BELEDWEYNE

Working paper on

FLOOD RISK

and

URBAN RESILIENCE

Beledweyne, the largest city of Hishabelle Sate of Somalia, has constantly suffered from devastating floods. Over the past decade, floods have increased in magnitude and recurrence, reaching alarming levels by 2019, where 68% of the city was flooded.

Students from the Institute for Cooperation in Basic Habitability (ICHaB-ETSAM) and colleagues from UN-Habitat Somalia Programme have jointly developed this working paper. It aims to establish the spatial basis for flood risk analysis and urban resilience of Beledweyne.

ICHaB-ETSAM is an academic institution that belongs to the Universidad Politécnica de Madrid (UPM). Since its foundation in 1995, ICHAB has continuously carried out teaching, research and awareness-raising activities in the field of basic habitability with a special focus upon informal settlements.

This working paper has been developed under Midnimo II (Unity) project - Support for the Attainment of Durable Solutions in Areas Impacted by Displacement and Returns in Galmudug and Hirshabelle States, funded by United Nations Peacebuilding Fund.

This study has been conceived as a first step to explore long-term solutions to make the city of Beledweyne, including its most vulnerable communities, more resilient to floods and other natural hazards.

Comments and further inputs to consolidate this paper are highly appreciated. Please send feedback to: unhabitat-som@un.org

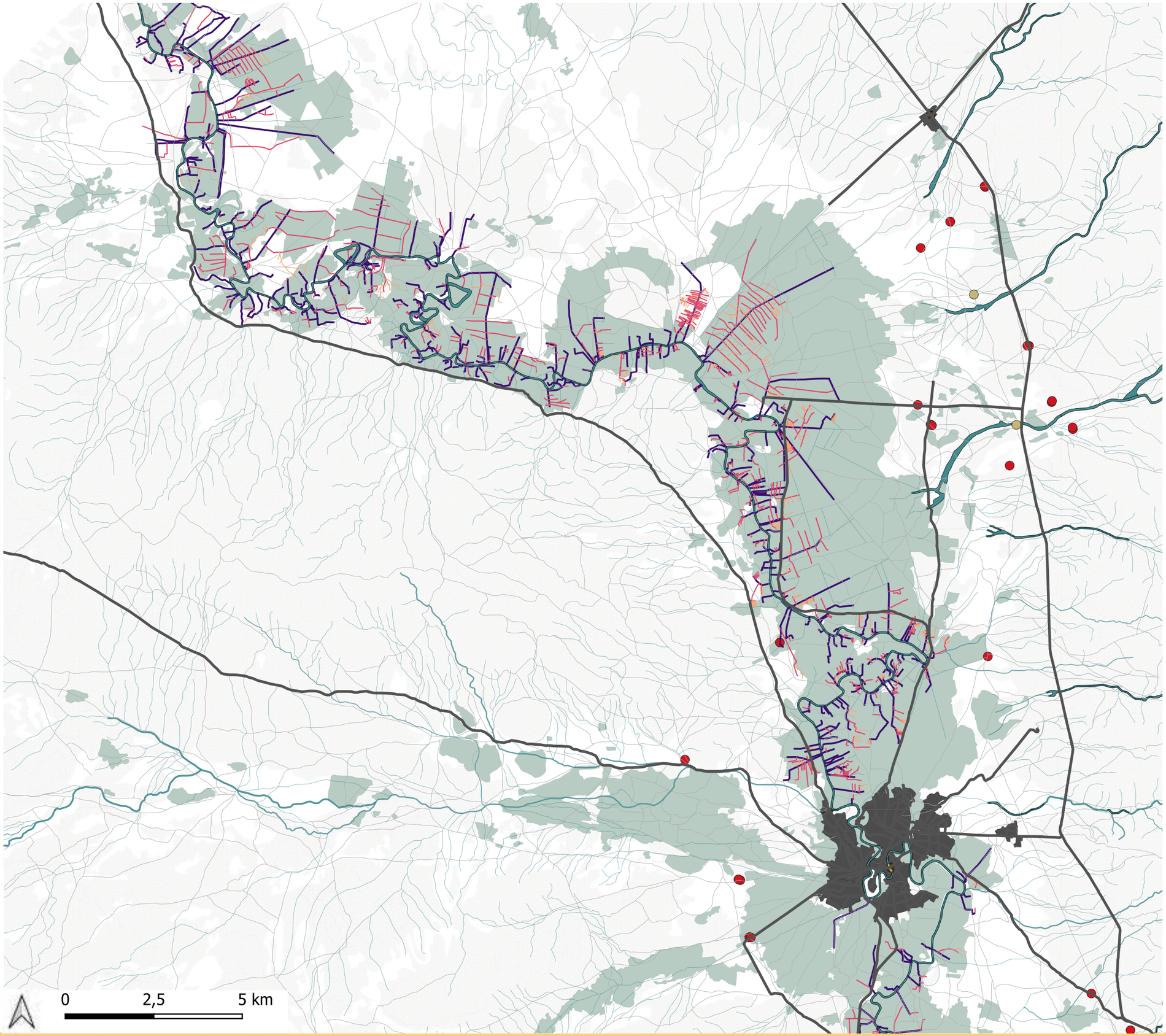
ICHaB-ETSAM

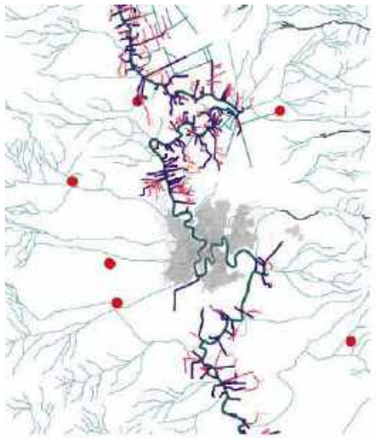
United Nations Peacebuilding

UN HABITAT
FOR A BETTER URBAN FUTURE

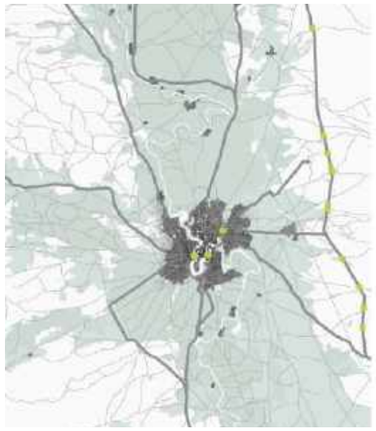
Photo: Beledweyne. AMISOM 2018

MAP 01 - ANALYSIS Territorial scale

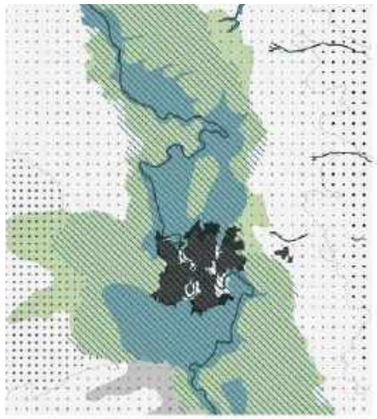




Irrigation infrastructure
- Direct intake
- Secondary canal
- Tertiary canal
- Dam
- Dug well



- Primary road
- Secondary road
- Bridge
- Built-up area
- Crops



- Pastoralism (low density)
- Pastoralism (mid density)
- Pastoralism (high density)
- Agropastoral
- Irrigated agriculture
- Rainfed agriculture
- Rangeland
- Wooded vegetation
- Built-up area

In pre-war Somalia, large-scale irrigation schemes existed along the Juba and Shabelle basins. This irrigation system comprised primary, secondary canals and numerous tertiary canals. Currently, the majority of this infrastructure is not functioning, and the area under irrigation has been significantly reduced.

Somalia economy is predominantly agricultural and it depends highly on water availability, which in turn is reliant on rainfall. There are two types of agriculture in Beledwayne area: Rainfed Agriculture characterized by water harvesting, and Irrigated Agriculture.

Land degradation in Somalia is negatively affecting land productivity

Sources (links):

FAO SWALIM (historical floods, river breakages 2019,) UNOSAT (november 2019 flood) Humanitarian response: UNICEF, health cluster, OCHA)

MAP 02 - ANALYSIS Urban scale

KOOSHIN
Makanne, Hawadle

HAWO TAKO
Makanne, Hawadle

HOWLWADAG
Galjeel, Jajelle

BUNDOWEYN
Makanne, Hawadle

0 500 1.000 m

Legend

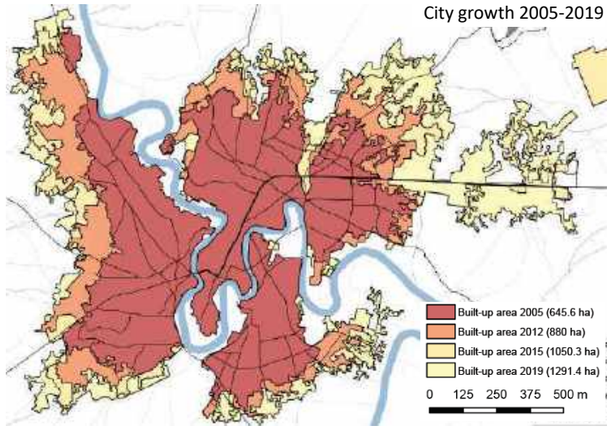
- Bridge
- River
- Green zone
- Crops
- Cementery
- Track
- Street
- Main street
- Primary road
- IDP Camp
- Medical
- Bank
- Market
- Educational
- UN
- Place of worship
- Water
- Prision
- Sport venue
- Government
- Fuel station
- Police
- Telecom
- Accomodation

The urban form is totally defined by the course of the river Shabelle. In the central part of the city, surrounded almost entirely by the meanders of the river, is one of the most dense areas characterized by having the **main urban services of the city: hospitals, markets and government facilities.**

The built-up area in Beledweyne has **grown steadily at an average rate of 5% per year** over the last fifteen years. This growth has mainly taken place in two urban villages and towards two directions: Howlwadag to the west and southwest, and Hawo Tako to the east and northeast. Most likely the city has grown in these directions by fleeing the north and south areas that are prone to continuous flooding. These two urban villages, Kooshin in the north and Bundoweyn in the south, are not expected to grow much further in the future as they border large areas of crops.

In the last five years, due to the lack of any planning system, a dispersed, organic development has sprawled towards the east, along the road that connects the city center with the trade corridor that goes from Mogadishu to Ethiopia. **The fast urbanisation rates of Beledweyne and the lack of proper planning will multiply vulnerability of the urban population, its physical assets and its economy because of the increasing frequency and intensity of natural hazards.**

City growth 2005-2019



Sources: *Beledweyne Urban Profile (Draflt). UN-Habitat*

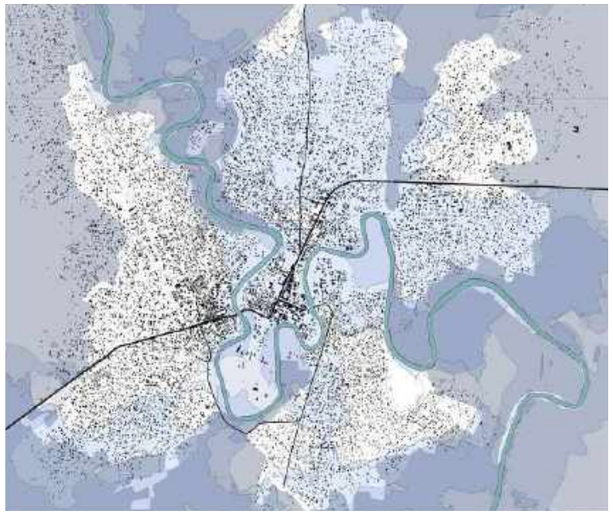
MAP 03 - ANALYSIS Historical floods and river breakages

Legend

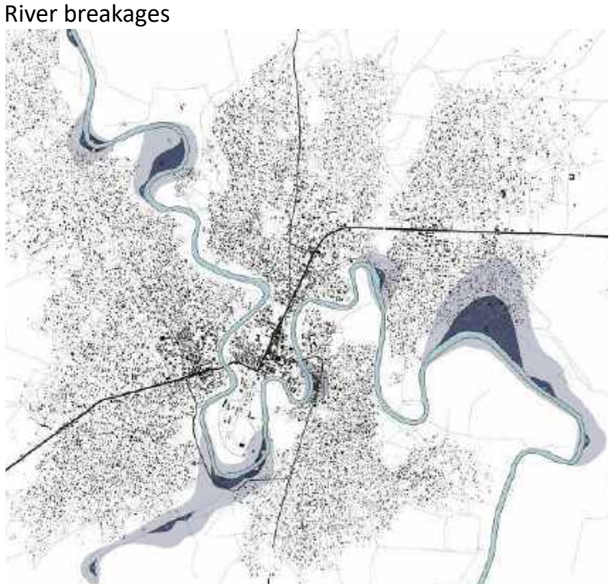
- Flood-prone area (UNSOS)
- Flooded area (SWALIM 2018)
- Flooded area (UNOSAT 2019)
- Overflow area
- Overflow point
- Open breakage point
- Closed breakage point
- Potential breakage point

Map 03 Historical floods and river breakages analyzes the flooding data of the last few years as well as the points of the Shabelle River overflow. For this purpose, information layers from different sources indicated below have been superimposed.

Historical floods



River breakages



0 500 1.000 m

Sources (links):

FAO SWALIM (historical floods, river breakages 2019,) UNOSAT (november 2019 flood) Humanitarian response: UNICEF, health cluster, OCHA)

MAP 04 - ANALYSIS Flood exposure

Legend

- Very High Exposure
- High Exposure
- Medium Exposure
- Medium - Low Exposure

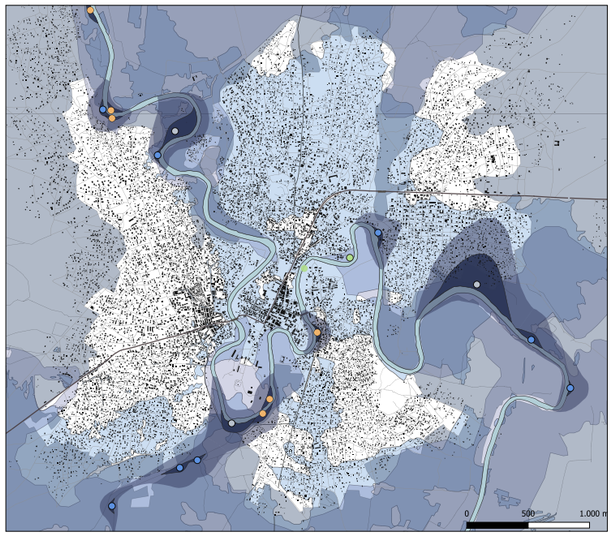
0 500 1.000 m

Flood exposure is the situation of people, infrastructure, housing, production capacities and other tangible human assets located in flood-prone areas.

