10	19
Tonj North	8	2	4	11	15
Gogrial East	25	15	21	25	26

This finding has to be considered with caution given: (1) the possibility of recall bias among community discussion participants who may have found it easier to recall more recent flood events (although flooding in 2008 was perceived to have been significantly more widespread than the following year); and (2) selection bias based on recall bias amongst Payam administrators who may in turn have been more likely to suggest villages that were recently flooded as potential communities to survey. However, NGO key informants also perceived that the level flooding had increased recently with the floods during 2013 perceived as even more severe than those occurring during the preceding years.

In addition to frequency of flooding, the severity of flooding was measured by multiplying the proportion of the community that was flooded by the duration in days of the flooding. The index shows that not only did the incidence of flooding increase in Warrap since 2008 (as seen in Figure 1), the severity of the floods was also perceived to have increased. The Warrap State flood severity index was 8.6 in 2008 and rose to 13.1 in 2012, a reflection of community perception of flooding as longer and more widespread. Figure 2 shows the flood severity score for each Warrap State county over the period 2008-2012.

[1] To estimate the level of flooding in Warrap three main data sources were consulted and triangulated: (1) UNOSAT inundation maps; (2) community discussion groups and; (3) NGO key informants. UNOSAT inundation maps based on satellite imagery and primary data gathered through community discussions. UNOSAT data is not possible to disaggregate by year but yields an average level of flooding during the period. Yearly variation was instead assessed through community discussions, which seemed to indicate an increase in duration and volume of flooding during more recent years

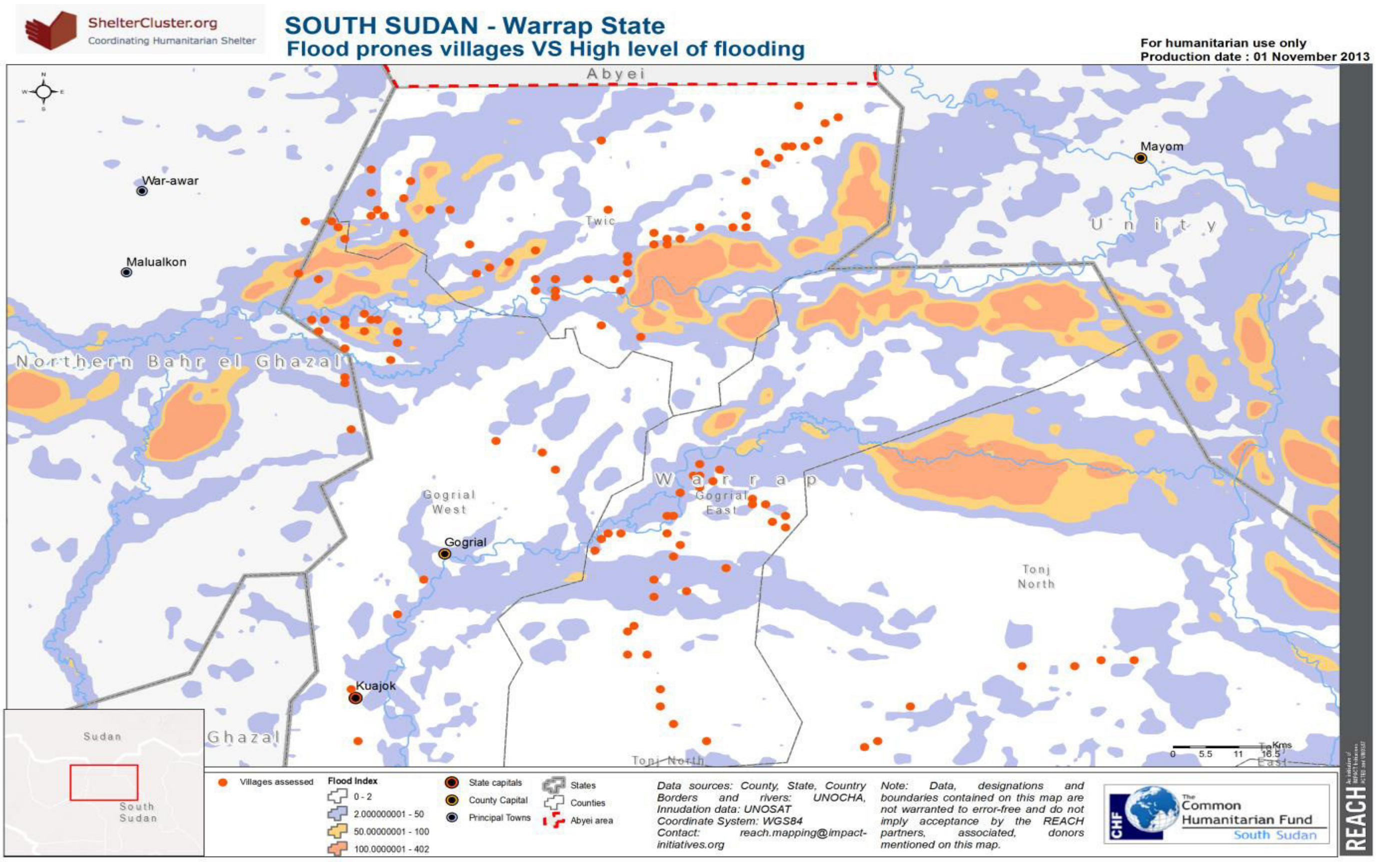
Figure 2: Severity of Floods in Assessed Villages by County (2008-2012)



	2008	2009	2010	2011	2012
Gogrial East	10.51470588	5.902777778	8.958333333	9.861111111	11.11111111
Tonj North	7.058823529	1.764705882	4.117647059	10	14.26470588
Tonj South	7.631578947	9.736842105	8.026315789	6.973684211	14.47368421
Twic	9.545454545	9.318181818	9.818181818	9.045454545	13.31818182
Gogrial West	6.018518519	2.407407407	7.407407407	8.703703704	13.51851852

As mentioned above, UNOSAT inundation maps were used to identify highly flood prone areas. Once in the field, however, areas identified as highly flood prone on UNOSAT inundation maps, were largely found to be uninhabited. This links with the finding explained later that one of the main flood coping strategies for communities is to relocate. Map 3 below shows that across the flood prone areas, communities considered as most affected by floods in the state were actually in 2013 situated outside the most flood prone areas. The major exception to this was in northwestern Warrap State where many communities were located in the highest flood prone areas.

Map 3: Flood-Prone Villages vs High Level Flooding



Housing Typology

In order to inform more effective shelter sector response, information on the types of building materials used, their sources and the seasonal differences in construction activities was collected. Table 3 shows the percentage of villages reporting each construction material type by housing component. The majority of villages use grass (96.6%) and wood (86.2%) for the roofs of their housing, while the vast majority of villages use mud (97.4%) for the walls of their house. Floors are mainly made of mud (93.1%) as well. Some housing units were made of cement and corrugated galvanized iron (CGI) sheets, but were not considered in the analysis as they constituted less than 1% of construction material types.

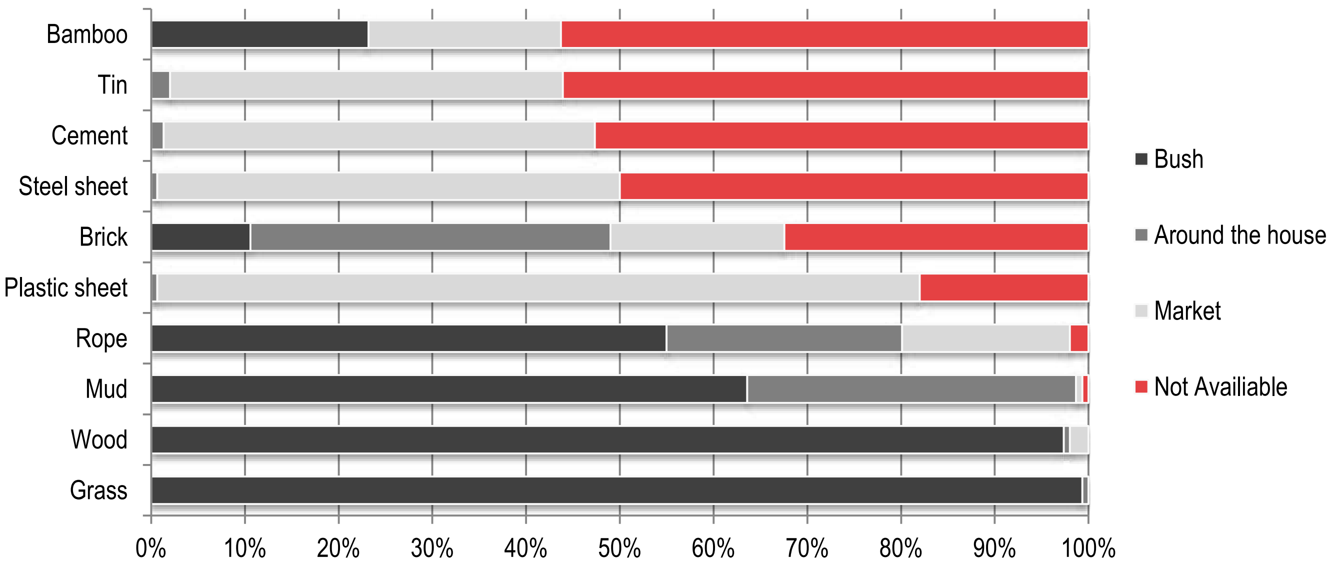
Table 3: Housing Construction Material by Housing Element

	Wall	Floor	Roof
Soil	97.4	93.1	9.5
Bamboo	9.5	0.9	22.4
Wood	59.5	15.5	86.2
Grass	33.6	1.7	96.6

Communities reported containing on average between 3 and 4 housing units within each compound, with on average between 4 and 5 individuals sleeping in one house. No significant variation was found between sub-tribes or counties in Warrap State in the average number of housing units within compounds and average number of individuals sleeping in each house. The most common uses of built units were sleeping, kitchen and food storage.

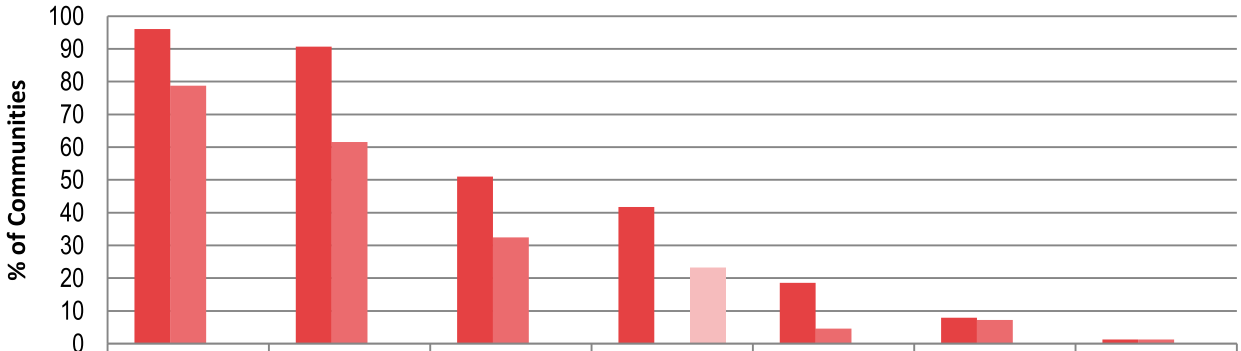
The source of building materials varied across villages, but the main sources were the bush or in the vicinity of the compound (grass, wood, soil, rope, brick and bamboo). Fewer villages cited the local market as the main source of materials, but materials such as tin, cement, steel sheets and plastic sheets were largely sourced from the market.

Figure 3: Housing Material Sources



Unsurprisingly, the typology of housing is reported as highly dependent on the local materials available locally, and the availability of building materials is reported as variable according to seasons. Surveyed communities reported an increase in the price of materials from the market during the rainy season and flood events. Plastic sheeting was reported as having the greatest price increase with 61% of communities reporting an increase of price during the rainy season and 75% of communities reporting an increase of price during the flood events. Steel sheets, cement and tin – all sourced from the market – followed as having price increases.

Figure 4: % of Communities Reporting Shortage of Materials

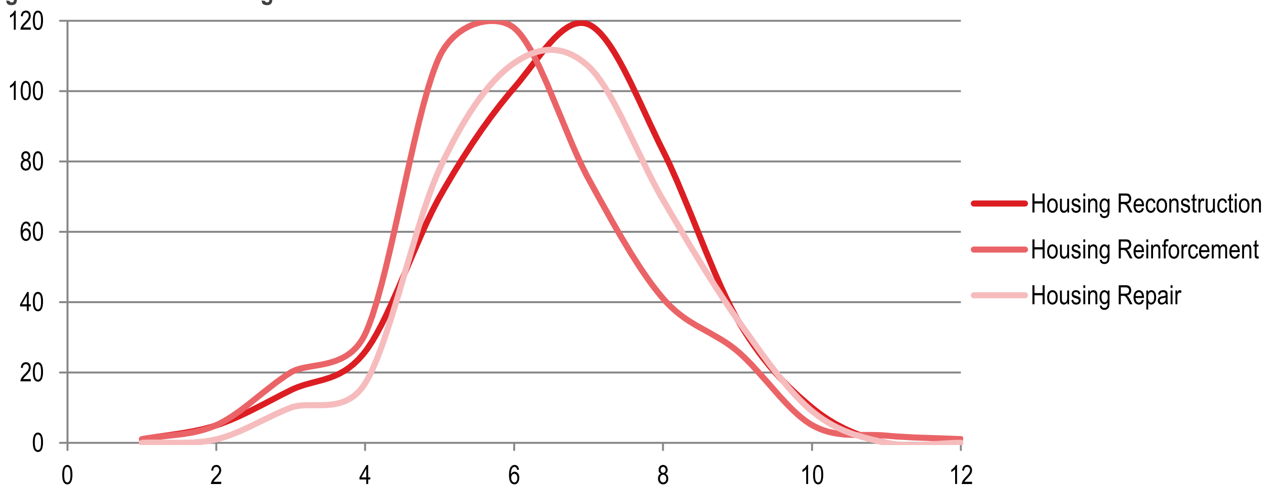


	Grass	Wood	Rope	Soil	Bamboo	Brisck	Tin
Flood	96.02649007	90.72847682	50.99337748	41.7218543	18.54304636	7.947019868	1.324503311
Rain	78.80794702	61.58940397	32.45033113	0	4.635761589	7.284768212	1.324503311
Dry	0	0	0	23.17880795	0	0	0

Given that most communities do not source materials from the market and instead collect them from the bush and in the vicinity of the house, it is more useful to understand which materials are reported as being unavailable or difficult to source. The main building material types of grass, wood, rope and soil are reported as having much higher shortages than other materials, especially during flood events. Figure 4 illustrates the relative shortage of materials during flood, rain and dry seasons. It is important to note that since most of the building materials are reported to be sourced from the bush and in the vicinity of the house, that this has a potential impact on the environment. Intensively using natural resources can lead to deforestation and degradation of soils, among other environmental impacts that can lead to increased flood vulnerability over time. An effective medium-longer term disaster risk reduction solution and relief assistance should include a focus on mitigating environmental impact and promoting sustainable use of natural resources by affected communities.

Interestingly, communities report different housing repair, reinforcement and reconstruction activities during different seasons of the year. Figure 5 illustrates the seasonal differences in housing construction activities starting in September and running until August. Housing reinforcement activities commonly run from December to March; the majority of communities conducting these activities in January. Repair activities run a little later in the dry season – from January to April – with the majority of communities conducting these activities in February. Reconstruction activities run longer throughout the dry season from December to April, but the majority of communities report that they undertake these activities later in the dry season; most commonly in March. These activity times are important for aid actors to understand in order to provide appropriate mitigation and preparedness responses at appropriate times throughout the calendar year.

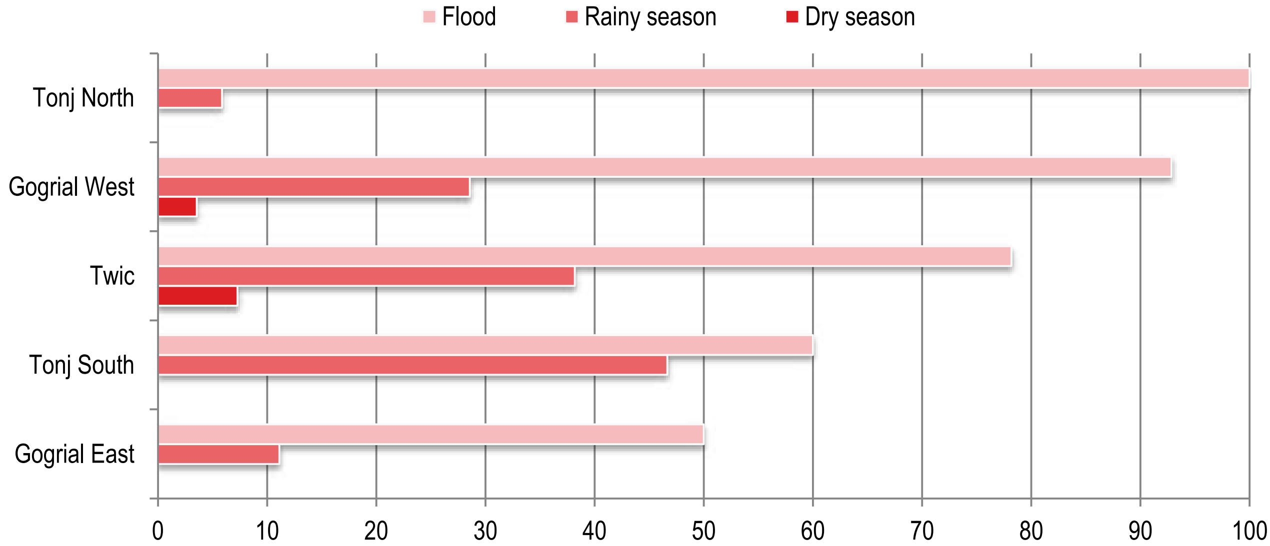
Figure 5: Seasonal Housing Construction Activities



Access to Services

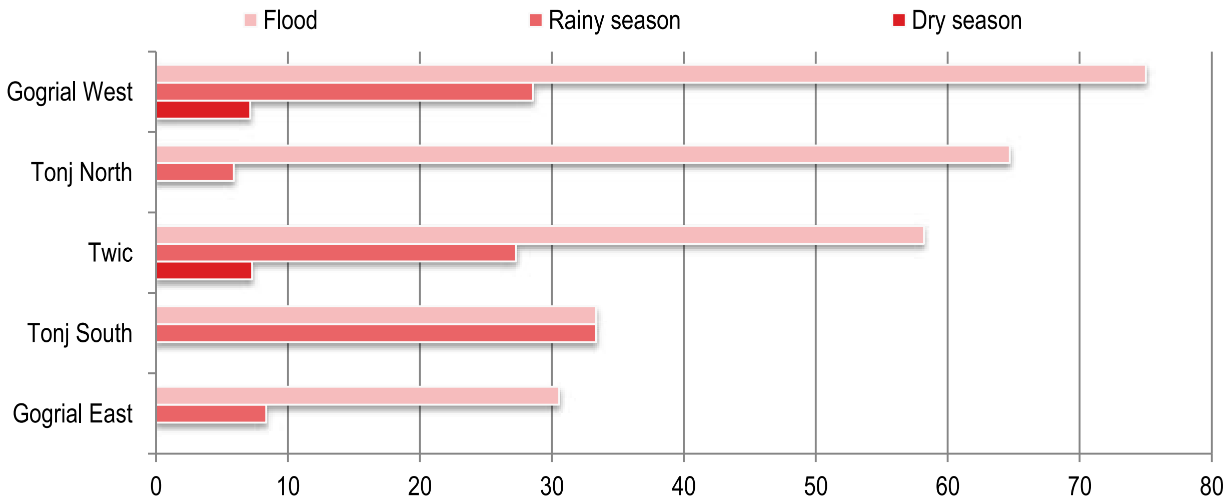
Overall, communities reported that access to services such as markets and health care were severely affected by flooding with some variation depending on county. For market access, communities assessed in Tonj North and Gogrial West were severely affected by lack of access to markets due to flooding during 2012, reported by 100% and 93% of villages, respectively. The rainy season alone, however, rarely caused lack of access to markets among villages in Tonj North (6%) and similarly for a smaller proportion of villages in Gogrial West (29%). In Tonj South, on the other hand, lack of access to markets was reported during the rainy season regardless of flooding by almost half of villages (47%) with flooding restricting access for 60% of villages. Figure 6 illustrates the lack of access to markets by county.

Figure 6: % of Communities Reporting Lack of Access to Markets



As far as health care access, communities assessed in Gogrial West and Tonj North were most likely to report a lack of access to health care services brought on by flooding; 75% and 65% of communities, respectively. Similar to market access, the rainy season alone caused little restriction for villages in Tonj North (6%) and to a lesser extent in Gogrial West (29%). In Tonj South, access to health care services was affected by the rainy season in 33% of cases, with the addition of flooding making no difference (33%). Figure 7 illustrates the lack of access to health care centers by county.