MAP 04 - ANALYSIS Flood exposure aims to synthesize the different parameters analyzed in the previous map to spatially categorize Beledweyne in different areas according to their level of exposure to flooding.

Beledweyne town is not only flooded by the river overflows caused by rainwater from the highlands of Ethiopia but also flash floods injecting huge amounts of water into the river. The city also rests in a huge depression between mountains that supports an easy flow of flood water from upstream, descending towards the depression zone in the lower stream.

Reference: MAP 03 - ANALYSIS



Sources (links):

FAO SWALIM (historical floods, river breakages 2019,) UNOSAT (november 2019 flood) Humanitarian response: UNICEF, health cluster, OCHA)

MAP 05 - ANALYSIS Vulnerability

Legend

< 400 people
401 - 700
701 -1200
> 1200

IDP settlement
534 female population
930 total population

Informal settlement
1244 estimated population

Vulnerability: 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.

Vulnerability is multidimensional and cannot be measured simply by analyzing a satellite image.

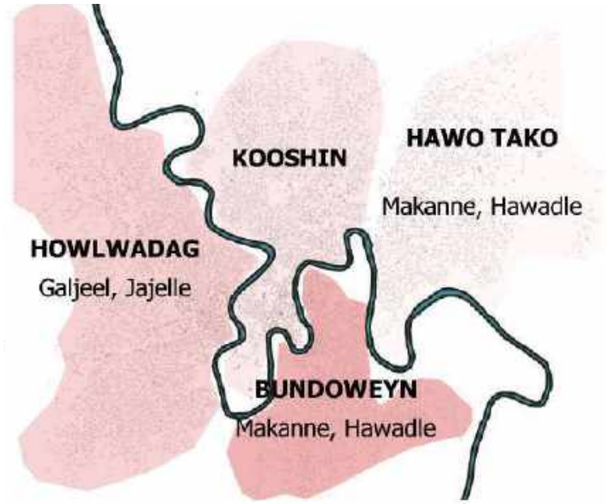
However, **MAP 05 - ANALYSIS Vulnerability** attempts to identify two settlement types of Beledweyne that are particularly vulnerable to flooding:

-IDP camps with gender-disaggregated population data and,

-Informal settlements, identified through visual analysis of the density and irregularity level of the settlement as well as housing building quality.

A more detailed analysis of the rest of the factors, including data collected on the ground, is necessary to achieve a more accurate and comprehensive vulnerability diagnosis of Beledweyne

Reference: Urban villages and clan distribution



Sources (links):

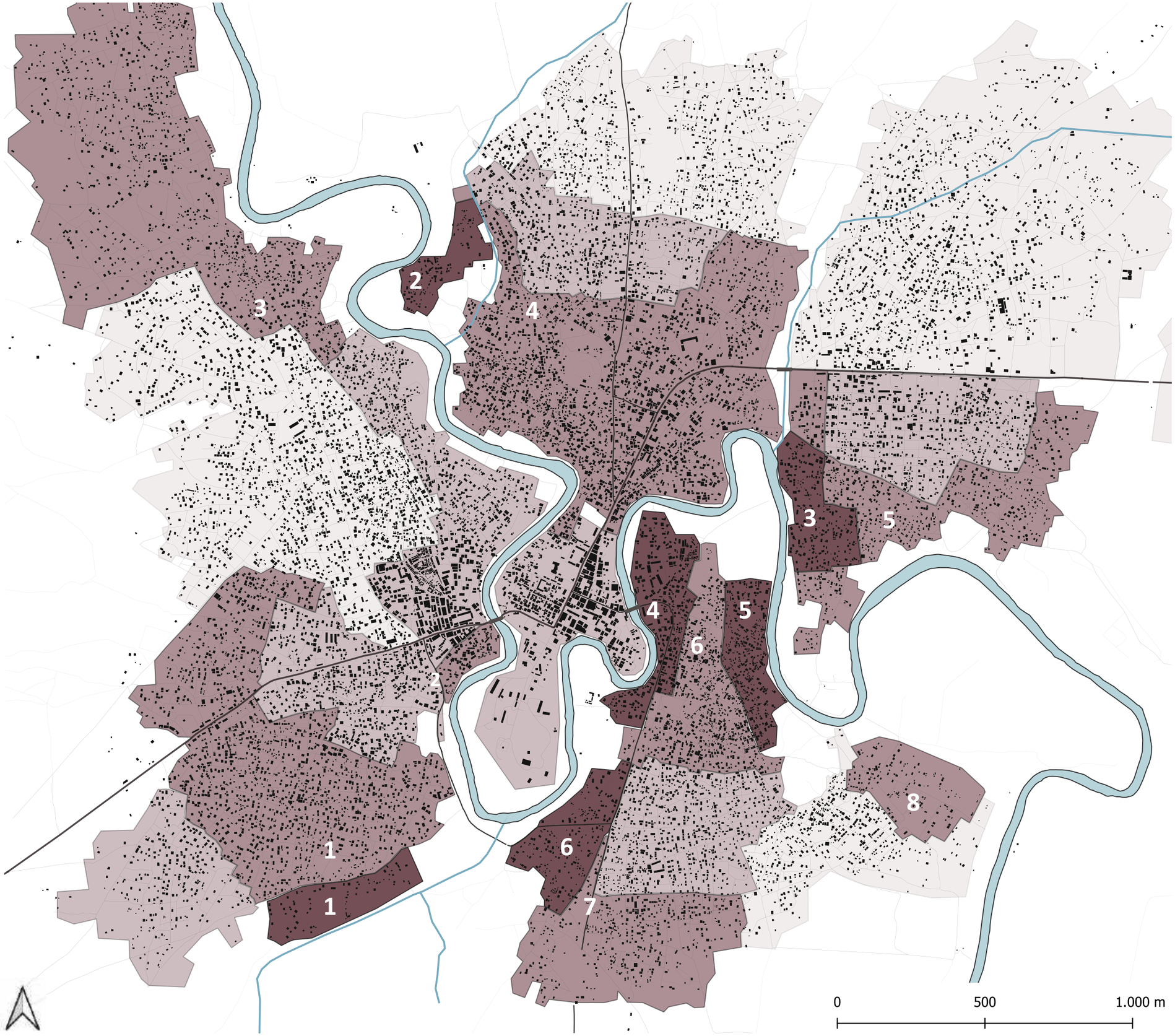
CCCM Cluster 2020 IDP data in Beledweyne, and 2017 information.

Political Economy Analysis of Urban Networks and Centres in Somalia. Beledweyne City Report. 2018

0 500 1.000 m

UN HABITAT FOR A BETTER URBAN FUTURE Peacebuilding Sustaining Peace

MAP 06 - ANALYSIS Flood Risk



Legend

- Very High Risk
- High Risk
- Medium Risk
- Medium - Low Risk

$$\text{RISK} = \frac{\text{HAZARD x EXPOSURE x VULNERABILITY}}{\text{CAPACITY}}$$

MAP 06 - ANALYSIS Flood Risk aims to analyse the flood risk levels by overlaying the **MAP 04 - ANALYSIS Flood exposure** and **MAP 05 - ANALYSIS Vulnerability**

The map is complemented by the table below which aims to estimate through GIS analysis the population exposed to different levels of risk both in IDP camps and informal settlements.

	TOTAL INDIVIDUALS	IDP settlements #	IDP settlements households	IDP settlements individuals	informal settlements households	informal settlements individuals
VERY HIGH RISK	18,053	9	1,310	7860	1,671	10,193
1		1	213	1278	133	**811**
2		2	571	3426	192	**1,171**
3		1	73	438	267	**1,629**
4					395	**2,410**
5		3	237	1422	443	**2,702**
6		2	216	1296	241	**1,470**
HIGH RISK	70,754	30	3,786	22,716	7,875	48,038
1		9	648	3888	1,700	**10,370**
2					95	**580**
3		8	1,431	8586	1,155	**7,046**
4		4	722	4332	2,350	**14,335**
5		2	200	1200	793	**4,837**
6					797	**4,862**
7		5	485	2910	725	**4,423**
8		2	300	1800	260	**1,586**

Reference: Overlay of Map4 Exposure + Map3 Vulnerability

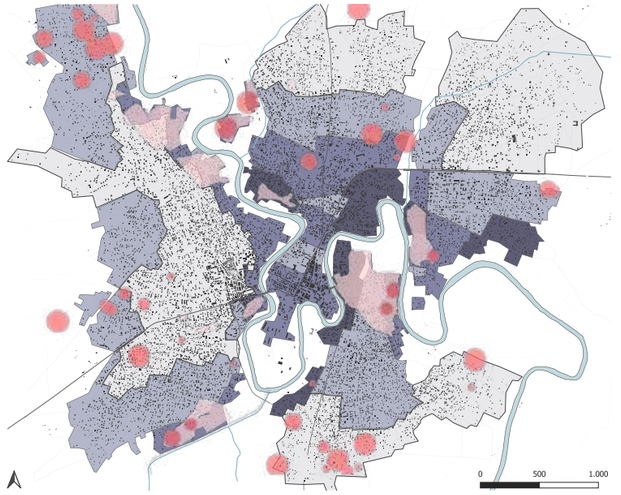


TABLE 01 - ANALYSIS Population at Flood Risk

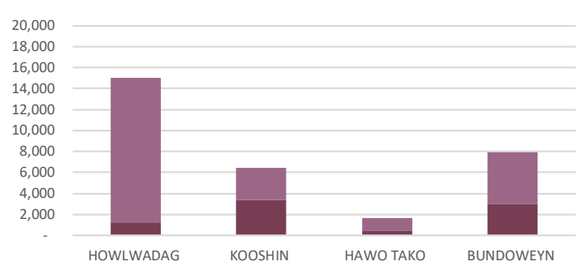
INTERNAL DISPLACED PERSONS

NEIGHBOURHOOD	RISK LEVEL	(Map ref #) Site Name	Households	Individuals	Male (0 - 4)	Female (0 - 4)	Male (5-17)	Females (5-17)	Male (18-59)	Female (18-59)	Male (> 60)	Female (> 60)	Total male	Total female	Disabled
HOWLWADAG	VERY HIGH RISK	(1) Bardaale	120	720	108	132	89	91	112	128	27	33	336	384	15
KOOSHIN	VERY HIGH RISK	(2) Bilisdlid	271	1,626	248	250	218	252	175	201	95	187	736	890	8
KOOSHIN	VERY HIGH RISK	(2) Buloqorah	300	1,800	301	323	287	307	189	185	96	112	873	927	21
HAWO TAKO	VERY HIGH RISK	(3) Gabooye2	73	438	74	72	89	93	40	46	11	13	214	224	4
BUNDOWEYN	VERY HIGH RISK	(5) Barwaaqo	88	528	80	90	100	120	50	82	2	4	232	296	5
BUNDOWEYN	VERY HIGH RISK	(5) Bilan 2	54	564	61	80	162	168	42	45	3	3	268	296	3
BUNDOWEYN	VERY HIGH RISK	(5) Lafweyn	95	570	92	98	123	162	21	24	22	28	258	312	25
HOWLWADAG	VERY HIGH RISK	(1) El - Ali	93	558	90	61	110	89	88	95	11	14	299	259	4
BUNDOWEYN	VERY HIGH RISK	(6) Doonsubagle G.	162	972	144	152	133	129	114	118	89	93	480	492	17
BUNDOWEYN	VERY HIGH RISK	(6) Towfiiq	54	324	36	62	64	68	38	48	3	5	141	183	-
HOWLWADAG	HIGH RISK	(1) Asal	70	420	67	73	100	110	22	26	9	13	198	222	-
HOWLWADAG	HIGH RISK	(1) Beerey	73	438	63	57	83	61	58	67	23	26	227	211	34
HOWLWADAG	HIGH RISK	(1) Bulsho	80	480	73	90	82	85	65	70	6	9	226	254	2
HOWLWADAG	HIGH RISK	(1) Doofil	85	510	119	153	43	77	30	61	18	9	210	300	3
HOWLWADAG	HIGH RISK	(1) Fatxi 1	97	582	120	112	103	83	56	81	11	16	290	292	19
HOWLWADAG	HIGH RISK	(1) Fatxi 2	78	468	58	98	112	122	28	30	8	12	206	262	8
HOWLWADAG	HIGH RISK	(1) Qaatumo	70	420	68	72	95	115	18	22	12	18	193	227	6
HOWLWADAG	HIGH RISK	(1) Rajo2	50	300	38	62	52	68	28	33	8	11	126	174	3
HOWLWADAG	HIGH RISK	(1) Dabadeey	45	270	42	48	67	68	15	17	5	8	129	141	5
HOWLWADAG	HIGH RISK	(3) Alla-amin2	379	2,274	248	320	540	670	220	260	7	9	1,015	1,259	2
HOWLWADAG	HIGH RISK	(3) Alla-Suge	207	1,242	165	249	184	230	175	190	20	29	544	698	2
HOWLWADAG	HIGH RISK	(3) Barakac Sigaaloow	40	240	35	45	52	68	12	18	4	6	103	137	12
HOWLWADAG	HIGH RISK	(3) Dayax Siigaalow	80	480	70	92	118	122	28	30	12	8	228	252	4
HOWLWADAG	HIGH RISK	(3) Iftin	260	1,560	180	340	163	295	270	290	8	14	621	939	13
HOWLWADAG	HIGH RISK	(3) Nasri 2	110	660	102	110	170	160	42	45	13	18	327	333	11
HOWLWADAG	HIGH RISK	(3) Naxariis	155	930	100	210	187	199	102	115	7	10	396	534	3
HOWLWADAG	HIGH RISK	(3) Tawakal2	200	1,200	210	190	280	320	75	90	15	20	580	620	5
KOOSHIN	HIGH RISK	(4) Gurmad iyo Gargar	142	852	123	131	111	118	98	106	76	89	408	444	15
KOOSHIN	HIGH RISK	(4) Nasteho	300	1,800	280	320	438	462	107	118	33	42	858	942	10
KOOSHIN	HIGH RISK	(4) Rabi yasir	60	360	55	65	85	90	26	27	5	7	171	189	-
HOWLWADAG	HIGH RISK	(4) Wabi-Shabele	220	1,320	241	245	158	150	189	252	66	19	654	666	19
HAWO TAKO	HIGH RISK	(5) Badbaado	80	480	68	92	108	132	30	28	9	13	215	265	10
HAWO TAKO	HIGH RISK	(5) Birmaal	120	720	120	140	138	145	72	65	18	22	348	372	15
BUNDOWEYN	HIGH RISK	(7) Cadaani	37	222	38	41	27	33	19	30	14	20	98	124	11
BUNDOWEYN	HIGH RISK	(7) Daryeel Bundowey	100	600	111	94	71	85	96	82	29	32	307	293	11
BUNDOWEYN	HIGH RISK	(7) Jabaanjiblow	60	360	57	63	87	93	14	17	12	17	170	190	8
BUNDOWEYN	HIGH RISK	(7) Midnimo	217	1,302	211	245	157	201	175	145	77	91	620	682	7
BUNDOWEYN	HIGH RISK	(7) Cadileey	71	426	81	87	55	63	41	47	24	28	201	225	9
BUNDOWEYN	HIGH RISK	(8) Doomeey	250	1,500	150	225	450	300	125	130	48	72	773	727	4
BUNDOWEYN	HIGH RISK	(8) Kulmiye	50	300	51	41	65	53	33	42	8	7	157	143	2
	MED. LOW RISK	Ceynta	162	972	152	172	195	210	98	107	16	22	461	511	7
	MED. LOW RISK	Gaboya 1	40	240	26	47	41	45	33	40	3	5	103	137	4
	MED. LOW RISK	Guhaad1	120	720	108	132	135	165	70	80	13	17	326	394	5
	MED. LOW RISK	Jumbur (7)	323	1,938	258	388	323	450	196	270	23	30	800	1,138	2
	MED. LOW RISK	Kulan	273	1,638	303	243	399	420	101	112	27	33	830	808	4
	MED. LOW RISK	Kutimbo	254	1,524	291	217	183	223	205	247	73	85	752	772	49
	MED. LOW RISK	Nasiib (1)	420	2,520	412	571	343	288	341	368	101	96	1,197	1,323	20
	MED. LOW RISK	Nuuriyoow Tawakal (7	369	2,214	319	326	296	319	257	264	213	220	1,085	1,129	7
	MED. LOW RISK	Qaboobe	142	852	134	150	218	242	41	45	9	13	402	450	3
	MED. LOW RISK	Shabele	160	960	161	146	127	125	135	125	63	78	486	474	7
	MED. LOW RISK	Shiilow	79	474	57	64	71	81	77	89	13	22	218	256	4
TOTAL IDPs (CCCM cluster data february 2020)			7,438	44,868	6,799	7,886	8,087	8,825	4,692	5,253	1,518	1,808	21,096	23,772	467
	VERY HIGH RISK		1,310	8,100	1,234	1,320	1,375	1,479	859	972	359	492	3,837	4,263	102
	HIGH RISK		3,786	22,716	3,344	4,110	4,381	4,778	2,269	2,534	605	695	10,599	12,117	253
	MED-LOW RISK		2,342	14,052											

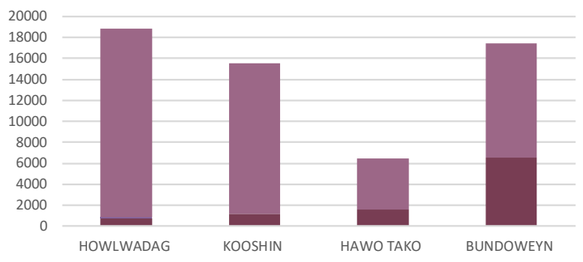
INFORMAL SETTLEMENTS

NEIGHBOURHOOD	RISK LEVEL	Site location	Households	(6 member	0-14 female	0-14 male	15-24 female	15-24 male	25-54 female	25-54 male	54-64 female	54-64 male	over 65 female	over 65 male	TOTAL FEMALE	TOTAL MALE
HOWLWADAG	VERY HIGH RISK	1. sud -west	133	811	174	174	78	79	123	131	18	18	11	7	403	409
KOOSHIN	VERY HIGH RISK	2. north-west	192	1,171	251	251	112	114	177	190	25	26	15	10	581	590
HAWO TAKO	VERY HIGH RISK	3. center-east	267	1,629	350	349	156	159	246	264	35	36	21	14	808	821
BUNDOWEYN	VERY HIGH RISK	4. center	395	2,410	517	516	231	235	364	390	52	53	31	21	1,196	1,214
BUNDOWEYN	VERY HIGH RISK	5. center-east	443	2,702	580	579	259	263	408	437	58	59	35	24	1,341	1,361
BUNDOWEYN	VERY HIGH RISK	6. south	241	1,470	315	315	141	143	222	238	32	32	19	13	729	741
HOWLWADAG	HIGH RISK	1. sud -west	1,700	10,370	2,225	2,220	996	1,010	1,566	1,678	224	226	135	90	5,146	5,224
HOWLWADAG	HIGH RISK	2. center	95	580	124	124	56	56	88	94	13	13	8	5	288	292
HOWLWADAG	HIGH RISK	3. north -west	1,155	7,046	1,512	1,508	676	686	1,064	1,140	152	154	92	61	3,496	3,550
KOOSHIN	HIGH RISK	4. north-center	2,350	14,335	3,076	3,069	1,376	1,396	2,165	2,319	310	313	186	125	7,113	7,222
HAWO TAKO	HIGH RISK	5. nort- east	793	4,837	1,038	1,036	464	471	730	783	104	105	63	42	2,400	2,437
BUNDOWEYN	HIGH RISK	6. center-east	797	4,862	1,043	1,041	467	474	734	787	105	106	63	42	2,412	2,449
BUNDOWEYN	HIGH RISK	7. south	725	4,423	949	947	425	431	668	716	96	96	57	38	2,194	2,228
BUNDOWEYN	HIGH RISK	8. east	260	1,586	340	340	152	154	239	257	34	35	21	14	787	799
TOTAL	VERY HIGH RISK		1,671	10,193	2,187	2,182	979	993	1,539	1,649	220	222	133	89	5,058	5,135
TOTAL	HIGH RISK		7,875	48,038	10,309	10,285	4,612	4,679	7,254	7,772	1,038	1,047	624	418	23,836	24,201

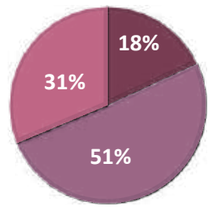
IDP sttlements population at risk by neighborhood



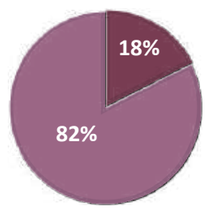
Informal sttlements population at risk by neighborhood



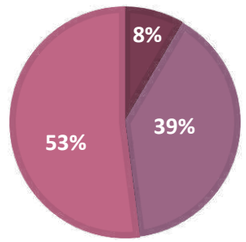
IDP settlements population



Informal settlements population



Beledweyne population



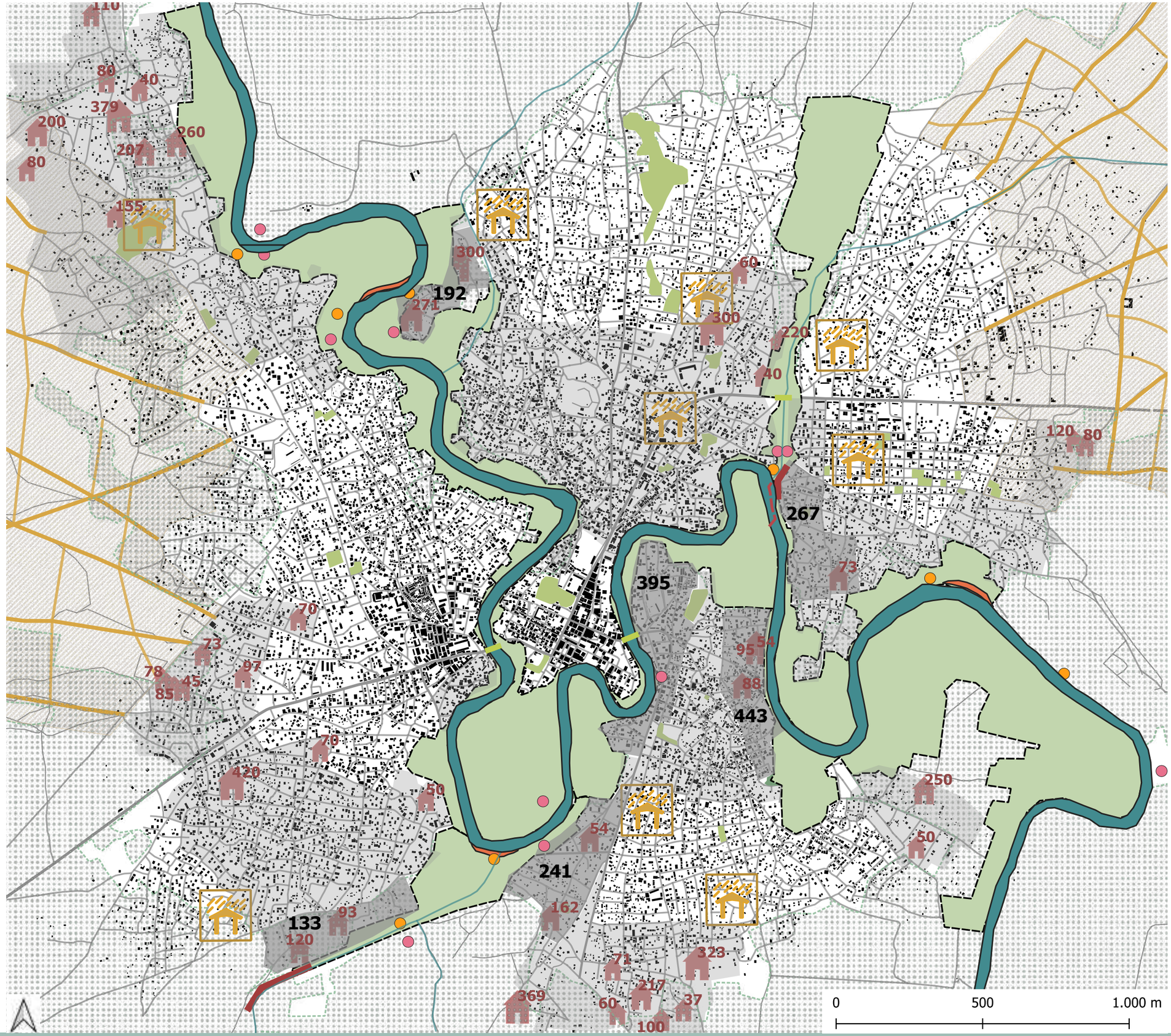
VERY HIGH RISK ■ HIGH RISK ■ MEDIUM/LOW RISK

TABLE 01 - ANALYSIS Population at Flood Risk aims to complement the spatial analysis of **MAP 06 - ANALYSIS Flood Risk** with numbers in order to roughly estimate the number of people living in Beledweyne under different levels of flood risk.

Sources (links):

CCCM Cluster 2020 IDP data in Beledweyne

MAP 07 - URBAN RESILIENCE PLAN



Legend

River management
- Sandbags
- Hesco barriers
- Retaining walls
- Embankment reinforcement

Green infrastructure
- Green river buffer zone
- Green areas
- Green ring: Agriculture

Urban planning
- # IDP households at very high and high flood risk
- Proposed arteries
- Planned city growth
- Neighbourhood upgrading. Phase 1
- Neighbourhood upgrading. Phase 2
- Collective centres

URBAN RESILIENCE

"The ability of any urban system, with its inhabitants, to maintain continuity through all shocks and stresses, while positively adapting and transforming toward sustainability"
(UN-Habitat)

The Beledweyne Urban Resilience Plan is a comprehensive plan that presents practical actions to strengthen the flood resilience of the city of Beledweyne.

The proposed actions cover a wide range of initiatives from the territorial scale to the scale of construction detail.

This exercise has been carried out through the analysis of secondary data without direct field validation and is intended to be a first step in exploring long-term solutions to make the city of Beledweyne more resilient to floods.

From this point of analysis, a participatory planning process with the local Government and other stakeholders is needed to identify Beledweyne's resilience building priorities and then, transform them into bankable projects to mobilise funds form implementation.

Sources

-City Resilience Action Planning Tool (CityRAP), UN-Habitat

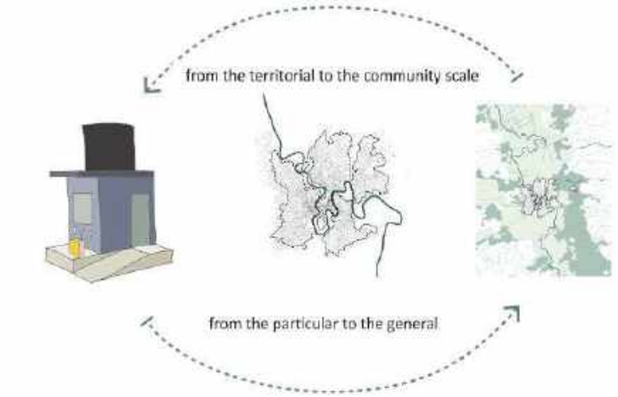
- Beledweyne Urban Profile (Draflt). Working Paper and Spatial Analyses for Urban Planning Consultations and Durable Solutions for Displacement Crises. UN Habitat

- Post Flood Solutions Assessment. Beledweyne, Somalia. MAY 2020 Durable Solutions Secretariat. Federal Government of Somalia.