Figure 7: % of Communities Reporting Lack of Access to Health Care Centers

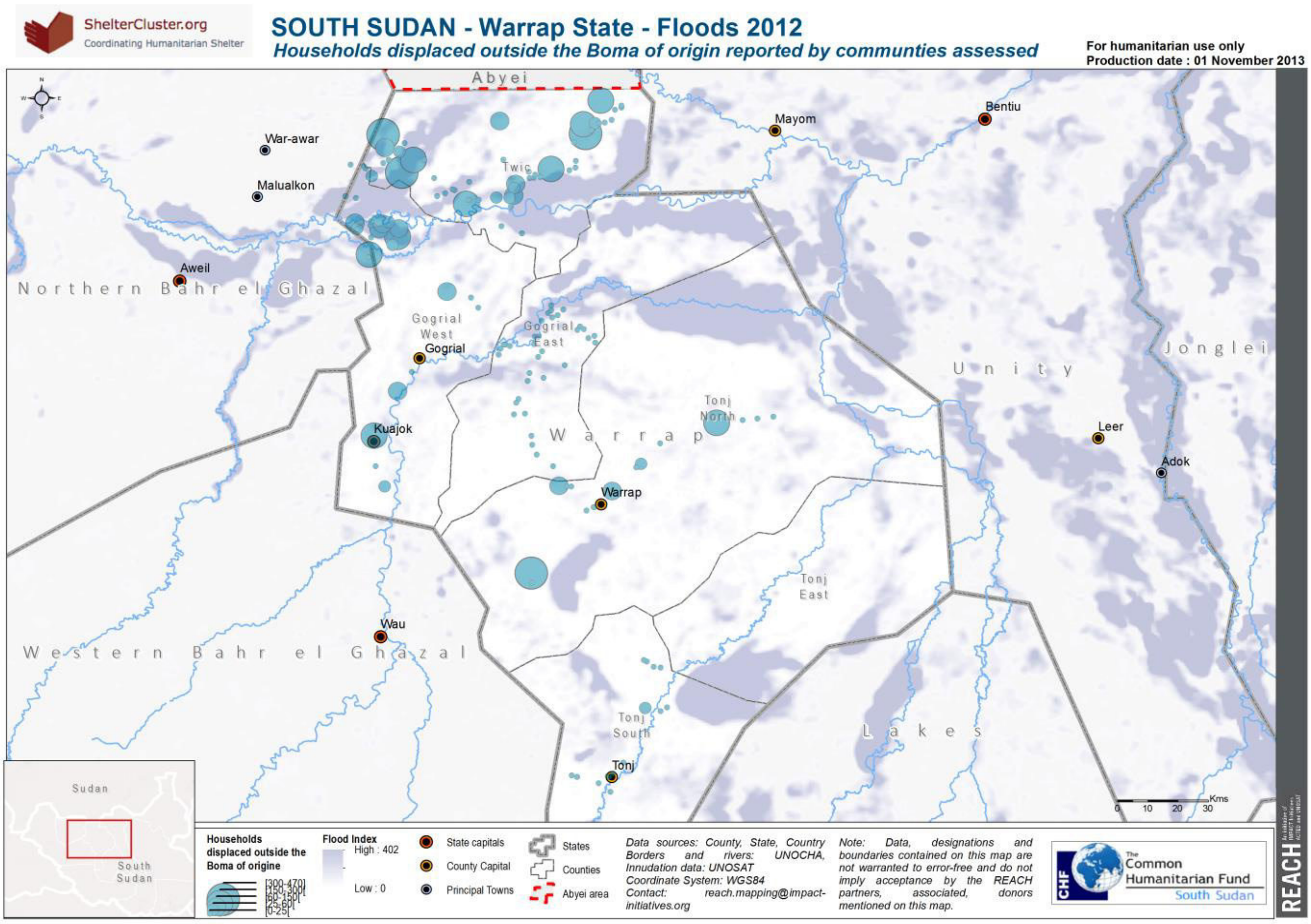


Flood Impact

Displacement

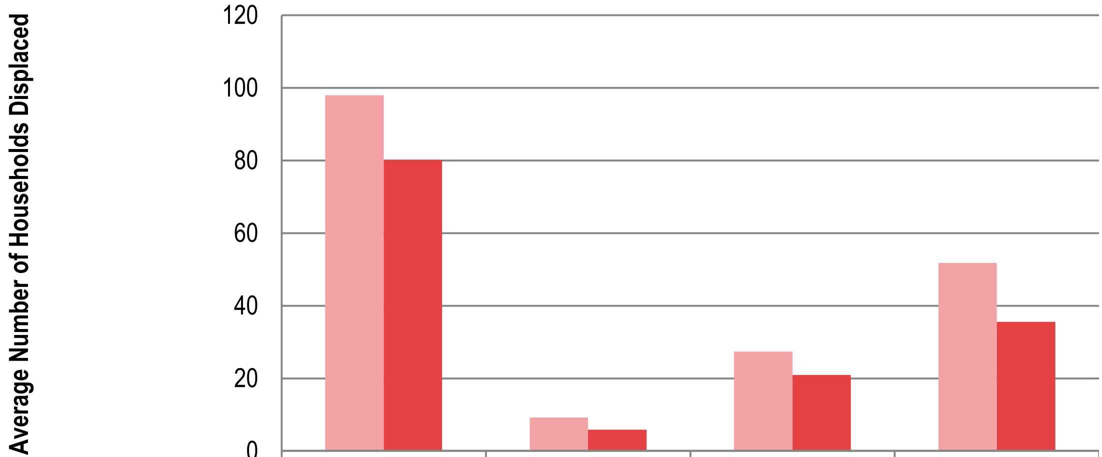
Among the surveyed communities, the average percentage of households displaced outside their boma of origin as a consequence of the floods in 2012 was highest in Twic, Tonj North and Gogrial West Counties. Although most displaced households were reported to have returned, a gap was observed in all counties, with the highest proportion of displaced that never returned seen in Twic County (14.4%). Map 4 illustrates the number of households displaced outside the Boma of origin per village.

Map 4: Households Displaced Outside Boma of Origin



The average number of displaced households was found to vary depending on severity of flooding (since 2008) – where the number of displaced households was higher among communities with a Very High flood severity rating (75-100) compared to those with a High (50-75) and Medium (25-50) rating. Interestingly, the highest average number of displaced households was found among communities with a Low flood severity rating (0-25). This could indicate that communities with larger populations tended to be located in areas that were less affected by flooding. It may also be the case that households in less affected areas found it easier to migrate temporarily as surrounding areas may have been easier to access. Figure 8 illustrates the number of households displaced outside the boma of origin by flood severity index.

Figure 8: Average Number of Households Displaced Outside Boma of Origin by Flood Severity Index



	(0,25]	(25,50]	(50,75]	(75,100]
Households dispalced outside the Boma	97.92	9.197368421	27.32352941	51.8
Household returns	80.12	5.868421053	20.97058824	35.53333333

Housing Damage

The highest proportions of housing damage caused by flooding were found in Twic and Gogrial West counties. On average, 135 housing unit were reported to have been damaged in Twic communities and 83 housing units were said to have been damaged in Gogrial West communities. In contrast, communities surveyed in Tonj South reported the lowest average damage to the housing stock (42).

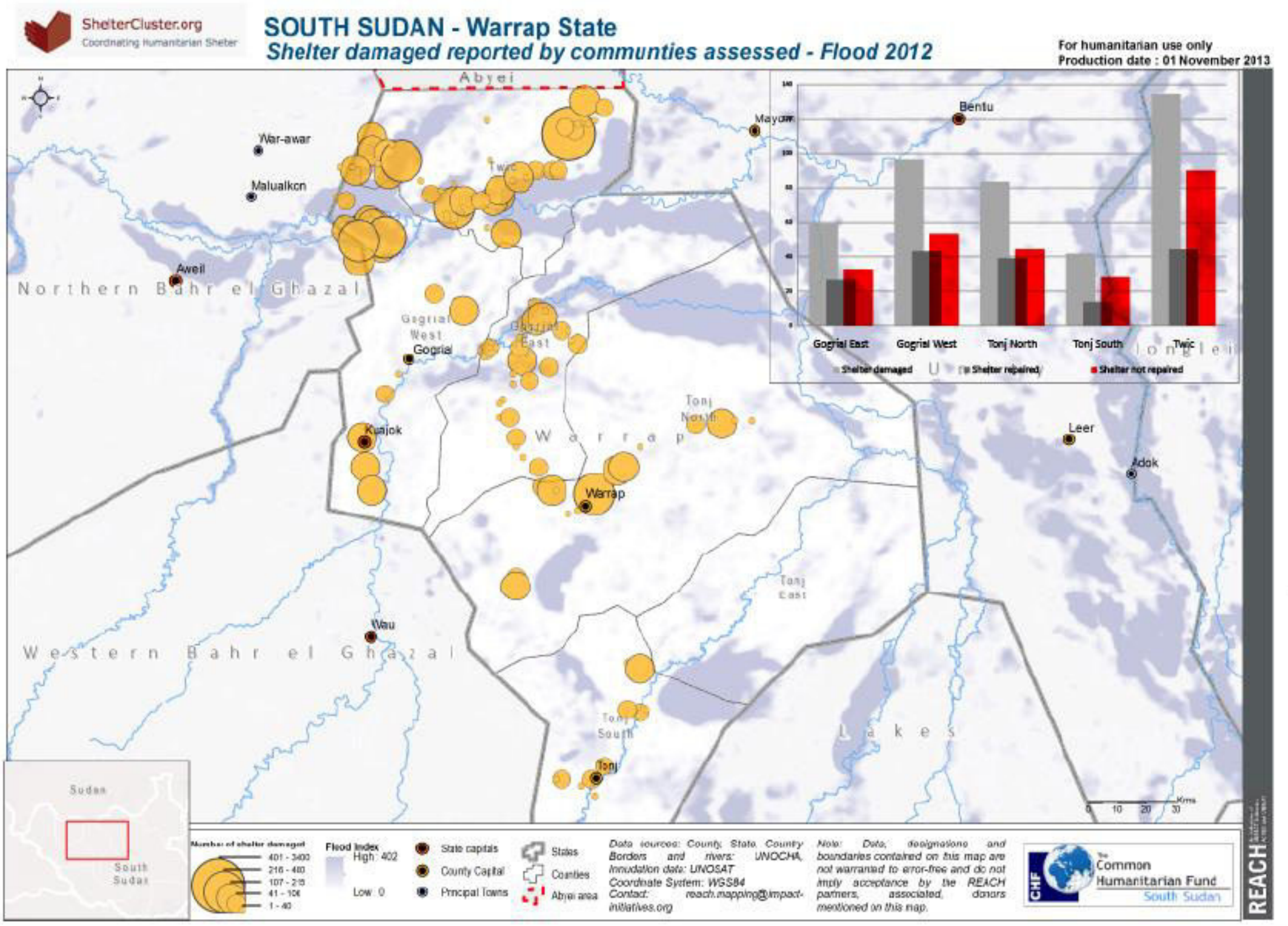
More than half of damaged housing units had been repaired across all counties, with the highest proportion of repaired houses found in Twic and Tonj South, where 67% of damaged houses were said to have been repaired. The lowest proportion of repaired houses was found in Tonj North (53%). Table 4 shows the numbers of houses damaged and assesses the percentage of houses not repaired.

Table 4: Shelter Damage & Repair by County

County	# Shelters damaged	# Shelters repaired	# Shelters not repaired	% of Shelters not repaired
Gogrial East	59	27	33	55%
Gogrial West	97	43	53	55%
Tonj North	84	39	44	53%
Tonj South	42	14	28	67%
Twic	135	44	90	67%
Total	**95**	**36**	**58**	**61%**

As noted earlier, materials used for housing construction were observed to be the same across all counties, hence the difference in the number of damaged housing units must be explained by other factors, such as the severity of floods.