TABLE 02 - RESILIENCE PLAN Actions

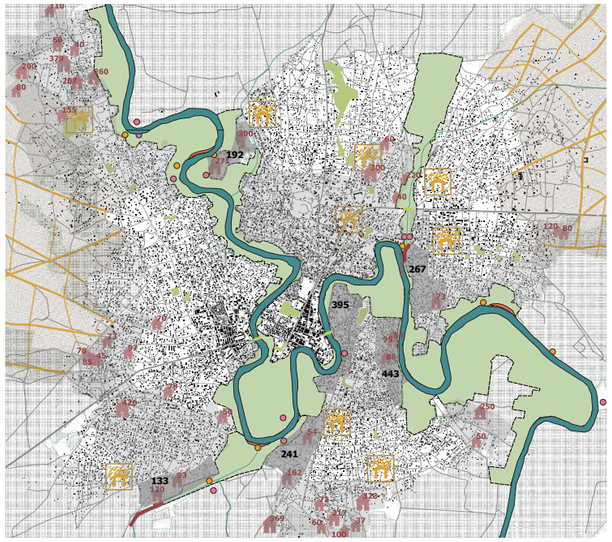
$$\downarrow \textbf{RISK} = \frac{\text{HAZARD} \times \downarrow \text{EXPOSURE} \times \downarrow \text{VULNERABILITY}}{\uparrow \text{CAPACITY}}$$

(ER = Exposure Reduction / VR = Vulnerability Reduction / CI= Capacity Increase)



SCALE	MAP	ACTION	RISK EQUATION	TIME
Territorial	MAP 08- RESILIENCE PLAN. Territorial scale	Irrigation infrastructure improvement	ER	2-8
		Dam rehabilitation	ER	1-2
		Water reservoirs construction	VR + CI	2
		Urban and rural wells improvement	VR + CI	1-2
		Agriculture enhancement	ER	4-8
		Reforestation	ER	8
City	MAP 09a/09b - RESILIENCE PLAN River Management	Sandbags	ER	0.5
		Hesco barriers	ER	0.5-1
		Reintaing walls	ER	1-2
		Desilting. Removal of sand and waste accumulation	ER	2
	MAP 10a/10b - RESILIENCE PLAN Road network and drainage system	Roads improvement	VR + CI	1-5
		Drainage system improvement	VR + CI	1-5
	MAP 11a/10b - RESILIENCE PLAN Green infrastructure	Green river buffer zone creation	ER	4-5
		Green areas creation. Infiltration	ER	1-2
	MAP 12a/12b - RESILIENCE PLAN Urban planning	Green river buffer zone creation	ER	4-5
		N0-BUILD zones regulation established	ER	1-2
		Households at very high flood risk reintegration at lower flood risk zones	ER	2-5
		Urban planning policies creation	ER + CI	2-5
Settlement	MAP 13 - RESILIENCE PLAN Neighbourhood upgrading	Neighbourhood upgrading	VR + CI	1-5
		Improvement of building construction techniques. Building code	VR + CI	1-4
		Improvement of access to safe water (water kiosks)	VR +CI	1-5
		Improvement of solid waste management	VR + CI	2-5
	MAP 14 - RESILIENCE PLAN Market - Collective centre	Construction of collective centres.	VR + CI	1-3
Governance	N/A	Increase the organisational capacity of the different stakeholders	CI	1-2
		Capacity building on Urban Disaster Risk Management	CI	1-3
		Development of Flood Preparedness Plan	CI	1-2
		Community awareness of urban resilience	CI	1-2

Reference Map12a:RESILIENCE PLAN Urban planning



MAP 08 - RESILIENCE PLAN Territorial scale

ACTION	RISK EQUATION	TIME (Years)
Irrigation infrastructure improvement	ER	2-8
Dam rehabilitation	ER	1-2
Water reservoirs construction	VR + CI	2
Urban and rural wells improvement	VR + CI	1-2
Agriculture enhancement	ER	4-8
Reforestation	ER	8

Legend

- Roads
- Built-up area
- Urban dug well
- Rural well
- Dam
- Agriculture enhancement
- Reforestation

Irrigation infrastructure improvement

- Direct intake
- Secondary canal
- Tertiary canal

0 1 2 km

ID	Establishing Date	House-holds	Management Type	Water and Sanitation Committee			Dugwell Depth	Dugwell Protection	Operating hours	Reservoir Type	Reservoir Capacity	Pump Type	Supply Condition Notes
				Y/N	Male members	Female members							
1	Aug. 23, 2012	700	Communal	yes	3	0	10	no	12	Concrete/Masonry tank	24	Hand Pump	The pump is not sufficient
2	June 7, 2016	300	Private/Ind.	none	none	none	58	yes	19	Concrete/Masonry tank	160	Submersible	Poor installation
3	April 17, 2011	3300	Communal	yes	6	0	45	no	24	Concrete/Masonry tank	136	Submersible	Not enough water supply system
4	June 23, 2004	80	Private/Ind.	none	none	none	30	yes	13	Concrete/Masonry tank	60	Submersible	The well is not yield enough water
5		360	-	-	-	-	-	-	-	-	-	-	Potable water

Better water management at territorial level will achieve improved use of the water and infiltration into the ground, reducing urban flooding. The proposal consists on **rehabilitation of existing infrastructures such as dams, irrigation channels, irrigation pumps, wells,** as well as the **analysis of the need for new infrastructure.**

Agriculture enhancement, **processes of reforestation and soil improvement** is needed to increase the water absorption capacity of the territory surrounding Beledweyne.

These actions will not only have an impact on flood mitigation, but also on food security, displacement reduction and livelihood opportunities of vulnerable people.

Reference: Satellite image

Sources (links):

FAO SWALIM (water sources, irrigation canals, dams, land degradation)

MAP 09a - RESILIENCE PLAN River Management

ACTION	RISK EQUATION	TIME (Years)
Sandbags	ER	0.5
Hesco barriers	ER	0.5-1
Reintaing walls	ER	1-2
Desilting. Removal of sand and waste accumulation	ER	2

Legend

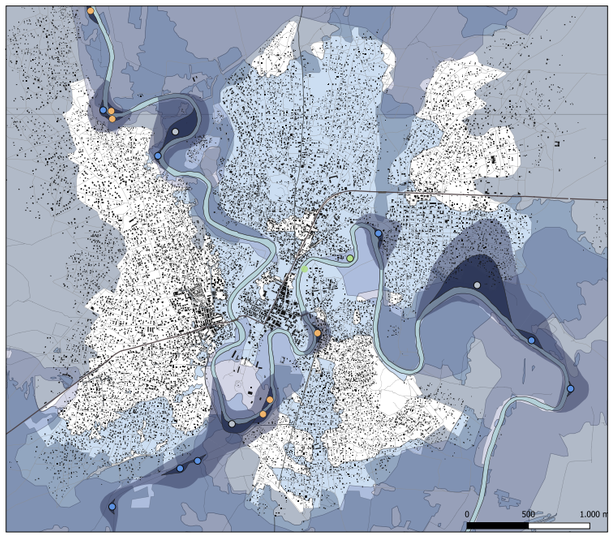
- Shabelle River
- Affluent
- Bridge
- Very high flood risk
- Overflow area
- River breakage points

Proposals

- Embankment reinforcement
- Sandbags
- Hesco barriers
- Retaining walls

River management include proposals according to the river breakages points types:
Potential - Sandbags
Open - Hesco Barriers
Overflows - embankment rinforcement
(definition of open overflow and potential on link below)

Reference: MAP 03 - ANALYSIS

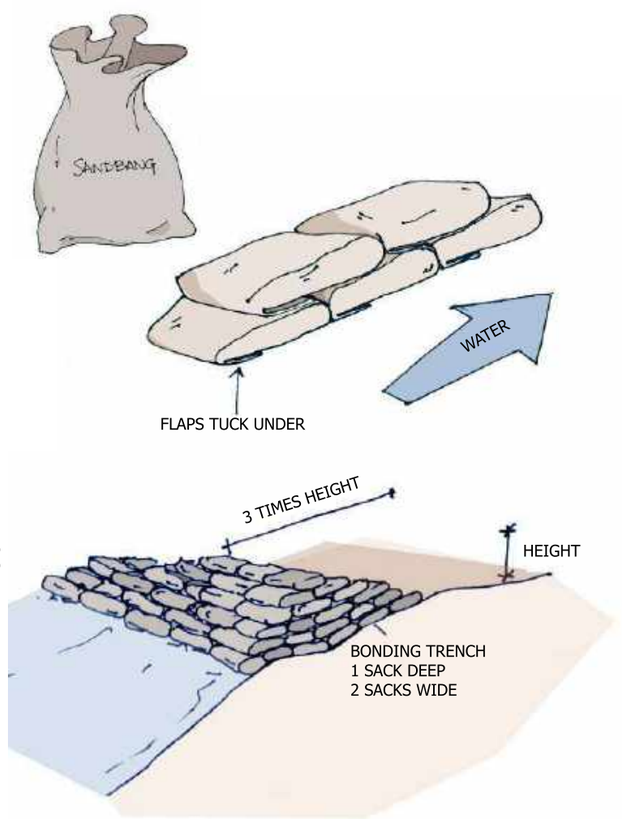


0 500 1.000 m

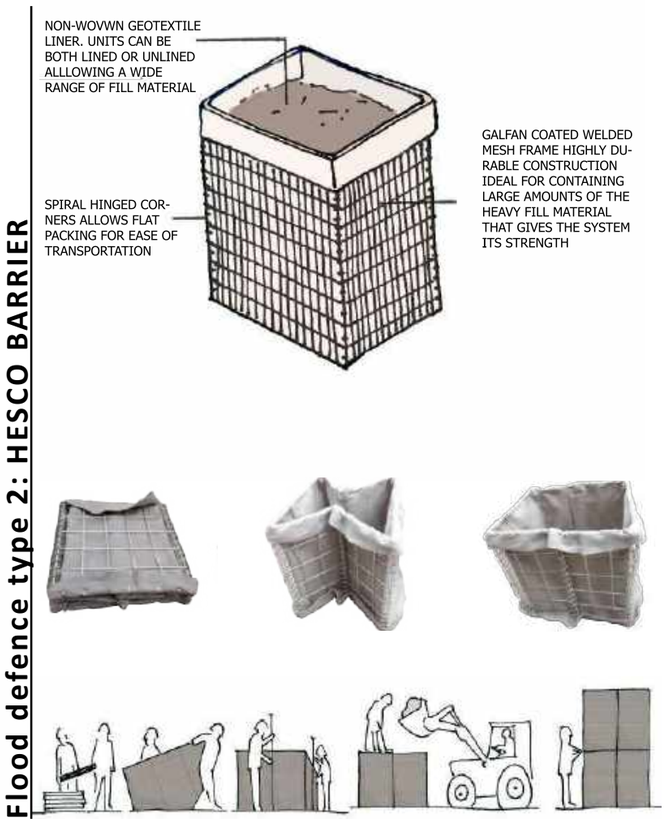
Sources (links):

FAO SWALIM (river breakages, river breakages 2019, River management)

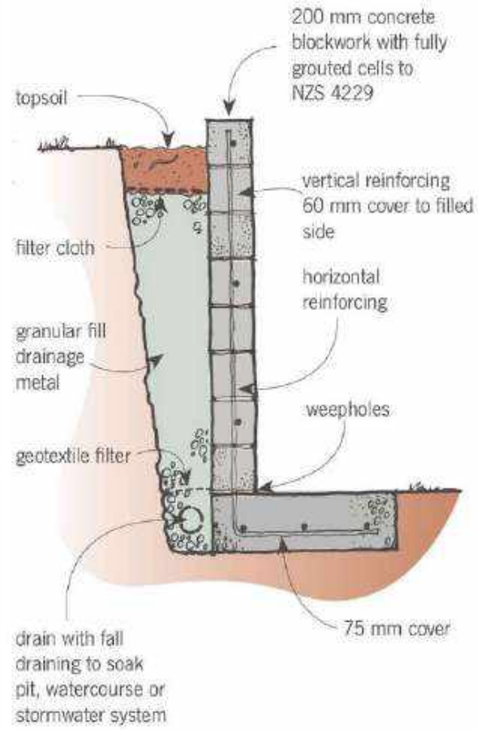
Flood defence type 1: SANDBAGS



Flood defence type 2: HESCO BARRIER



Flood defence type 3: RETAINING WALL



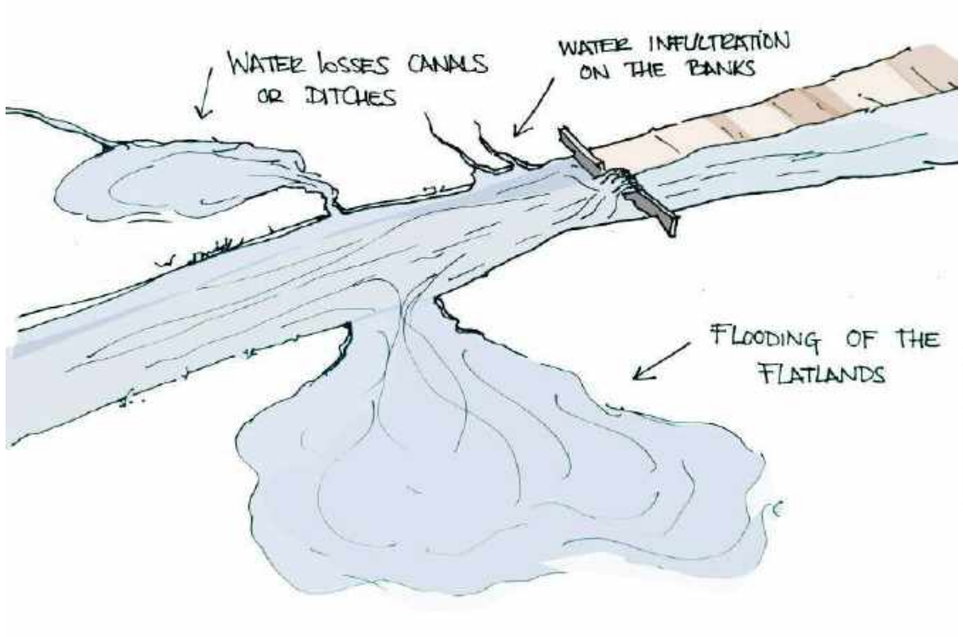
ACTION	RISK EQUATION	TIME (Years)
Sandbags	ER	0.5
Hesco barriers	ER	0.5-1
Reintaing walls	ER	1-2
Desilting. Removal of sand and waste accumulation	ER	2

Sandbags for potential river breakages points.
They are used to protect against small currents (two feet deep or less). Fill the bags halfway through, use sand if available; however, any type of soil can serve. To make the sandbags last longer, mix one part cement. Place partially filled bags lengthwise and parallel to the direction of flow, with the open end facing against the flow of water. Tuck in all the smaller flaps, keeping the unfilled portion under the weight of the bag to prevent it from opening. This technique has certain limitations: Sandbags will not completely seal the water passage. They deteriorate when exposed to rain and sun for several months, so if the bags are placed too far in advance, they may not be as effective when needed. If it is required that the bags remain for a long time, the addition of cement can increase their effectiveness.

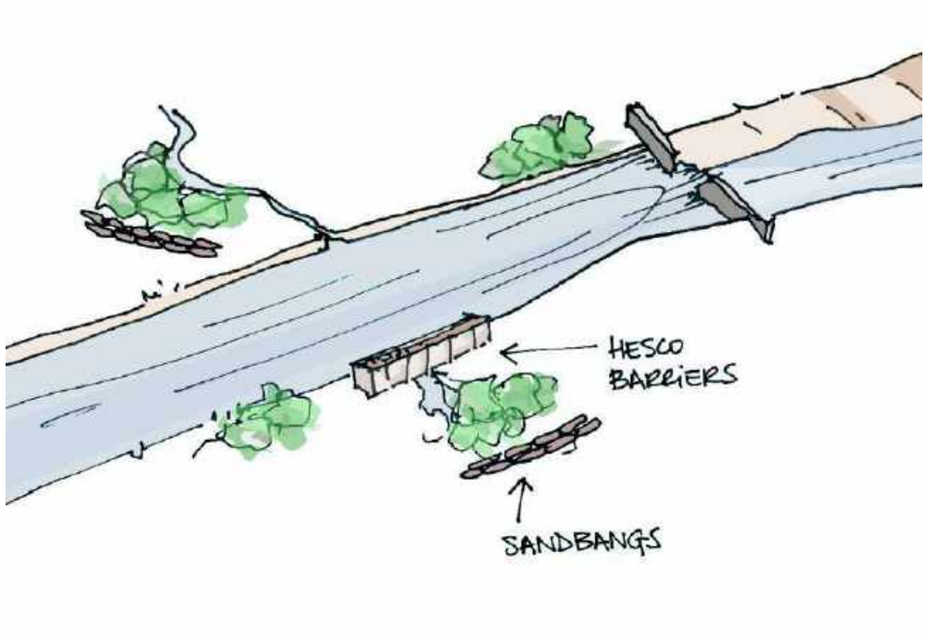
Hesco Barriers for open river breakages points.
Muti-cellular barrier system manufactured from welded zink-aluminum coated steel wire mesh and jioned with vertical, helical-coil joints. The units are lined with a heavy-duty non-woven geotextile. When joined and filled, the system can be used to create barriers of exceptional strength and structureal integrity.

Retainig walls for embankment reinforcement.
Take into consideration the conditions of the terrain.

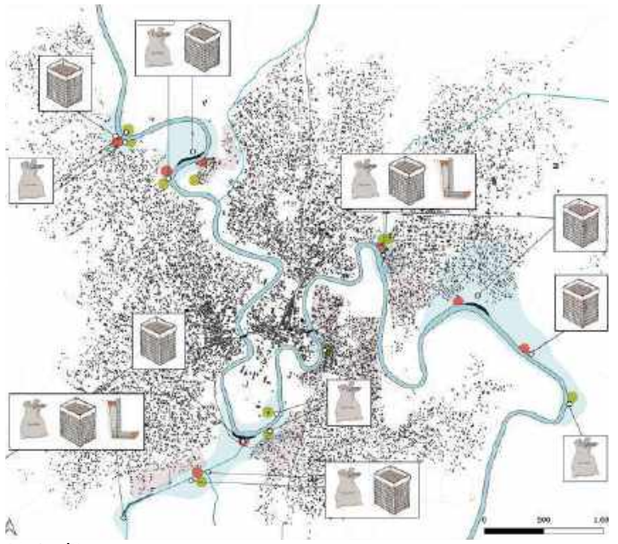
Example of the existing problem:



Proposal:



Reference Map: Proposal plan 02a



Links/Sources:

FAO SWALIM (river breakages, river breakages 2019, River management)

MAP 10a - RESILIENCE PLAN Road network and drainage system

ACTION	RISK EQUATION	TIME (Years)
Roads improvement	VR + CI	1-5
Drainage system improvement	VR + CI	1-5

Legend

- Very high flood risk area
- High flood risk area
- Primary road (9-15 m wide)
- Secondary road (6-9 m wide)
- Tertiary road (<6 m wide)

0 500 1.000 m

During November 2019 floods, 50% of the total road network in the district was affected and infrastructures such as bridges and culverts were also heavily impacted.

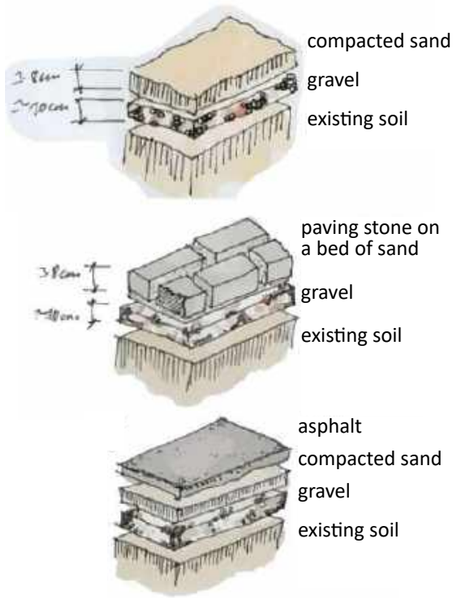
MAP 10a - RESILIENCE PLAN Road network and drainage system analyses the road sections that are at high and very high risk of flooding and need pavement and drainage improvement to ensure proper mobility for the inhabitants of Beledweyne.

The road sections length in flood risk within the city of Beledweyne are:
-Primary road at very high risk: 1967 metres.
-Primary road at high risk: 8908 metres.
-Secondary road at very high risk: 2990 metres.
-Secondary at high risk: 7030 metres.

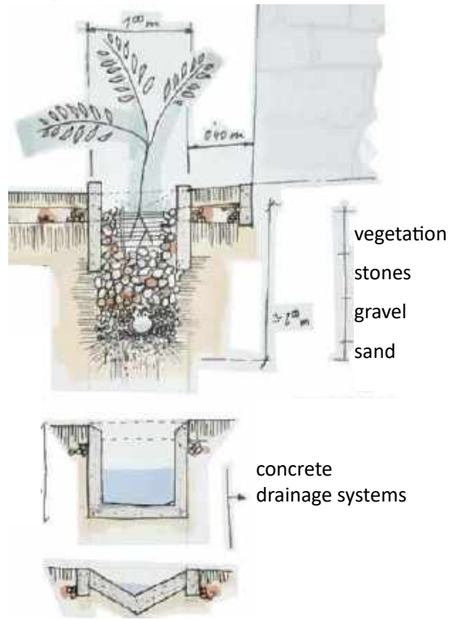
A community engagement approach through cash for work activities for the improvement of road infrastructure can be considered to improve livelihood opportunities for the most vulnerable communities

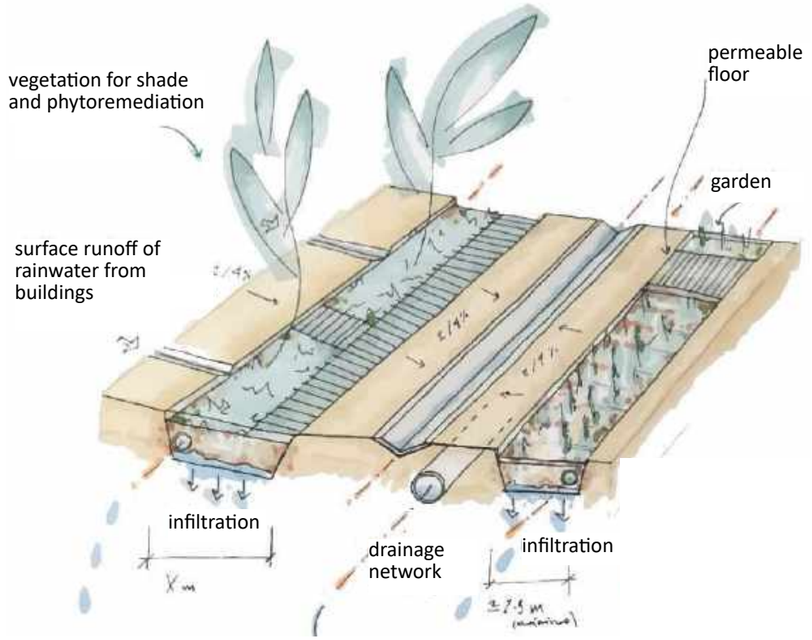
MAP 10b - RESILIENCE PLAN Road network and drainage system

Pavement options: *(from more to less infiltration)*



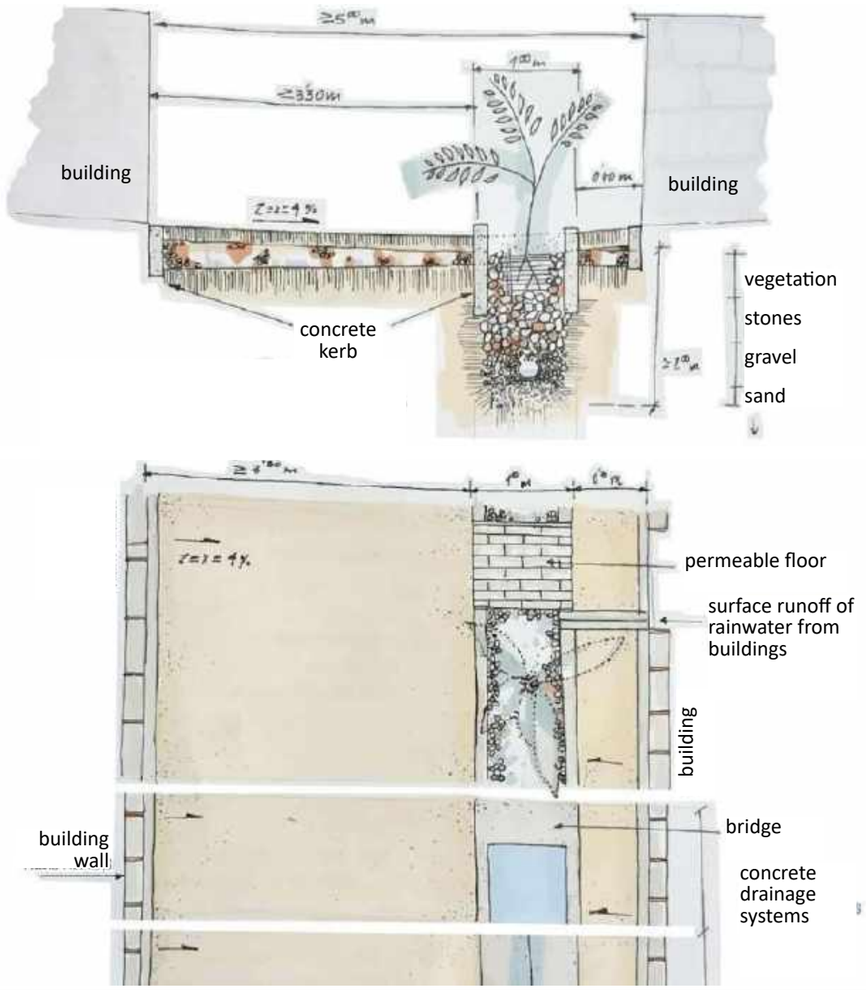
Drainage options: *(from more to less infiltration)*



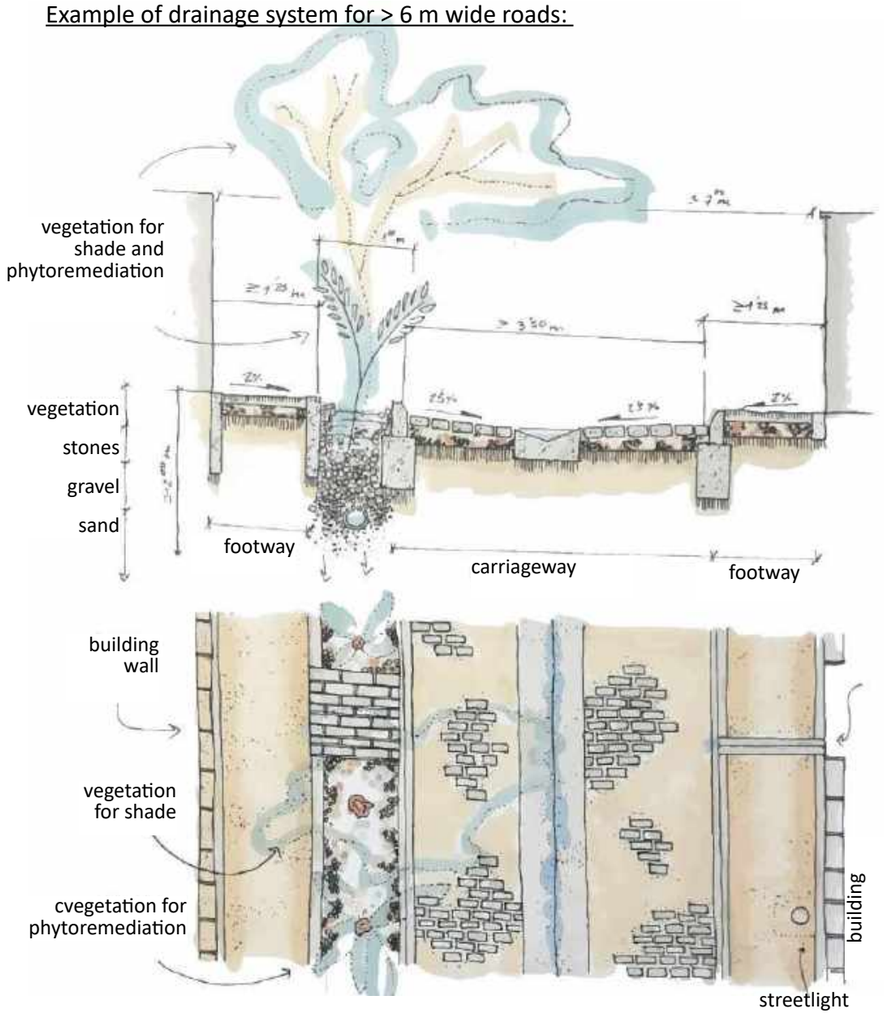


ACTION	RISK EQUATION	TIME (Years)
Roads improvement	VR + CI	1-5
Drainage system improvement	VR + CI	1-5

Example of drainage system for < 6 m wide roads:



Example of drainage system for > 6 m wide roads:



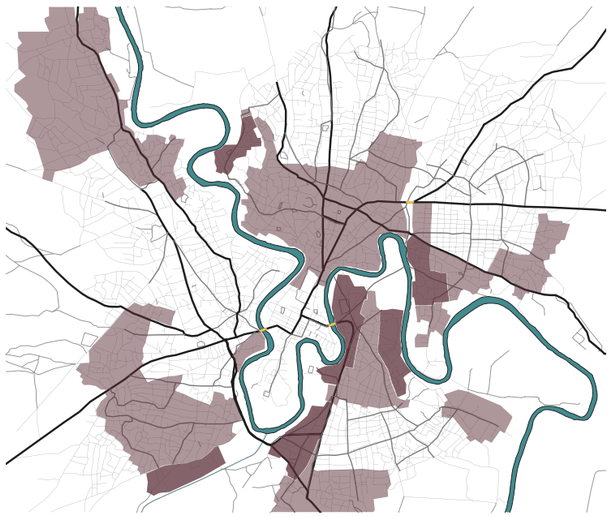
According to the **MAP 10a - RESILIENCE PLAN Road network and drainage system,** 7 kms of roads and streets in Beledweyne are at a very high risk of flooding, while more than 16 kms are at high risk. Most of these road sections are flooded every year for several weeks until the water is pumped out.