Map 5: Reported Shelter Damage by Communities Assessed



Casualties

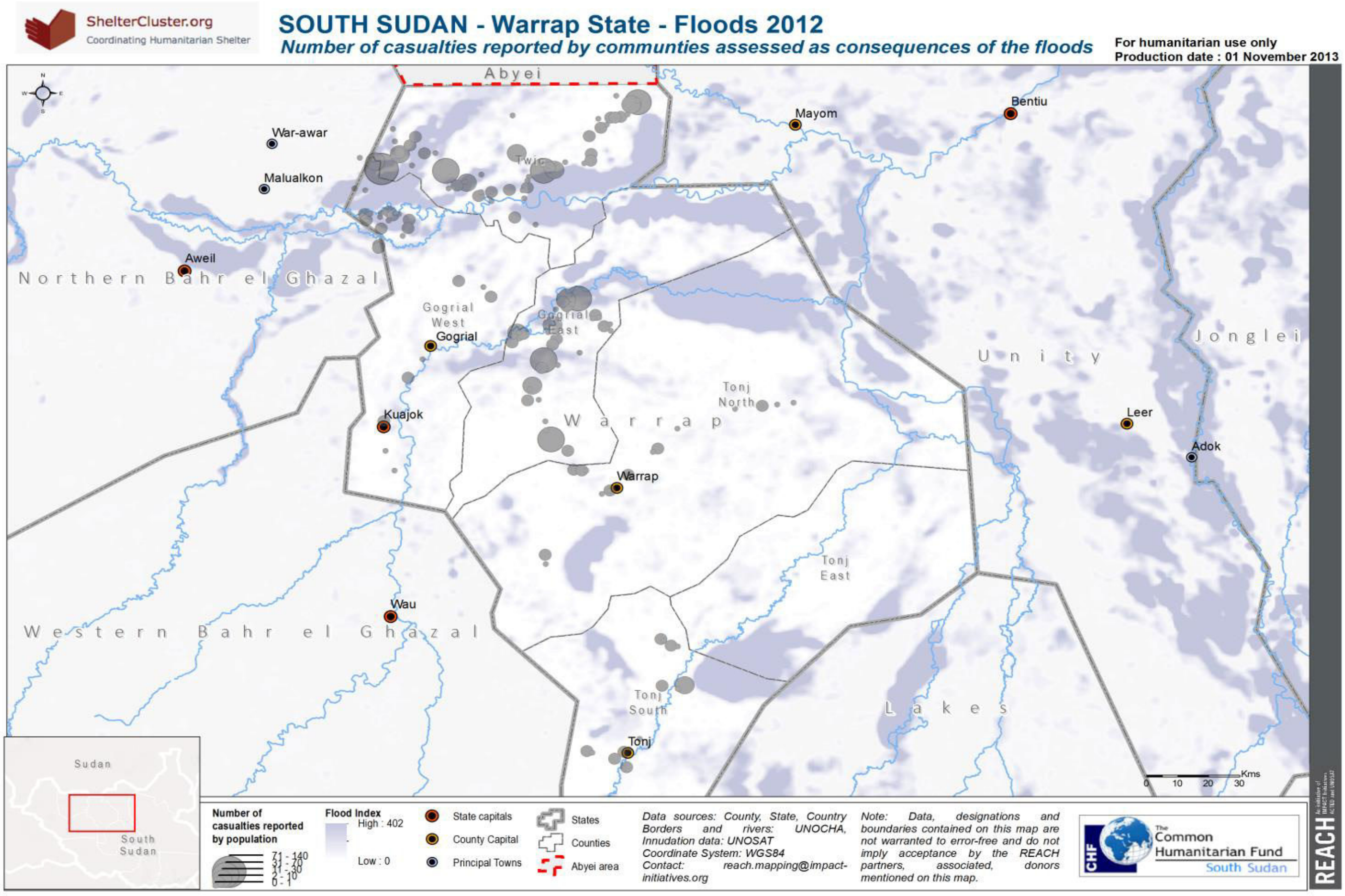
Communities assessed in Twic County reported the highest number of casualties with 449 individuals reported to have died as a consequence of the 2012 floods, followed by Gogrial West (292) people. This amounted to 8 individuals on average per community in each county, respectively. The lowest total number of casualties was reported in Tonj North county (24), with on average 2 casualties per community.

Linear Regression – Access to Health Centers and Casualties

Significant variation was found in reported casualties due to flooding across the following variables: (1) severity of flooding; (2) health care access; and (3) market access. The key findings include:

- An increase of one point on the flood severity index was associated with a 0.2% increase in the proportion of casualties due to flooding during 2012, controlling for access to health care and markets.
- Reported lack of access to health care centers due to flooding was associated with a 4% increase in proportion of casualties due to flooding, controlling for severity of flooding and access to markets.

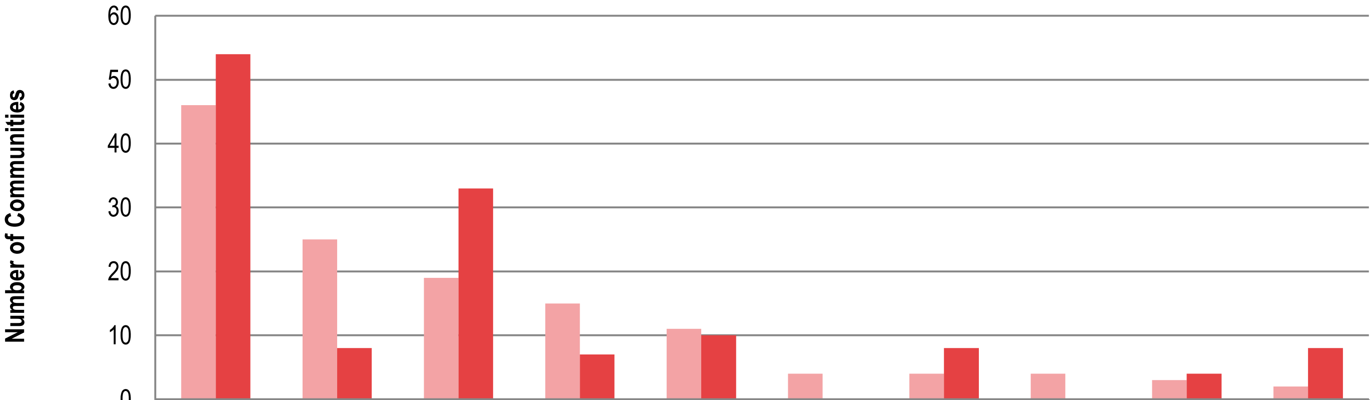
Map 6: Number of Casualties as a Consequence of Floods



Perceived Impact of Flooding on Communities

The primary impact of flooding according to the communities assessed was the destruction of crops which was rated as the main impact by 34% of communities. Casualties was the second most often reported primary impact, rated as the main impact by 19% of communities, followed by destruction or damage of houses which was rated as primary impact by 14% of communities. The secondary impacts according to the assessed communities were crop destruction (reported by 40%); destruction of houses (24%); and casualties (7%). Figure 9 illustrates these results.

Figure 9: Primary and Secondary Impact of Flooding Reported by Communities



	Crop Destruction	Casualties	Housing Damage	Disease	Pest	Food Shortage	Infrastructure Loss	Livelihood Loss	Displacement	Livestock Loss
Main Impact	46	25	19	15	11	4	4	4	3	2
Second Main Impact	54	8	33	7	10	0	8	0	4	8

Preparedness & Mitigation Strategies

Preparedness

Although crop destruction was the most commonly cited primary impact of flooding, a correspondingly small proportion of communities reported preparedness measures against crop destruction as their main preparedness measure – only 1.5% of communities said early cultivation was their main preparedness strategy. An additional 3.7% of communities reported early cultivation as their secondary preparedness strategy.

During the participatory rating exercise, the preparedness strategy most commonly rated as most effective by the communities was dyke construction (considered the most effective by 68% of communities). The second most efficient preparedness strategy according to communities was water channel construction (considered as the second most efficient by 50% of communities assessed). Most of the villages that mentioned dyke construction as the most effective preparedness strategy mentioned water channel construction as the second most efficient preparedness strategy. Table 5 illustrates these results.

Table 5: Community Preparedness Strategies

Preparedness Strategy	% reported as Primary strategy	% reported as Secondary strategy	% reported as Third strategy
Construction of dykes	68%	13%	4%
Construction of water channel	17	51	13
Resource sharing	7	3	4
Construction of water storage	2	2	3
Displacement	2	12	24
Early cultivation	1	4	0
Leveling compound	1	1	4
Contingency items	1	0	9
Protection of belongings	0	3	0
Tree plantation	0	1	1
Housing reinforcement	0	1	0

When looking at the effect of preparedness strategies on other variables, there are interesting results associated with displacement and level of housing damage. Through linear regression modeling, it was found that:

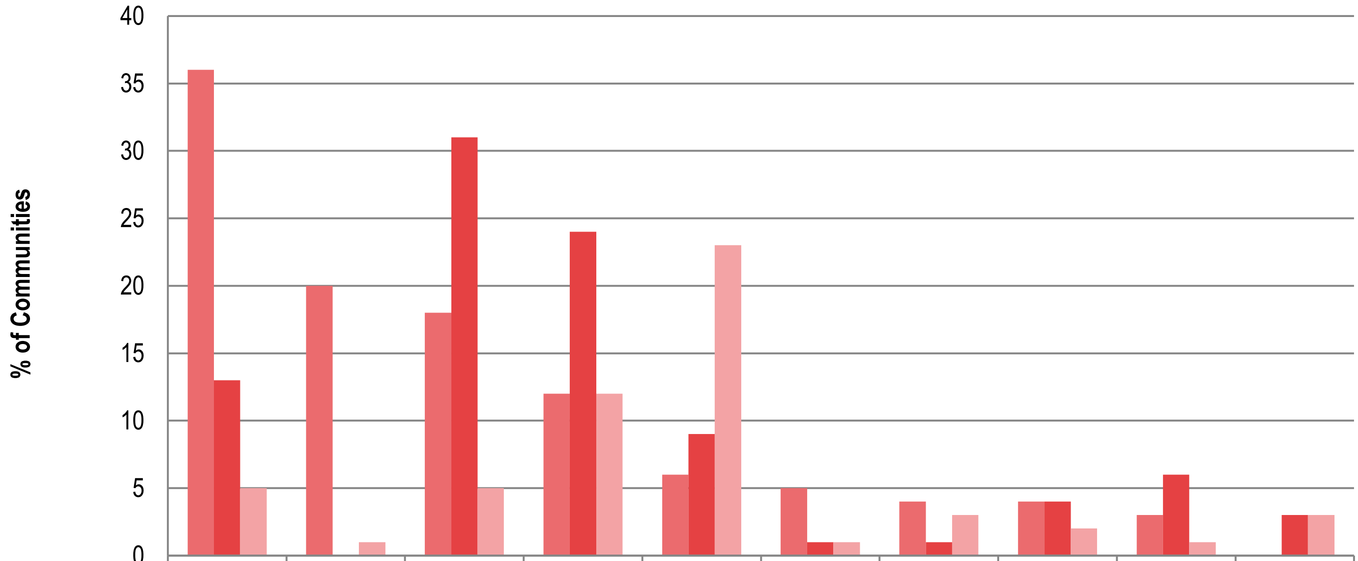
- Migration as a preparedness strategy has a significant negative effect on the number of reported casualties. In other words, migration is associated with a decrease in the number of reported casualties.
- Construction of dykes before flooding was found to be associated with lower levels of displacement outside the Boma of origin (migration). Communities where dykes were constructed had on average 32 fewer displaced households.
- Construction of a water channel also reduced displacement outside the Boma of origin (migration). Communities constructing water channels had on average 31 fewer displaced households than those that had not constructed water channels.
- Communities that reported constructing dykes in public spaces and around compounds also experienced a higher level of housing damage. This counter intuitive finding may simply be due to the fact that communities that were constructing dykes did so because they were overall more severely affected by flooding than those that did not, hence being more at risk of housing damage.

Mitigation

Reconstruction of dykes was most commonly considered as the most effective mitigation method, cited by 36% of communities. Change in mode of livelihood was the second most commonly cited mitigation method (20%) followed by shelter reconstruction and reconstruction of canals.

Interestingly, communities that mentioned reconstruction of dykes as a mitigation strategy in the event of flooding were less likely to have had shelters damaged and were more likely to have had a lower number of displaced people. On the other hand, communities that mentioned a change of livelihood as a mitigation strategy were more likely to report a higher number of displaced households.