A more long-term solution would be to improve the drainage of these streets in a sustainable way. To do this, various solutions are suggested depending on the width and type of use of each street.

A detailed topographical assessment, the correct choice of pavement materials, the connection of the drainage systems of the surrounding buildings, and the inclusion of appropriate vegetation for phytoremediation are key to the success and sustainability of a drainage system improvement.

Note: Phytoremediation refers to the use of plants and associated soil microbes to reduce the concentrations or toxic effects of contaminants in the environment. Phytoremediation is a cost-effective environmental restoration alternative to engineering procedures that are usually more destructive to the soil.

Reference Map: 10a Road network and drainage system



Source: nature.com, Daniel Vázquez Paredes, ETSAC

MAP 11a - RESILIENCE PLAN Green infrastructure

ACTION	RISK EQUATION	TIME (Years)
Green river buffer zone creation	ER	4-5
Green areas creation. Infiltration	ER	1-2

Legend

- Green river buffer zone
- Main green areas
- Secondary green areas
- Green ring: Agriculture

0 500 1.000 m

This **MAP 11a - RESILIENCE PLAN** is based on the Green infrastructure concept: a cost-effective approach mitigate the impact of floods.

The proposal is to establish differents kind of green zones at different locations to infiltrate water from rain and and overflows of the river:

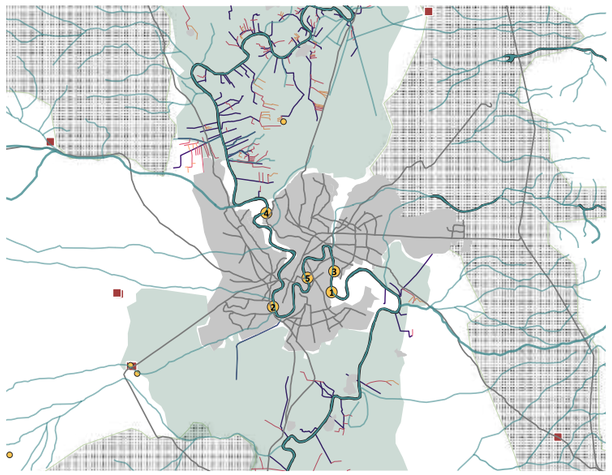
1. Green river buffer zone on both sides of the river and its main tributaries with local phytoremediation vegetation or agriculture, without creating a visual barrier. This zone should be connected with the "Green ring" creating one integrated water management system.

2. Green areas or parks. the two largest green existing areas should be improved increasing their density of the vegetation. Drainage system from the streets and roads should end here.

3. **Other future green parks** should be identified and created, and green areas should be incorporated into the streets and roads.

These areas should be considered as **NO-BUILD ZONES** in the local regulations and the local authorities should ensure compliance.

Reference Map: 08 - RESILIENCE PLAN Territorial scale

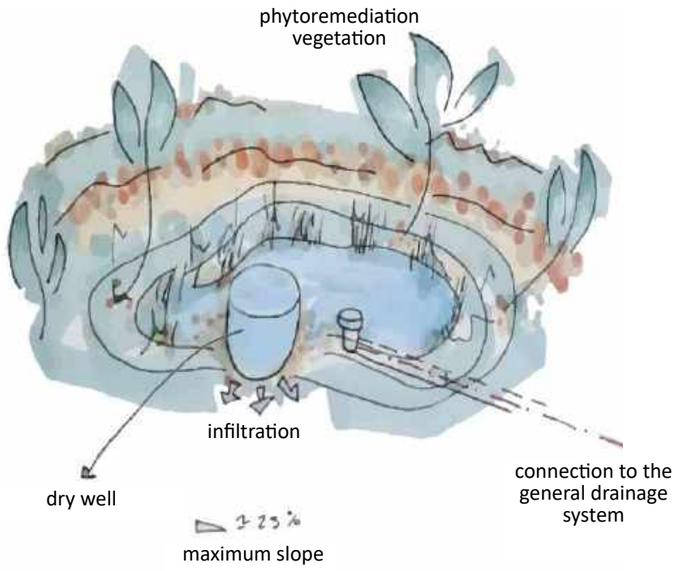


Links/Sources:

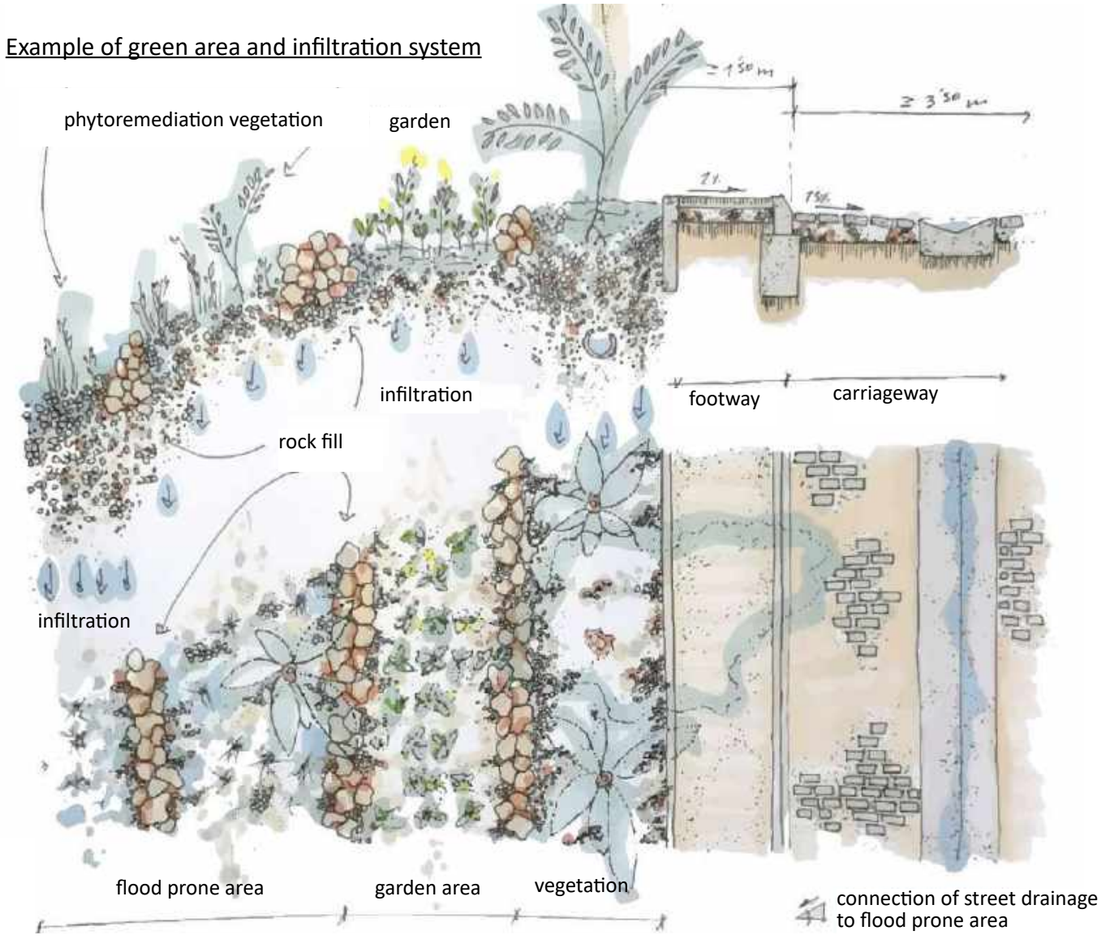
ICLEI. 2018. Sustainable River-Based Urban Planning Guidelines for Sub-Saharan Africa.

MAP 11b - RESILIENCE PLAN Green infrastructure

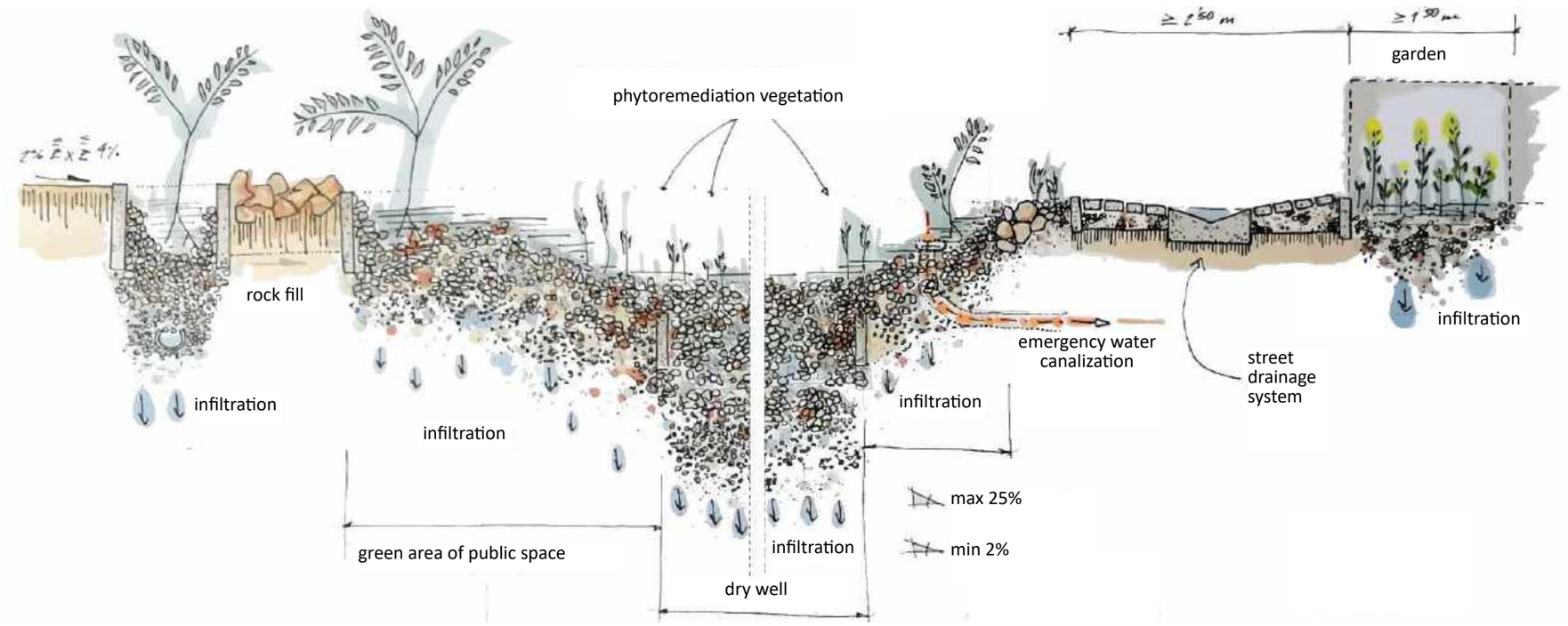
Example of green area in public space
connected to drainage network and
phytoremediation cleaning system



Example of green area and infiltration system



Example of green area and infiltration system



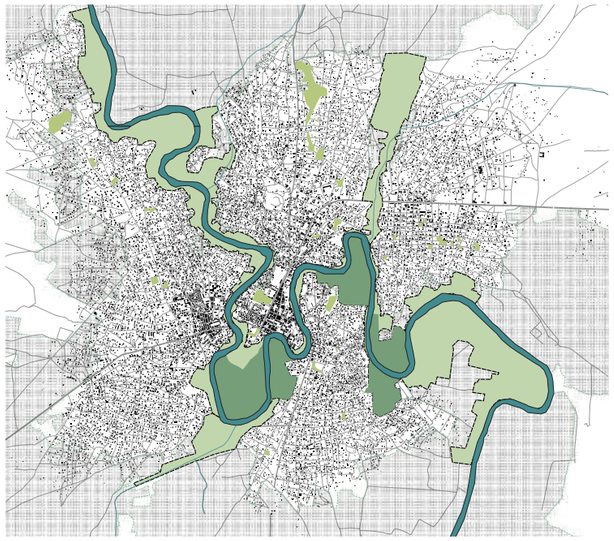
ACTION	RISK EQUATION	TIME (Years)
Green river buffer zone creation	ER	4-5
Green areas creation. Infiltration	ER	1-2

To ensure a successful functioning, the city's drainage system has to be designed in a holistic and integrated manner.

The drainage systems of the streets and roads explained in the **MAP 10a and 10b- RESILIENCE PLAN Road network and drainage system** must be properly connected to green spaces of infiltration spatially identified in the **MAP 11a - RESILIENCE PLAN Green infrastructure**

The use of vegetation is key for solving the challenges of soil degradation as well as improving water infiltration and, therefore, mitigating the impact of flooding in the city.

Reference Map: 11a-RESILIENCE PLAN Green infrastructure



Sources (links):

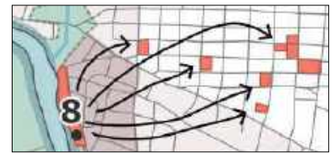
ICLEI. 2018. Sustainable River-Based Urban Planning Guidelines for Sub-Saharan Africa. , Daniel Vázquez Paredes. ETSAC

MAP 12a - RESILIENCE PLAN Urban planning

ACTION	RISK EQUATION	TIME (Years)
Green river buffer zone creation	ER	4-5
N0-BUILD zones regulation established	ER	1-2
Households at very high flood risk reintegration at lower flood risk zones	ER	2-5
Urban planning policies creation	ER + CI	2-5

Legend

- Riverfront enhancement
- Tributary
- Bridge
- Tayeeglow corridor
- Mogadisgu / Ethiopia corridor
- Very high flood risk zone
- High flood risk zone
- Green river buffer
- Green ring / agriculture
- Planned city growth
- Main proposed artheries
- Secondary proposed arteries
- # IDP households at very high risk
- # IDP households at high risk
- # households at very high risk to be relocated
- Reintegration areas



Example of possibility of relocation of 8 households from a very high flood risk area to 8 empty plots nearby in low risk area.

A sustainable urban development plan for the city of Beledweyne should include short-term urban actions that address urgent challenges while, at the same time, thinking about long-term strategies that guide the city's growth in a sustainable and resilient way.

One short-term action is to seek solutions for the households that are in areas of very high flood risk at this moment. One option to be explored is the relocation and reintegration of these households to the nearby urban fabric in order to maintain their current livelihoods but loacted in areas with less exposure to flooding,.