Figure 10: Mitigation Methods Used by Assessed Communities (%)



	Dyke Recon.	Livelihood Change	Housing Recon.	Canal Recon.	Displacement	Comm. Infra. Recon.	Humanitarian	Protection of Belongings	Sharing Resources in Comm.	Leveling of Compound
1st Effective Method	36	20	18	12	6	5	4	4	3	
2nd Most Effective Method	13		31	24	9	1	1	4	6	3
3rd Most Effective Method	5	1	5	12	23	1	3	2	1	3

Linear Regression – Mitigation Methods, Housing Damage and Displacement

When looking at the effect of preparedness strategies on other variables, there are interesting results associated with displacement and housing damage. Through linear regression modeling, it was found that:

- Communities where dykes were reportedly reconstructed following the floods reported a lower level of displacement. Reconstruction of dykes was associated with on average 291 fewer households being displaced as consequence of the floods, a significant effect which remained when comparing communities that experienced the same severity of flooding.
- Similarly, communities where water channels were reportedly reconstructed after the floods also reported a lower level of displacement. On average 273 fewer households were displaced as consequence of the floods, an effect that remained when comparing communities that experienced the same severity of flooding.

Flood Vulnerability Index

As mentioned above, a flood vulnerability index was designed to assess differences in flood vulnerability across communities included in the present study. The index is based on the hypothesis that communities are more resilient to the effects of flooding if they are prepared and use mitigation techniques to limit the effects. The index includes two components: (1) a mitigation score and (2) a preparedness score. The answers to specific questions in the questionnaires were ranked by the communities from the least efficient to the most efficient. Each community was assigned a cumulative preparedness and mitigation score which were based on the three preparedness and mitigation strategies they had reported using. Ranking of effectiveness of these strategies were supplied by a community ranking exercise.

Communities were asked which preparedness and mitigation techniques they felt were most effective. Based on these responses, mitigation and preparedness techniques were: (1) identified and (2) weighted according to the level of their respective level of efficacy in limiting negative effects of flooding, as determined by the consulted communities.

The preparedness and mitigation scores both ranged from 0 to 9 and were divided into 3 categories: low [0-3]; medium [3-6]; and high [6-9] levels of preparedness/mitigation. These two indexes were then combined to create the FVI in order to categorize communities as to their potential vulnerability to flooding. Table 6 shows this matrix.

Table 6: Flood Vulnerability Index

	Mitigation Index		
Preparedness Index	[0,3]	[3,6]	[6,9]
[0,3]			
[3,6]			
[6,9]			

The results can thus be interpreted as follows: a village that has high preparedness and high flood mitigation scores is considered to be more resilient and less vulnerable (green in Table 6) while a village with low preparedness and low mitigation scores would be more vulnerable (red in Table 6).

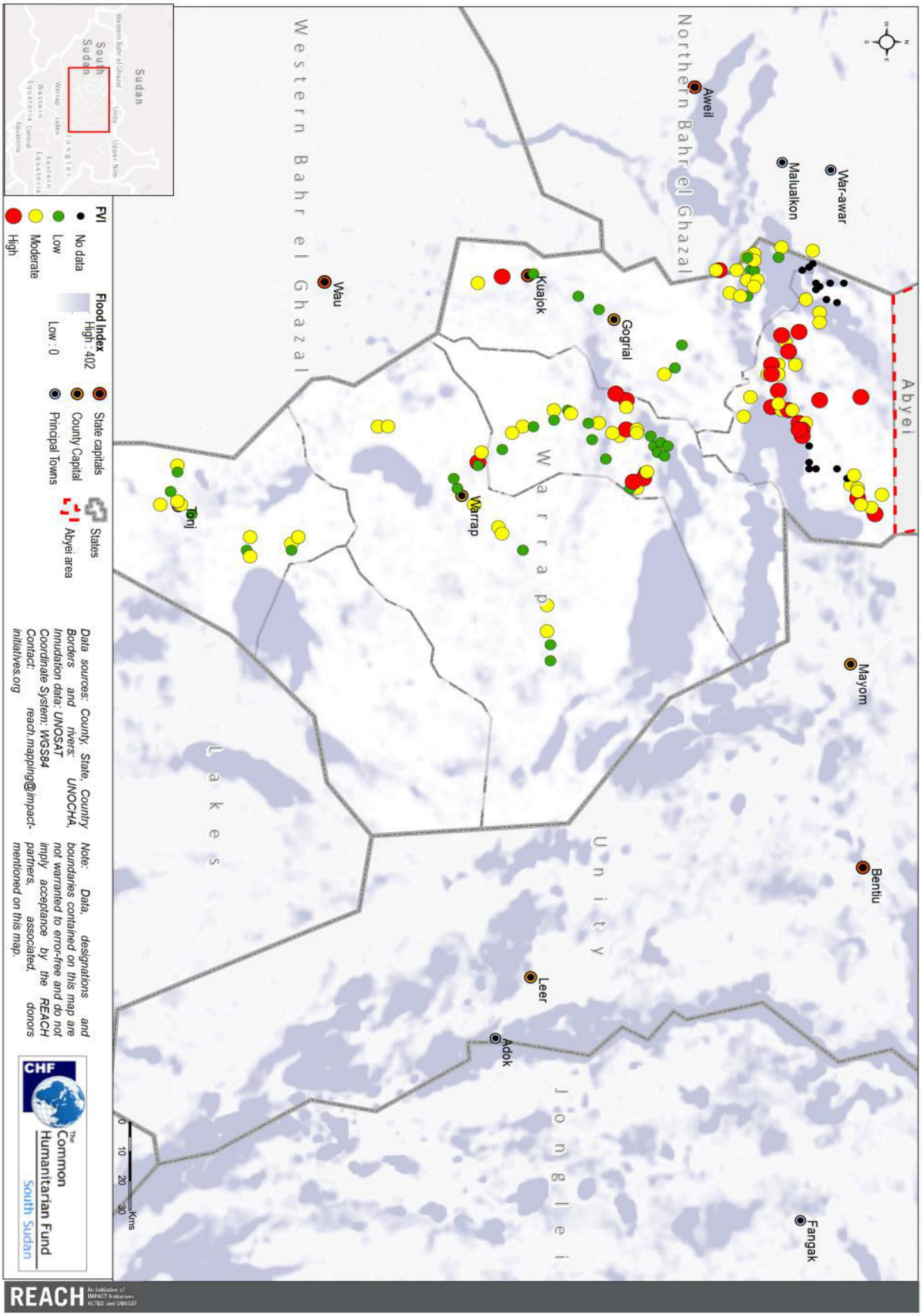
Map 7 (next page) illustrates the results of the classification of each assessed village according to the FVI. Here it can be seen that Twic County has the highest concentration of High and Moderate vulnerability classified villages along the index while Gogrial East and West have higher concentrations at the Low and Moderate ends of the index. Overall, as seen in Table 7, there are 24 villages considered to be highly vulnerable, 68 moderately vulnerable and 43 with low vulnerability classification.

Table 7: FVI Village Classification

FVI Classification	Number of Villages[1]	Number of Households
High	24	8335
Moderate	68	27597
Low	43	15390
Grand Total	**135**	**51322**

[1]Not all sampled villages have been included in the classification due to unreliable data for 16 villages (see Annex 1).

Map 7: Flood Vulnerability Index by Community



CONTINGENCY PLAN

The following contingency plan is the result of analysis of the key results alongside the Flood Vulnerability Index (FVI). This contingency plan is intended to provide humanitarian actors with information about activities to be carried out both before and during a flood event.

By using classification information for each assessed village and combining it with both the preparedness/mitigation activities already used by communities and information on support requested by communities, discreet activities were developed for each FVI classification[2]. An annotated list of villages, their classifications and key information about individual village needs and requests can be found in Annex 1. Three maps outlining the FVI classification of each village can be found in Annex 2.

The proposed contingency plan comprises activities are organized by FVI classification for both before and during a flood event. Each activity grouping includes a description. The Shelter and NFI Cluster in South Sudan will be responsible for identifying NGOs responsible for carrying out the suggested activities and deadlines.

These activities are part of a multi-sectoral strategic response plan informed by the previously outlined analysis. While some of these activities are not specifically related to the shelter sector (e.g. building dykes), they directly impact housing in flood prone areas and should be considered during any flood mitigation programming for shelter.

This section also draws on information contained within the separate Housing Design Report (October 2013) also commissioned by the Shelter/NFI Cluster and facilitated by REACH and ACTED. Information contained within the report on raising compounds/shelters, construction methods and required materials directly inform some of the activities below.

Activities to Be Carried Out Before a Flood Event

The following activities are intended to be carried out before a flood event. Using the information found in Tables 8 and 9, preparedness activities were developed for each classification of the FVI.

Table 8: Preparedness Methods Used by Communities (Number of Communities)

FVI	Water Channels	Dykes	Raising of compound/house	Shelter Preparation	Preventive displacement
High	9	18	1	0	2
Moderate	55	55	7	3	37
Low	41	41	5	0	19
Grand Total	**105**	**114**	**13**	**3**	**58**

Table 9: Support Requested Before Floods (Proportion of Communities Assessed)

FVI	DRR	Food	NFI	Others	Vegetation plantation	WASH	Grand Total
High	69.57%	17.39%	13.04%	0.00%	0.00%	0.00%	100.00%
Moderate	47.27%	25.45%	23.64%	1.82%	1.82%	0.00%	100.00%
Low	57.50%	10.00%	7.50%	5.00%	15.00%	5.00%	100.00%
Grand Total	**55.08%**	**18.64%**	**16.10%**	**2.54%**	**5.93%**	**1.69%**	**100.00%**

[2] It should be noted that, due to the lack of updated information regarding human resources and logistical capacity of cluster partners, this plan rests on the assumption that partners have unlimited capacity and are willing to participate. Geographic information about stocks and locations of humanitarian actors was not available for this study, thus it remains the Shelter/NFI Cluster's responsibility to use the information contained within this study in order to inform locations and agency responsibilities for pre-positioning and response.

Flood Vulnerability HIGH

Representing 24 villages (8,335 HH) across 4 of the counties assessed. Based on: (1) preparedness methods used by the communities and (2) the support the communities recommended, the following 6 activities have been identified:

#	Activity
1	Building of dykes in 6 communities that had not constructed dykes (could be conducted as food for asset activities)[3]
2	Building of water channels in 15 communities that had not constructed water channels (could be conducted as food for asset activities)[4]
3	Raising compound/housing units in all 24 villages (see the Housing Design Report for recommendations on how to raise buildings/compounds and required materials)
4	Reinforcing housing units in all 24 villages (see Housing Design Report for advice on recommended construction methods and materials)
5	Prepositioning of NFI kits in villages that are most difficult to access from current NGO bases during the rainy season (by creating committees in charge of the storage and distribution) in case of an emergency[5]
6	Prepositioning of shelter relief aid materials in villages the most difficult to access (by creating committees in charge of the storage and distribution) in case of an emergency[6]

Flood Vulnerability MEDIUM

Representing 68 villages (27,597 HH) across 4 of the counties assessed. Based on: (1) preparedness methods used by the communities and (2) the support the communities recommended, the following 4 activities have been identified:

#	Activity
1	Building of dykes in 12 communities that had not constructed dykes (could be conducted as food for asset activities)
2	Building of water channels in 12 communities that had not constructed water channels (could be conducted as food for asset activities)
3	Raising compound/housing units in 68 villages (see the Housing Design Report for recommendations on how to raise buildings/compounds and required materials)
4	Reinforcing housing units in 68 villages (see Housing Design Report for advice on recommended construction methods and materials)

[3] See Annex 1 for village names
[4] See Annex 1 for village names
[5] NGO locations not known at the time of the study so villages could not be identified
[6] NGO locations not known at the time of the study so villages could not be identified

Flood Vulnerability LOW

Representing 43 villages (15,390 HH) across 4 of the counties assessed. Based on: (1) preparedness methods used by the communities and (2) the support the communities recommended, the following 2 activities have been identified:

No.	Activity
1	Raising compound/housing units in 43 villages (see Housing Design Report for recommendations on how to raise buildings/compounds and required materials)
2	Reinforcing housing units in 43 villages (see Housing Design Report for advice on recommended construction methods and materials)

Activities to Be Carried Out During a Flood Event

The following activities are intended to be carried out during a flood event. Using the information found in Tables 10 and 11, mitigation activities were developed for High and Moderate classifications of the FVI – it is assumed that Low FVI classifications would not need prioritized assistance.

Table 10: Mitigation Methods Used by Communities (Number of Communities)

FVI	Displacement	Change in livelihood	Shelter reconstruction	Reconstruction water channel	Reconstruction of dykes	Raising compound
High	6	0	2	6	7	2
Moderate	9	1	16	22	28	5
Low	24	22	32	20	19	6
Grand total	**39**	**23**	**50**	**48**	**54**	**13**

Table 11: Support Requested During Floods (Proportion of Communities Assessed)

FVI	DRR	Food	NFI	Shelter	WASH	Grand Total
High	50.00%	18.75%	6.25%	25.00%	0.00%	100.00%
Moderate	21.05%	50.88%	12.28%	14.04%	1.75%	100.00%
Low	14.29%	69.05%	4.76%	11.90%	0.00%	100.00%
Grand Total	**22.61%**	**53.04%**	**8.70%**	**14.78%**	**0.87%**	**100.00%**

Flood Vulnerability HIGH

Representing 24 villages (8,338 HH) across 4 of the counties assessed. Based on: (1) preparedness methods; (2) mitigation methods used by the communities; and (3) the support the communities recommended, the following 5 activities have been identified:

#	Activity
1	Distribution of shelter materials for affected villages
2	Distribution of NFI kits for affected households
3	Rebuilding/maintenance of dykes in 24 communities that need to reconstruct dykes (could be conducted as food for asset activities)[7]
4	Rebuilding/maintenance of water channels in 24 communities that need to reconstruct water channels (could be conducted as food for asset activities)[8]
5	Raising compound/housing units in all 24 villages (see the Housing Design Report for recommendations on how to raise buildings/compounds and required materials)
6	Reinforcing housing units in all 24 villages (see Housing Design Report for advice on recommended construction methods and materials)

Flood Vulnerability MEDIUM

Representing 68 villages (27,597 HH) across 4 of the counties assessed. Based on: (1) preparedness methods; (2) mitigation methods used by the communities; and (3) the support the communities recommended, the following 4 activities have been identified:

#	Activities
1	Rebuilding/maintenance of dykes in communities that need to reconstructed dykes (could be conducted as food for asset activities)
2	Rebuilding/maintenance of water channels in communities that need to reconstructed water channels (could be conducted as food for asset activities)
3	Maintenance and raising of compound/housing units in 68 villages (see the Housing Design Report for recommendations on how to raise shelter/compounds and required materials)
4	Reinforcing housing units in 68 villages (see Housing Design Report for advice on recommended construction methods and materials)

[7] See Annex 1 for village names
[8] See Annex 1 for village names

ANNEXES

Annex 1: List of Communities Assessed with FVI Classification

Tong South County	
Village	**FVI score**
Aguka	Moderate
Genanyuon	Moderate
Kombania	Moderate
Mabior yar	Moderate
Madol	Moderate
Maper	Moderate
Moragoor	Moderate
Wanh_Alel	Moderate
Warcuei	Moderate
Warwut	Moderate
Abar	Low
Madhal	Low
Majok	Low
Piok koi	Low
Waratit	Low

Tong North County	
Village	**FVI score**
Gumeer	High
Ageeny	Moderate
Aricdeng	Moderate
Athieng poul	Moderate
Guac_Awan	Moderate
Jur-ciek	Moderate
Managul	Moderate
Marial abuok	Moderate
Rual malith	Moderate
Apuor	Low
Bundir	Low
Kondok	Low
Lil-keet	Low
Majok	Low
Mariik	Low
Panthiou	Low
Roor-kou	Low

Gogrial East County	
Village	**FVI score**
Manyiel	Very high
Nyang	Very high
Panroor	Very high
Puoth-kuel	Very high
Buk Agok	High
Abyei	Moderate
Bulic	Moderate
Chueicirar	Moderate
Hal ajak	Moderate
Lang	Moderate
Liet Chan	Moderate
Majok amal	Moderate
Mayom chol	Moderate
Pathuon	Moderate
Roorcol	Moderate
Rumjual	Moderate
Toch	Moderate
Wun_Liet	Moderate
Wunchuei	Moderate
Yiikadoor	Moderate
Agagal	Low
Agor	Low
Alabek	Low
Anapriang	Low
Bolich	Low
Kual _kou	Low
Lil_Athian	Low
Mading akot	Low
Maluth	Low
Mangok	Low
Pagoot	Low
Panhomaker	Low
Roor mayom	Low
Tit Agok	Low
Tuong Adoor	Low
War Nyang	Low

Gogrial West County	
Village	**FVI score**
Rumdhol	High
Panrang	High
Makuac payum	Moderate
Majakkou	Moderate
Wet-buol	Moderate
Malek	Moderate
Lake_Yangyom	Moderate
War_Mabwoit	Moderate
Maper agal	Moderate
Nyinlir	Moderate
Milo	Moderate
Achierchok	Moderate
Tiit majak	Moderate
Adutbul	Moderate
Arany piny	Low
Ridic village	Low
Makuei village	Low
Powang	Low
Cuom-lual	Low
Adeer	Low
Thur	Low
Majok	Low
Kar-ajak	Low
Mayen_Pajok	Low
Adun	Low
Totin	Low
Kuajok	Low

Twic County	
Village	**FVI score**
Rumajing	Very high
Toch yoou	Very high
Achol khor	Very high
Manoor akol	Very high
Abei	Very high
Audhap	High
Mayne-guotjuol	High
Ayen	High
Mayen haal	High
Wuncum	High
Makuei-yuou	High
Mangok Amuol	High
Ahot	High
Mayen	High
Mathiang aheer	High
Audhur	High
Managok	Moderate
Panyimo	Moderate
Achakoi	Moderate
Liil	Moderate
Mangok Pannot	Moderate
Ayikou	Moderate
Lien village	Moderate
Aweei village	Moderate
Manyiel	Moderate
Liil 1	Moderate
Pakot	Moderate

Twic County	
Village	**FVI score**
Toch tiit	Moderate
Awany	Moderate
Akoc deng bol	Moderate
Machar agep	Moderate
Mayen- jang	Moderate
Wang lath	Moderate
Gomguoi	Moderate
Muolbang	Moderate
Long aheer	Moderate
Nyanaluel	Moderate
Gok/kueth dhiac	Moderate
Guok village	Moderate
Majok noon	"-"
Pan tiok	"-"
Adindaw	"-"
Fan_Agork	"-"
Muor	"-"
Man-nyuar	"-"
Aweng	"-"
Aluel village	"-"
Wunchum	"-"
Apapping village	"-"
Matdiar	"-"
Akoc	"-"
Akok village	"-"
Akec piny	"-"
Rum Akoon	"-"
Pajaka	"-"

Annex 2: Maps of Communities Assessed with FVI Classification

SOUTH SUDAN - Warrap State - Gogrial East

Vulnerability to floods of assessed villages

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Production date : 01 November 2013

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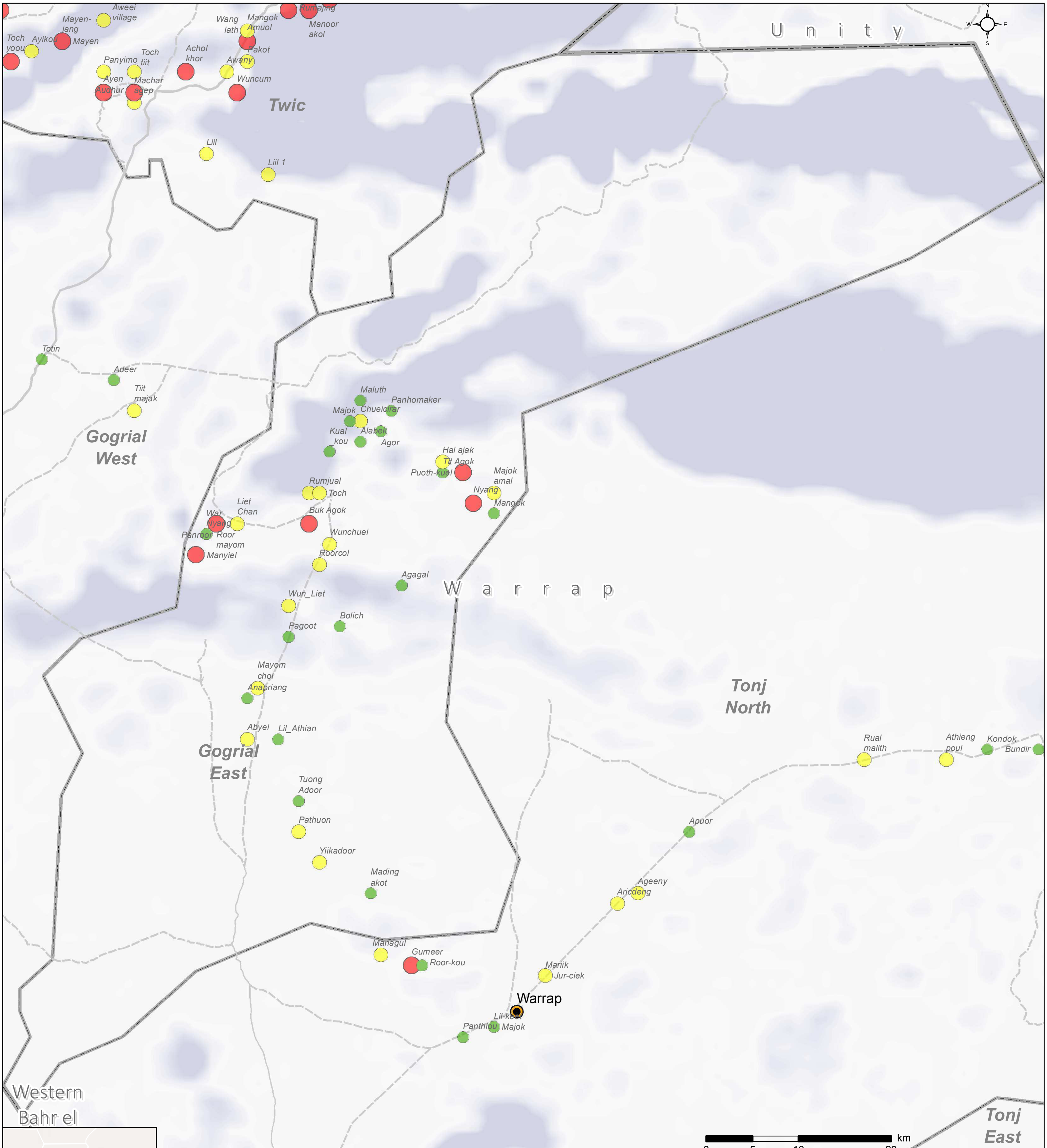

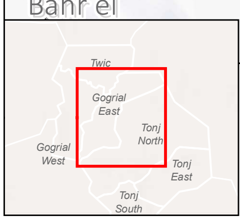

FVI
- No data
- Low
- Moderate
- High

Flood Index
High : 402
Low : 0

Road
- Primary
- Secondary
- Tertiary

Data sources: County, State, Country Borders and rivers: UNOCHA, Innudation data: UNOSAT

Coordinate System: WGS84
Contact: reach.mapping@impact-initiatives.org

Note: Data, designations and boundaries contained on this map are not warranted to error-free and do not imply acceptance by the REACH partners, associated, donors mentioned on this map.