Reference Map06: ANALYSIS Flood Risk

Sources (links):

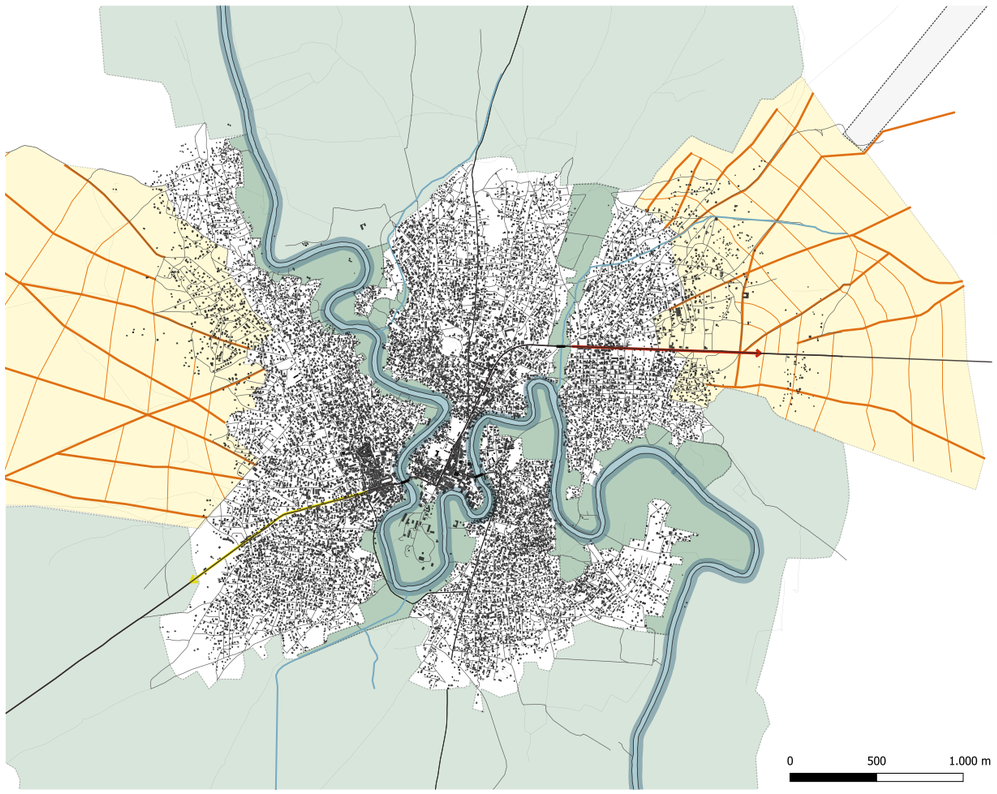
Verified IDP sites in Beletweyne. February 2020. CCCM Cluster

Beledweyne Urban Profile. UN Habitat, IOM, Somalia Government.

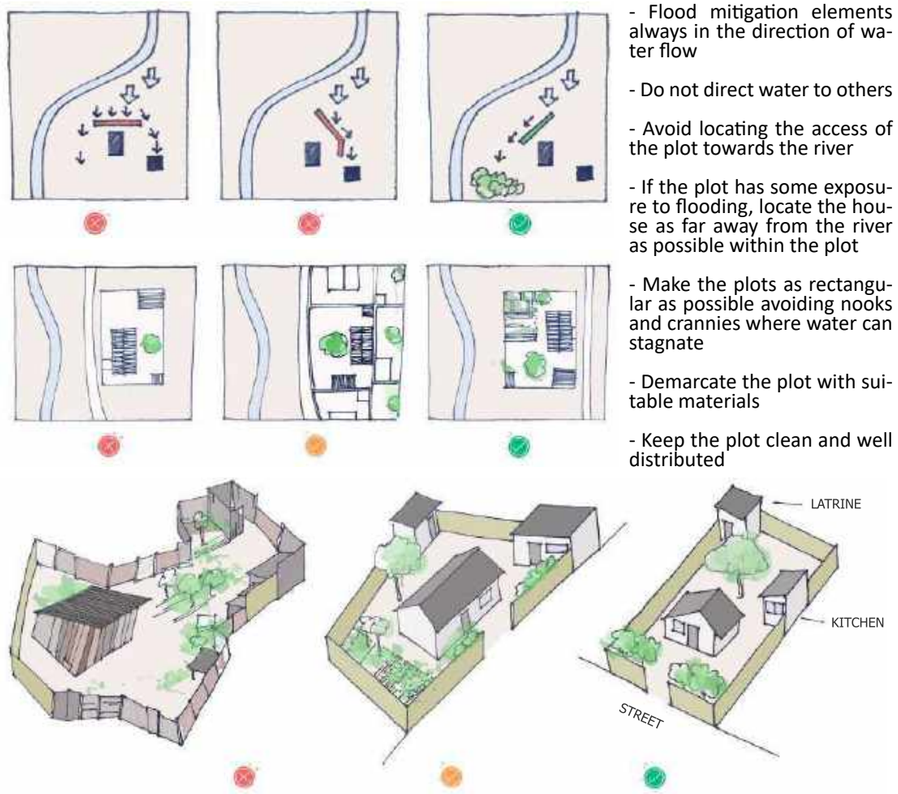
0 500 1.000 m

MAP 12b - RESILIENCE PLAN Urban planning

SITE ELECTION: identification of suitable land avoiding flood-prone areas.



PLOT DIVISION



- Flood mitigation elements always in the direction of water flow

- Do not direct water to others

- Avoid locating the access of the plot towards the river

- If the plot has some exposure to flooding, locate the house as far away from the river as possible within the plot

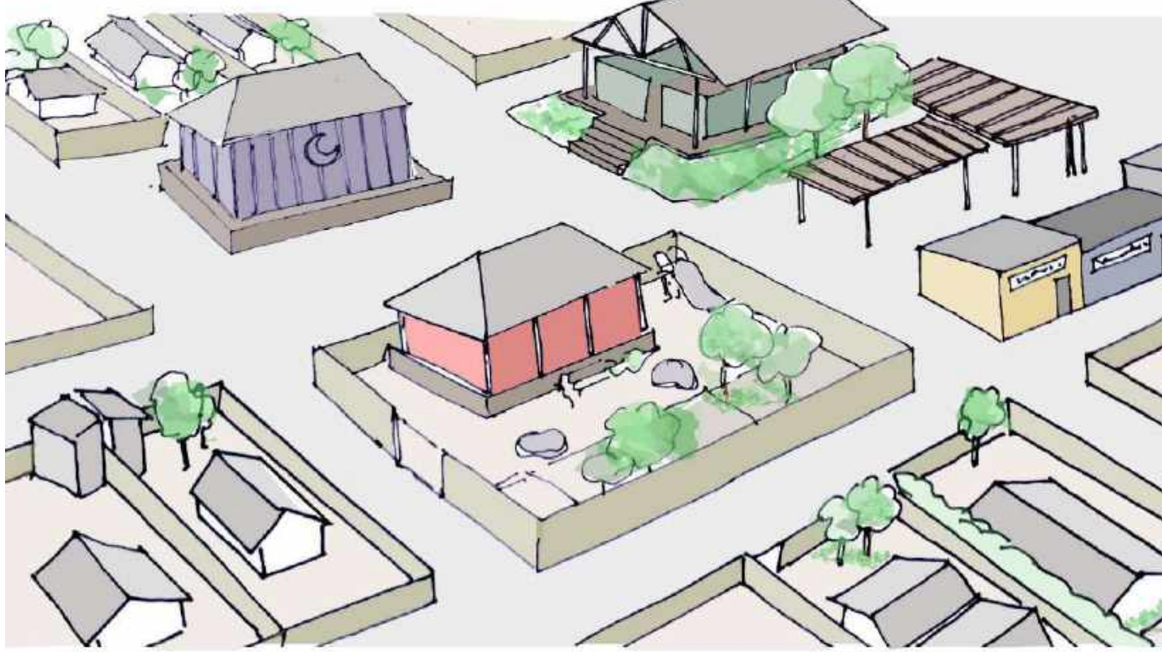
- Make the plots as rectangular as possible avoiding nooks and crannies where water can stagnate

- Demarcate the plot with suitable materials

- Keep the plot clean and well distributed

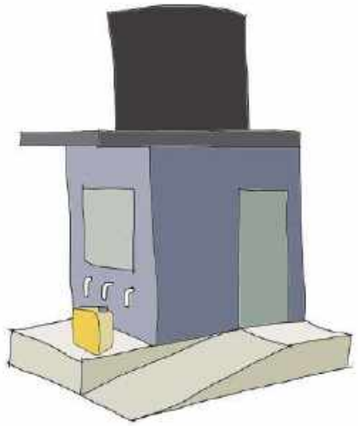
ACTION	RISK EQUATION	TIME (Years)
Green river buffer zone creation	ER	4-5
N0-BUILD zones regulation established	ER	1-2
Households at very high flood risk reintegration at lower flood risk zones	ER	2-5
Urban planning policies creation	ER + CI	2-5

SITE PLANNING. BASIC SERVICES



Services have different catchment distances according to the type of service, the need for the service and the size of the population but the main services that have to be considered are:

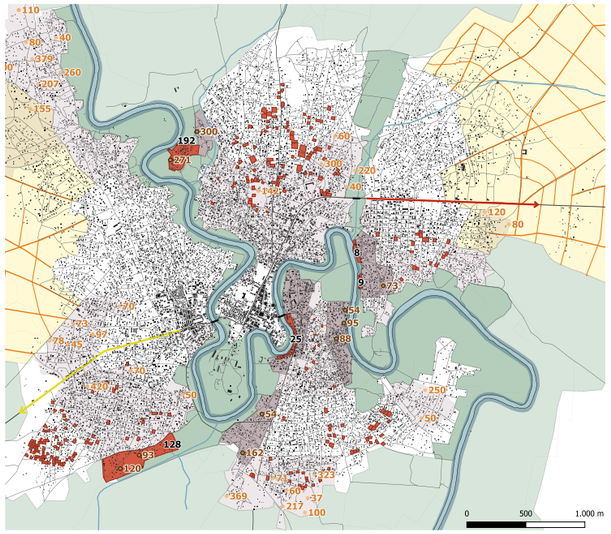
-schools
-heath facilities
-administration buildings
-markets
-water and sanitation services
-waste management services
-electricity
-telecommunication
-playgrounds and recreation facilities
-green areas / public spaces
-community facilities
-social and religious services



Water kiosk connected to the water network and operated and maintained by community water committees to provide safe and affordable water to the most vulnerable of both IDP and host communities.

In flood prone areas it is important to have water tanks elevated above the maximum water level during the floods to ensure access to clean and safe water in any situation

Reference Map12a:RESILIENCE PLAN Urban planning

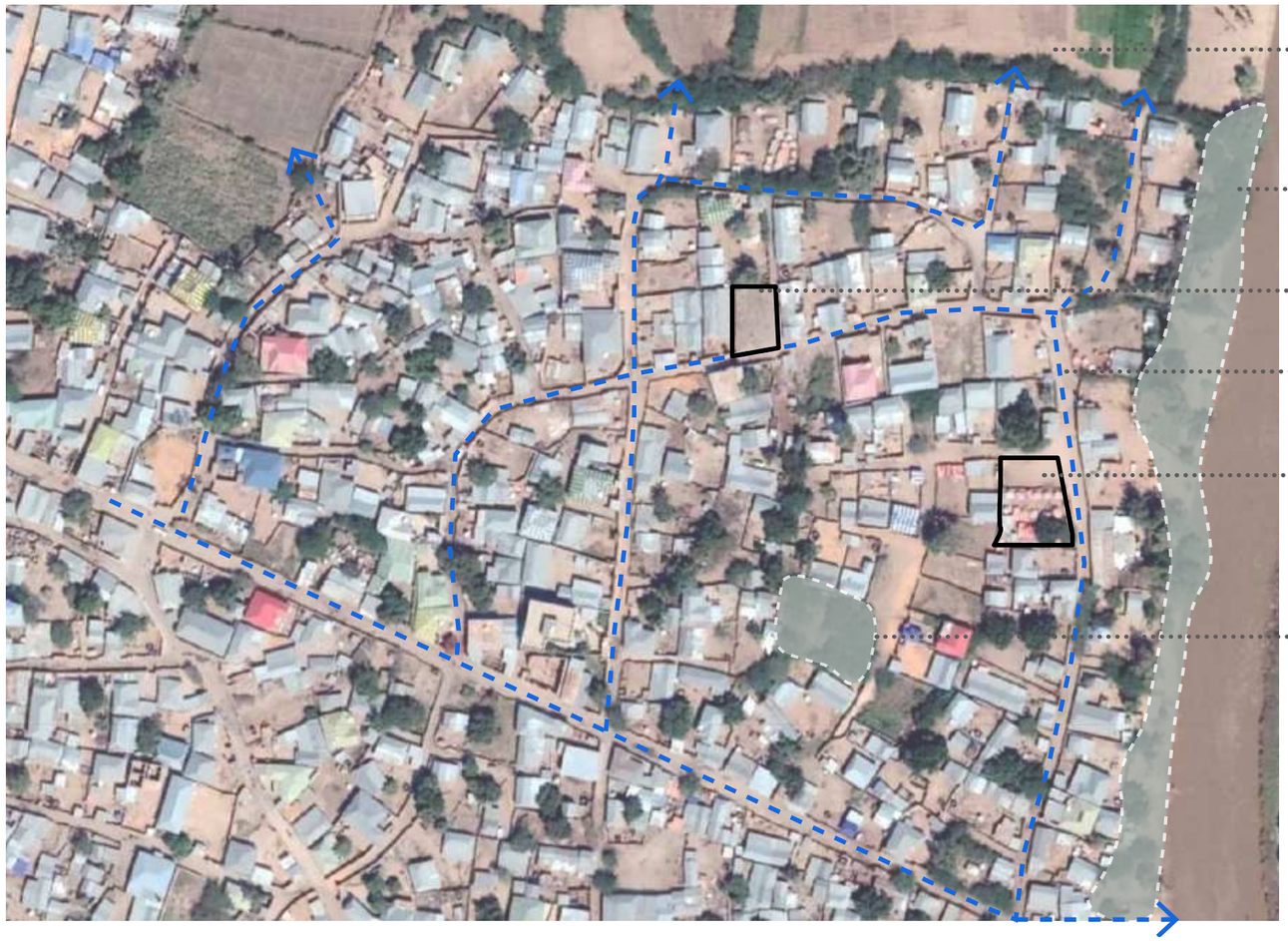


Sources (links):

-*Verified IDP sites in Beletweyne. February 2020. CCCM Cluster*
-*Beledweyne Urban Profile. UN Habitat, IOM, Somalia Government.*
-*Shelter Cluster documents: Stategic Operating Framework. A search for complementary aproches. + Shelter Cluster Response in Somalia.*

MAP 13 - RESILIENCE PLAN Neighbourhood upgrading

Examples of upgrading actions of neighbourhood at very high flood risk area



ACTION	RISK EQUATION	TIME (Years)
Neighbourhood upgrading	VR + CI	1-5
Improvement of building construction techniques. Building code	VR + CI	1-4
Improvement of access to safe water (water kiosks)	VR +CI	1-5
Improvement of solid waste management	VR + CI	2-5

Acording to the Risk Analisis 1,671 households are living in informal settlements at very high flood risk and 7,875 households at high flood risk.