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SOUTH SUDAN - Warrap State - Gogrial West

Vulnerability to floods of assessed villages

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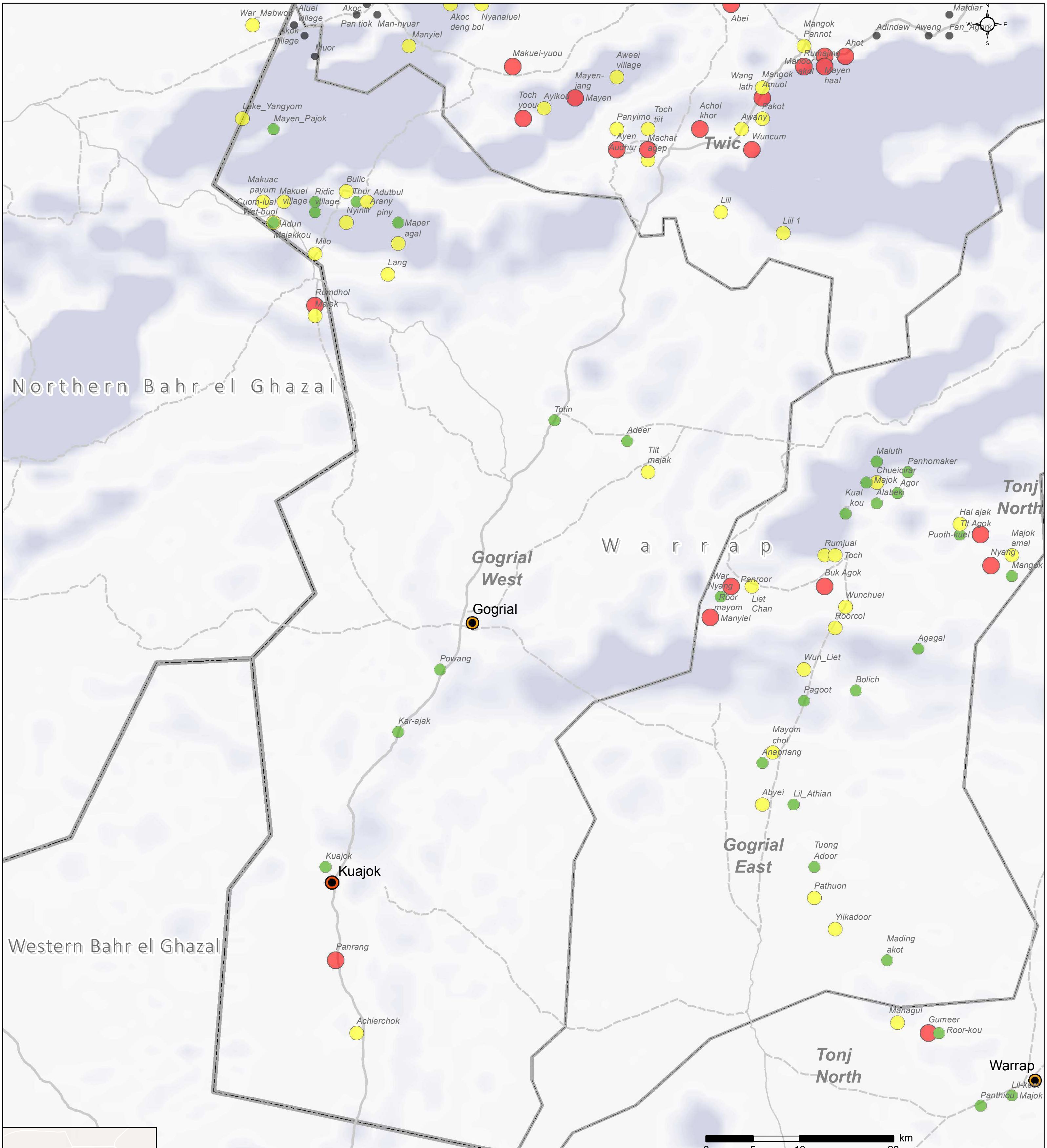

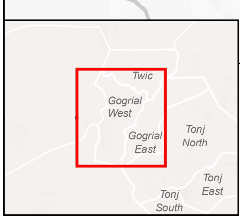

FVI
- No data
- Low
- Moderate
- High

Flood Index
High : 402
Low : 0

Road
- Primary
- Secondary
- Tertiary

Data sources: County, State, Country Borders and rivers: UNOCHA, Inundation data: UNOSAT

Coordinate System: WGS84
Contact: reach.mapping@impact-initiatives.org

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SOUTH SUDAN - Warrap State - Tonj East

Vulnerability to floods of assessed villages

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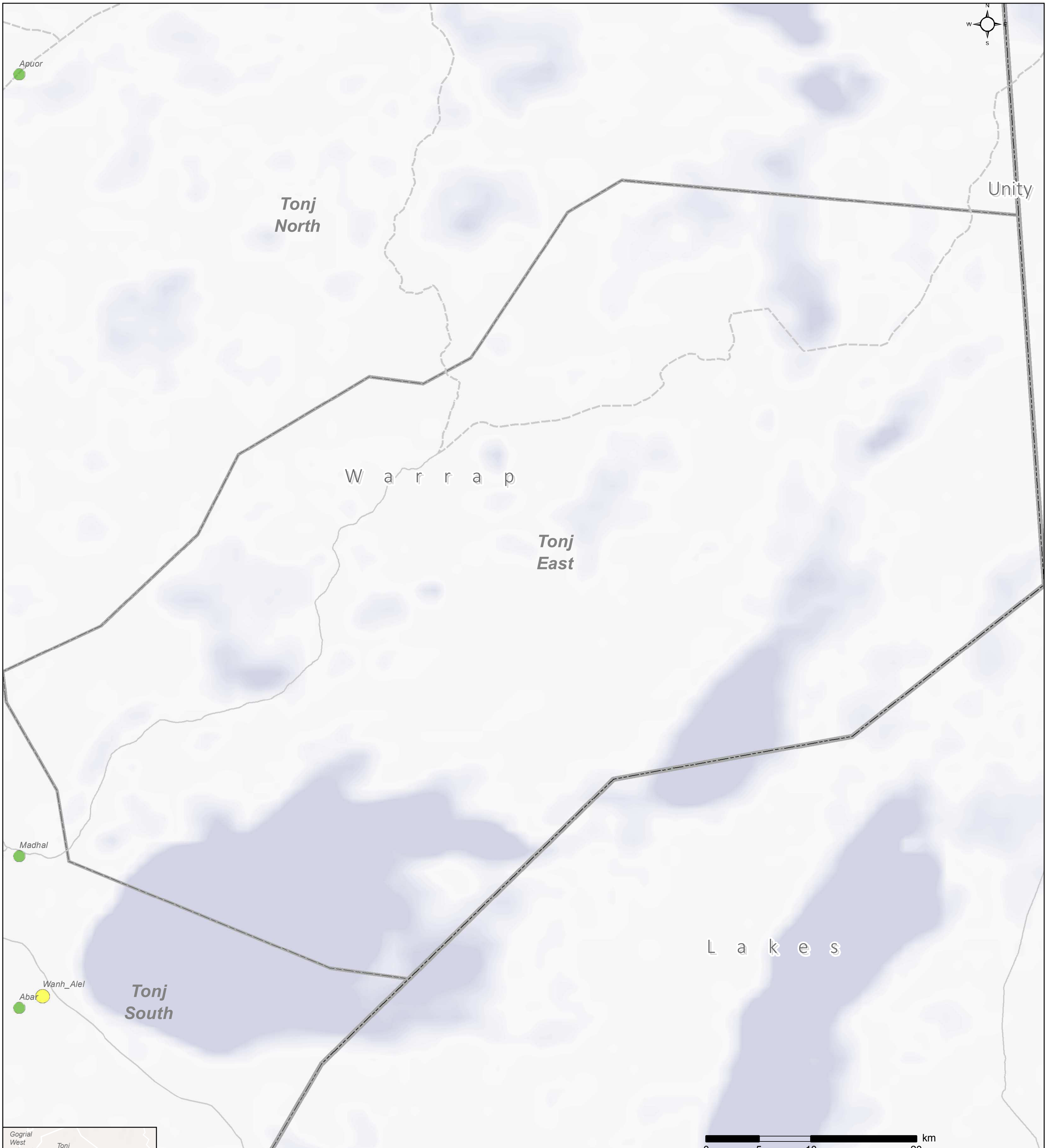

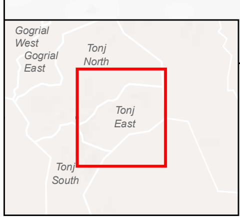

FVI
- No data
- Low
- Moderate
- High

Flood Index
High : 402
Low : 0

Road
- Primary
- Secondary
- Tertiary

Data sources: County, State, Country Borders and rivers: UNOCHA, Innudation data: UNOSAT

Coordinate System: WGS84
Contact: reach.mapping@impact-initiatives.org

Note: Data, designations and boundaries contained on this map are not warranted to error-free and do not imply acceptance by the REACH partners, associated, donors mentioned on this map.