It is not feasible to relocate all these households, almost 60,000 individuals, therefore, alternative neighborhood upgrading actions should be explored to make these communities more resilient to future flooding.

MAP 12c - RESILIENCE PLAN Neighbourhood upgrading aims to analyse a catalogue of improvement proposals from a settlement scale to a building construction scale.

After november 2019 floods, there were 1995 fully damaged and 6713 partially damaged houses in Beledweyne.

A process of repairing and rebuilding these houses should be carried out following a Build Back Better approach to avoid similar damage in future floods. The house improvement process can be carried out in two phases, starting with those houses located in very high flood risk areas and continuing with those at high risk (See map below)

Flood resilient housing

Elevated latrines. Latrines can cause serious health problems during floods, so it is important to have elevated latrines and keep them closed and clean

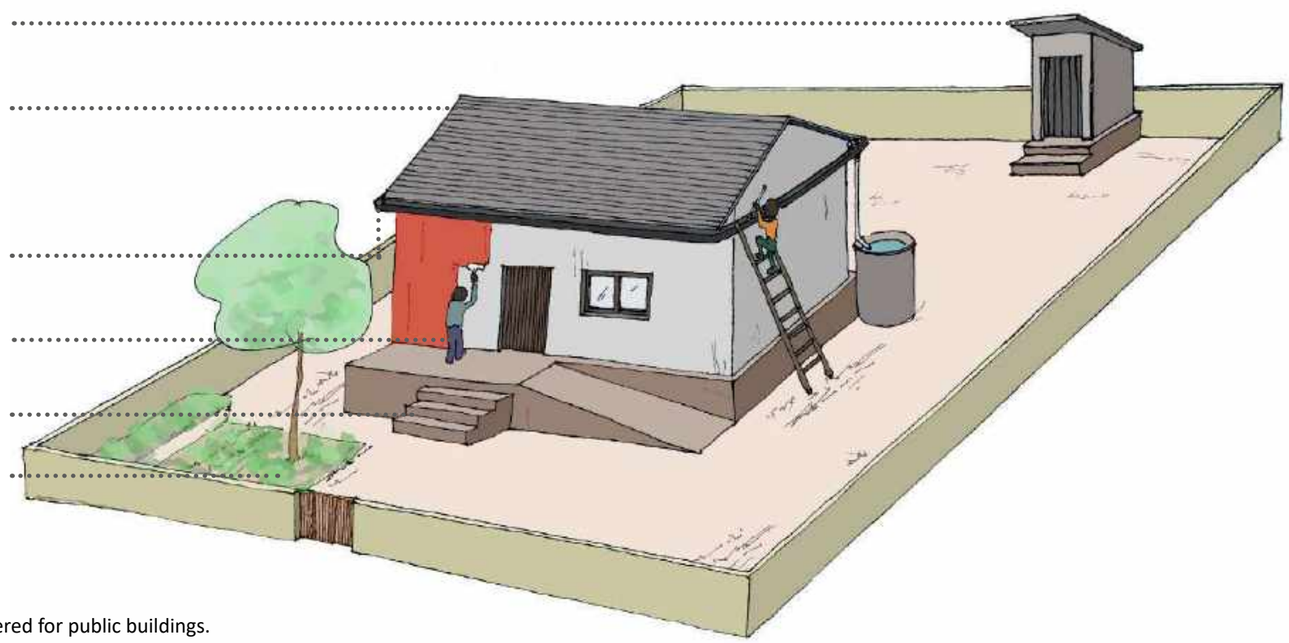
Reinforcement of the structural elements of the house, including roof and walls, to prevent it from collapsing under the force of water.

Rainwater harvesting can provide access to water which can be critical during floods

Protect the walls with waterproof materials to prevent the walls from being washed out by water

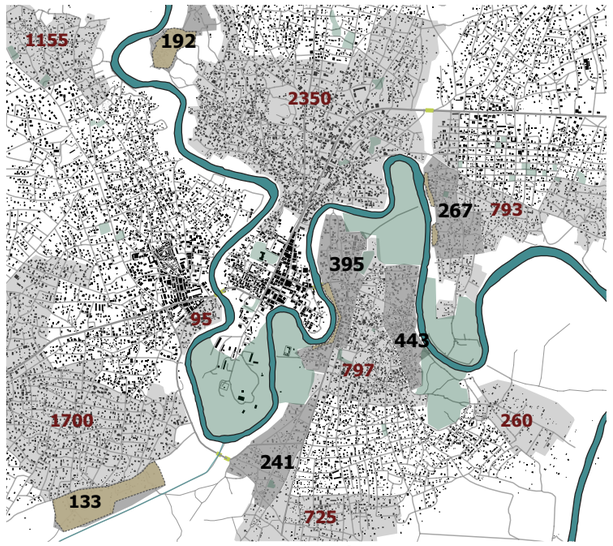
Elevated houses. Build a platform or plinth to raise the floor level of the house above the water level during flooding

Slope the plot towards the green area and if there is a drainage system in the street, direct the water from the plot towards it. (See details at MAP 10b - Road network and drainage system)



✻ Similar measures to ensure flood resilience should be considered for public buildings.

Reference Map:



N. HOUSES TO IMPROVE PHASE 1 / N. HOUSES PHASE 2

Links: *CCCM Cluster Somalia* / *Shelter cluster Somalia*
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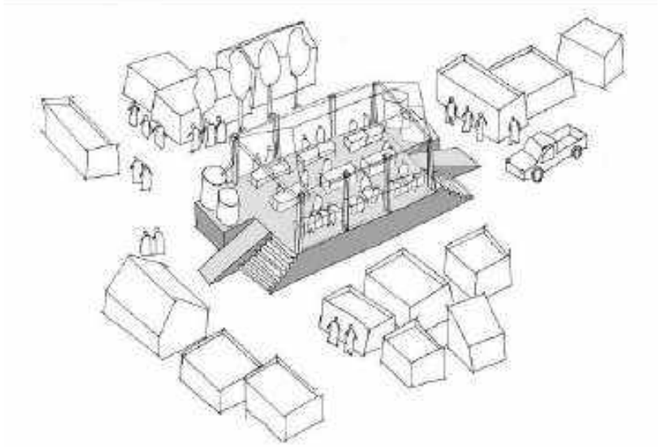
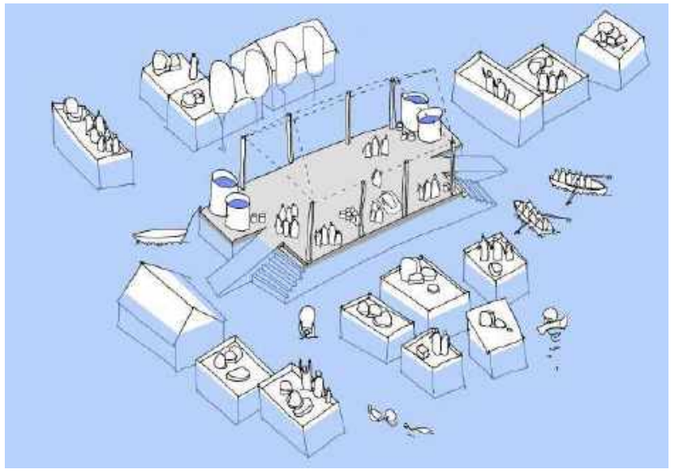
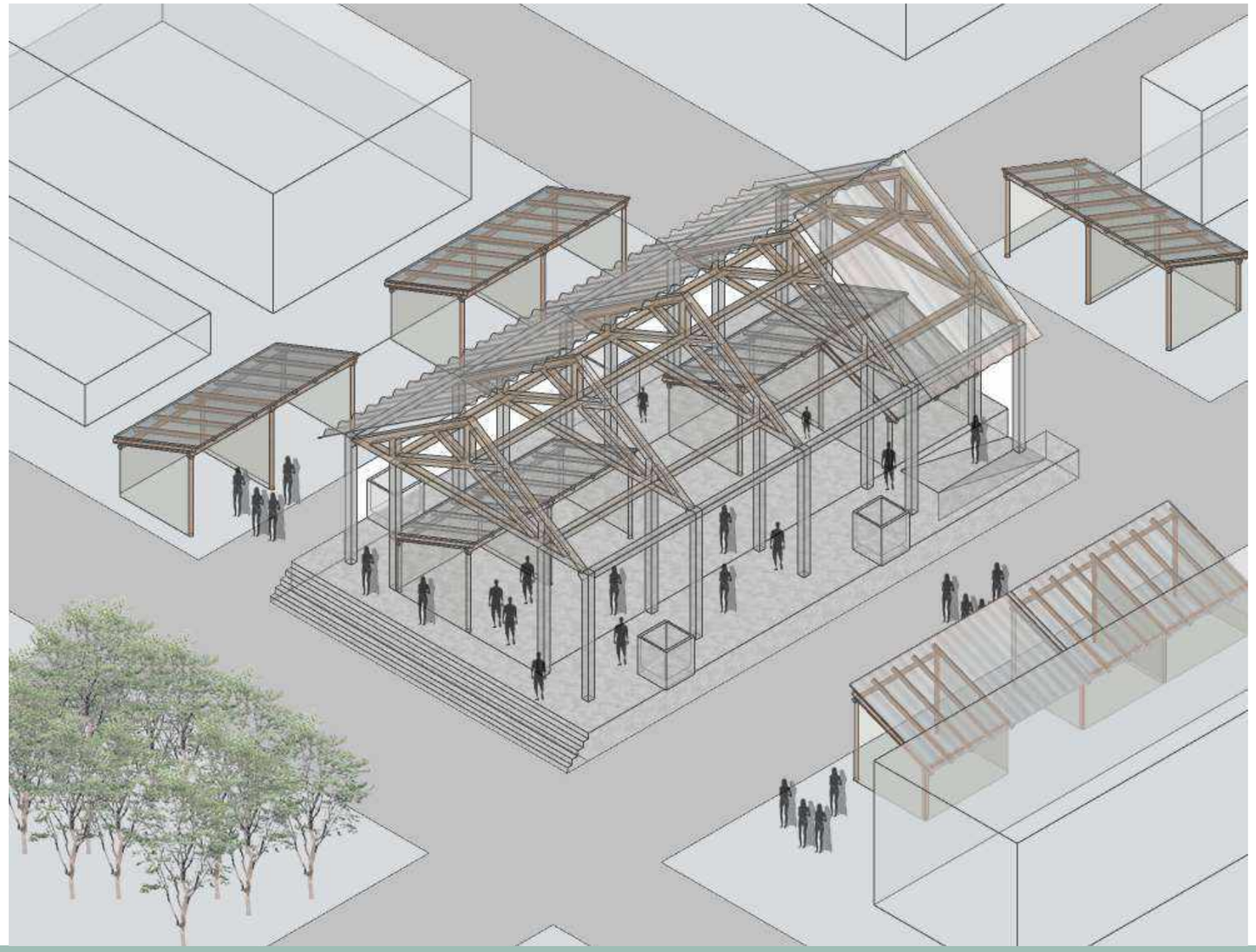
MAP 14 - RESILIENCE PLAN Market - Collective centre

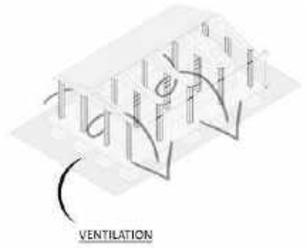


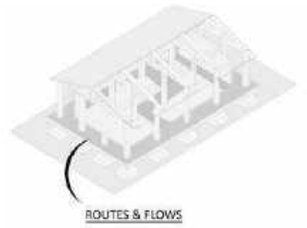
It is used as a marketplace during normal times

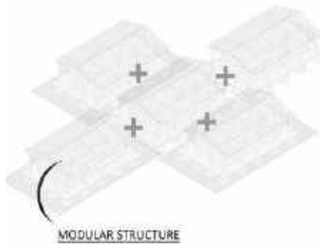


It becomes a collective centre to provide temporary shelter to the most affected people during the floods







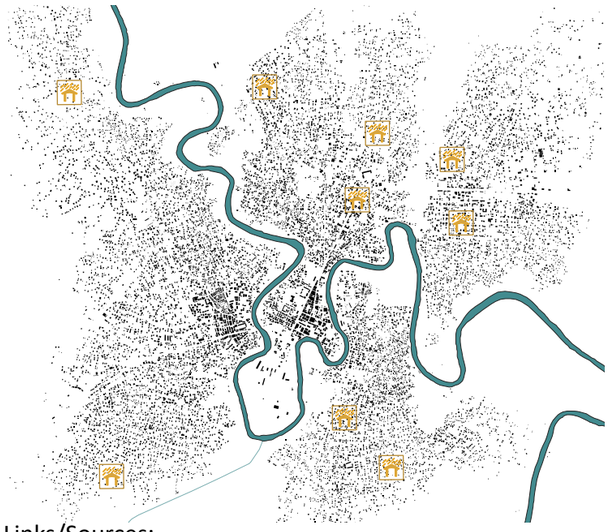


ACTION	RISK EQUATION	TIME (Years)
Construction of collective centres.	VR + CI	1-3

In addition to all the measures explained before, it is advisable to have also certain buildings identified in advance that can function as a collective center to temporarily shelter the most affected people after the floods.

In places that suffer flooding, public facilities such as schools or sports centres are often used as temporary collective centres. However, it is recommended that schools resume operation as soon as possible since the return of children to school is a clear engine of recovery after a disaster.

For this reason, the identification of possible infrastructures that can function as a collective center is needed. However, in case there are not enough, it is recommended to build elevated infrastructure that can be used as a basic service in normal times, like a marketplace, and to shelter the most vulnerable in times of flooding.



Links/Sources:

- CCCM Cluster Somalia. https://data2.unhcr.org/en/situations
- UNOPS: https://www.unops.org/es/
- PUNTLANDPOST: https://puntlandpost.net/2017/10/02/

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