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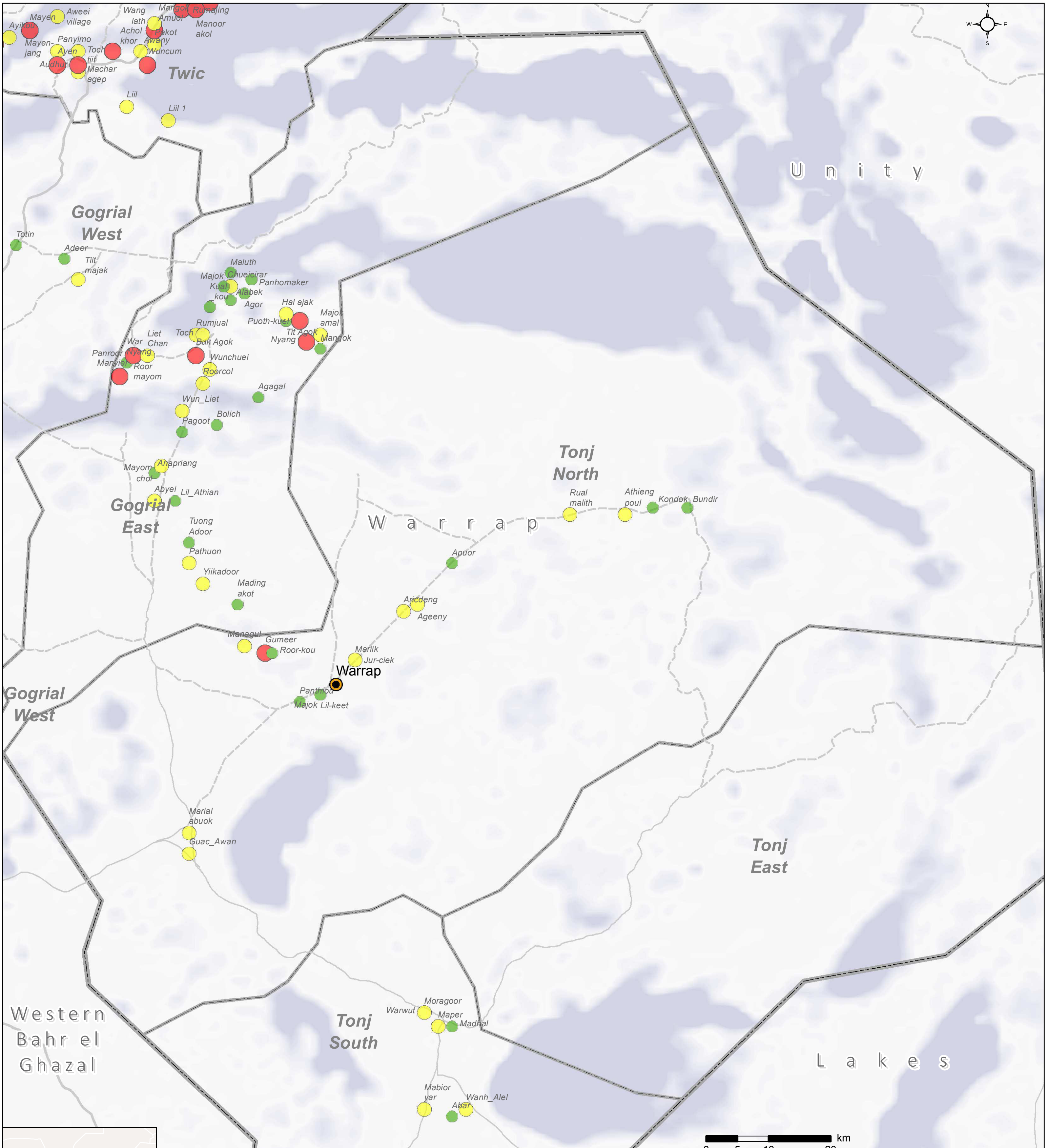
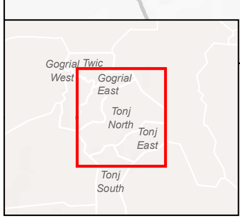
SOUTH SUDAN - Warrap State - Tonj North

Vulnerability to floods of assessed villages

For humanitarian use only
Production date : 01 November 2013





FVI
- No data
- Low
- Moderate
- High

Flood Index
High : 402
Low : 0

Road
- Primary
- Secondary
- Tertiary

Data sources: County, State, Country Borders and rivers: UNOCHA, Inudation data: UNOSAT

Coordinate System: WGS84
Contact: reach.mapping@impact-initiatives.org

Note: Data, designations and boundaries contained on this map are not warranted to error-free and do not imply acceptance by the REACH partners, associated, donors mentioned on this map.

CHF The Common Humanitarian Fund South Sudan

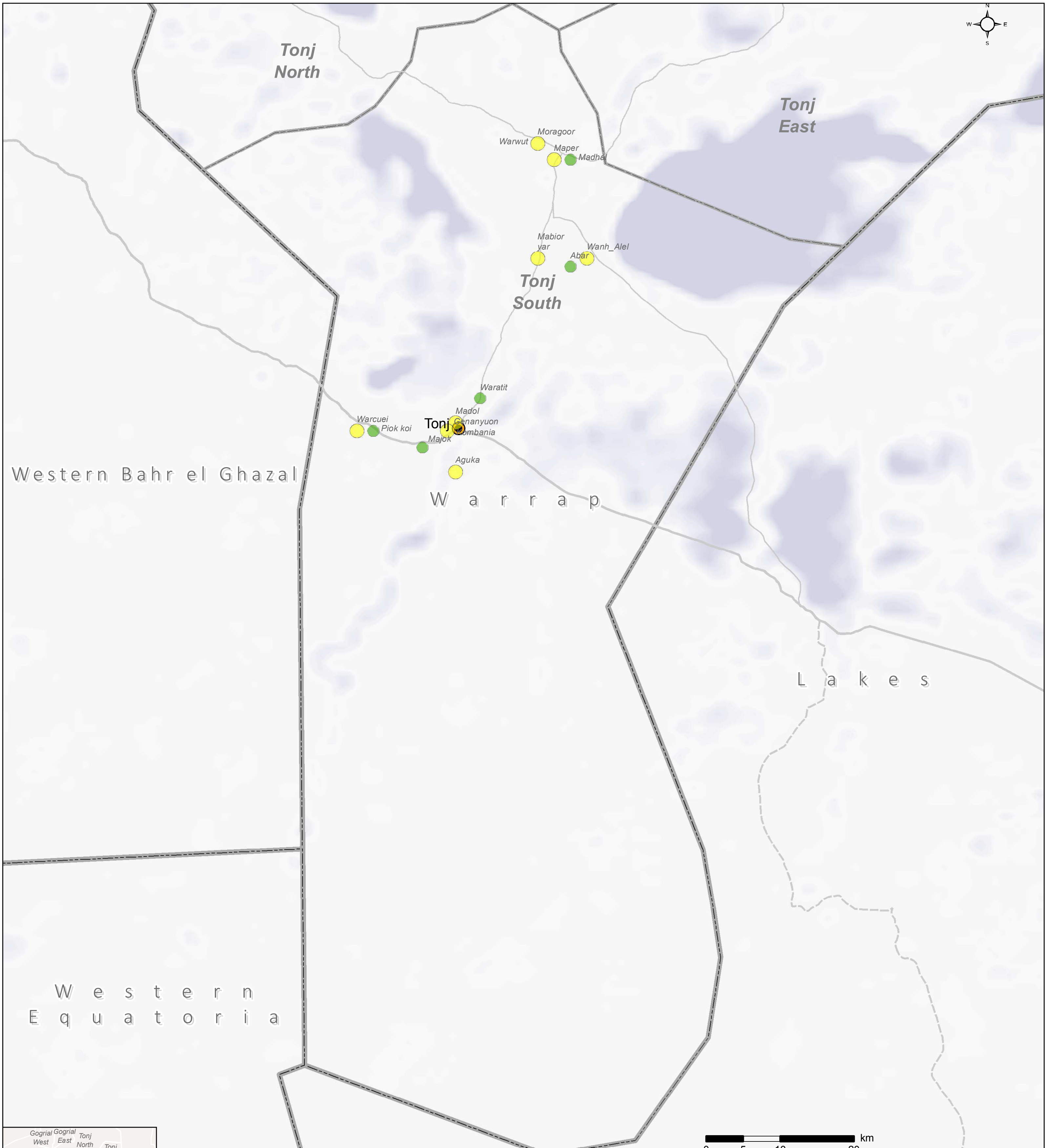
REACH An initiative of IMPACT Initiatives ACTED and UNOSAT

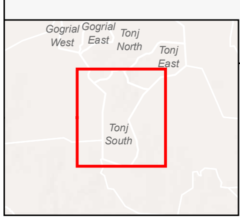
SOUTH SUDAN - Warrap State - Tonj South

Vulnerability to floods of assessed villages

ShelterCluster.org
Coordinating Humanitarian Shelter

For humanitarian use only
Production date : 01 November 2013





FVI
- No data
- Low
- Moderate
- High

Flood Index
High : 402
Low : 0

Road
- Primary
- Secondary
- Tertiary

Data sources: County, State, Country Borders and rivers: UNOCHA, Innudation data: UNOSAT

Coordinate System: WGS84
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SOUTH SUDAN - Warrap State - Twic County

Vulnerability to floods of assessed villages

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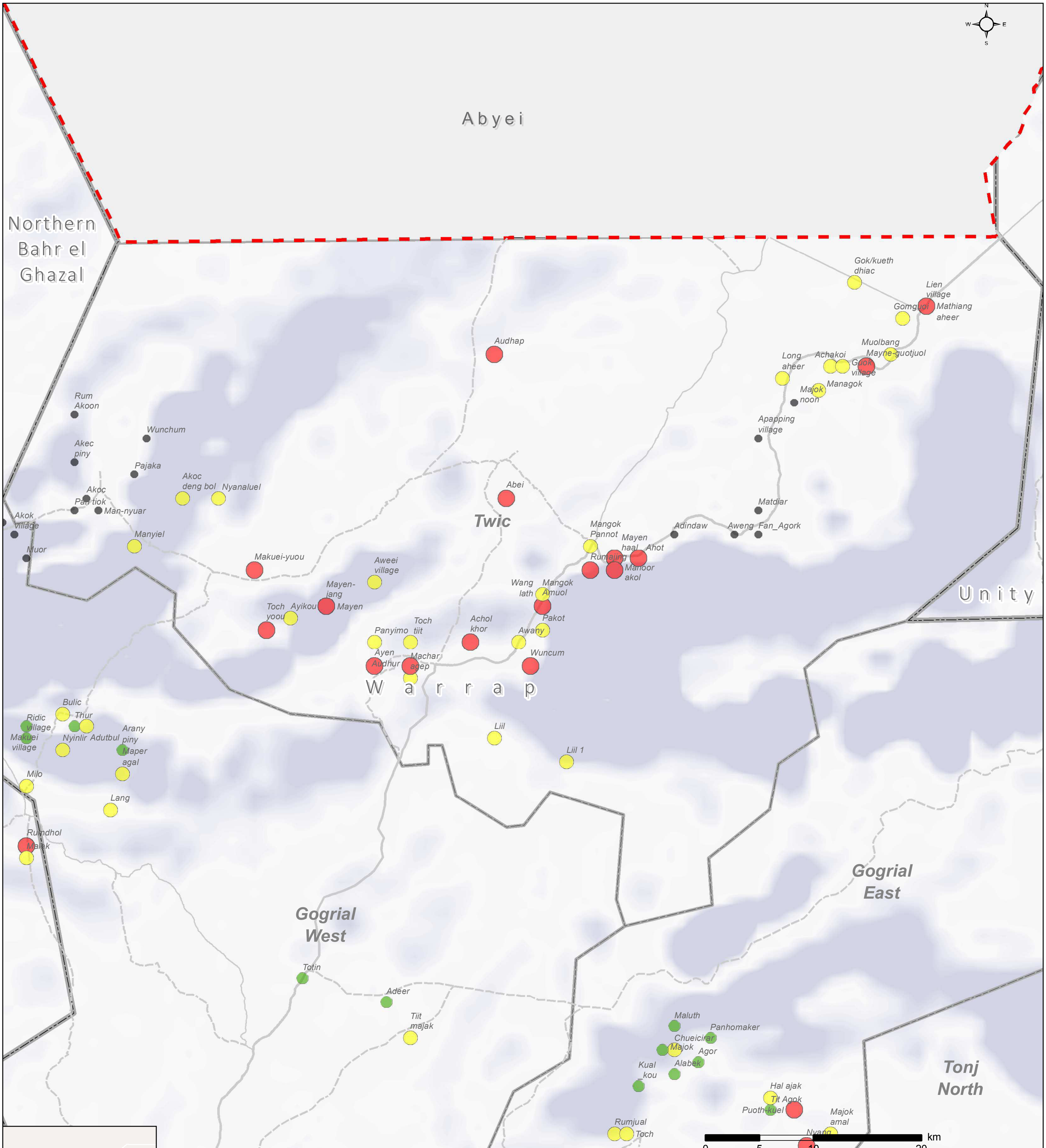

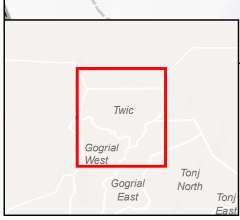

FVI
- No data
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Flood Index
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Data sources: County, State, Country Borders and rivers: UNOCHA, Inundation data: UNOSAT

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