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FOLLOW-UP TO THE NANSEN INITIATIVE

Comparative report on flood displacement mitigation policies

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Introduction

Flooding is one of the most common and devastating environmental disasters that causes significant property damage, and loss of livelihood, and affects millions of people worldwide every year. Flooding can also lead to displacement, with people forced to leave their homes or places of habitual residence to seek shelter elsewhere as a result of a disaster or in order to avoid the impact of an immediate and foreseeable natural hazard (= disaster displacement[1]). Displaced people's basic needs include shelter, water, food, and sanitation, but more and different needs may arise in specific disaster scenarios as well as depending on individuals' characteristics (age, gender, illness, or disabilities, etc.), the nature of displacement (short-term or long-term, internal or cross-border, etc.), and contextual characteristics (geographical characteristics, weather conditions, etc.).

According to IDMC data, floods triggered more than 185 million new internal displacements globally between 2008 and 2022, around 12 million every year. In the IGAD region[2], floods have become increasingly frequent and intense due to climate variability and change, resulting in 10.7 million new displacements between 2008 and 2022, related to 291 flood disasters reported (IDMC Database, data retrieved on 15/06/2023). The associated impact of those events highly depends on the contextual socioeconomic, political, and individual or household characteristics. In fact, the same hazardous event may affect people in different ways in the same area. This would depend, for example, on the housing material and their income level, which is crucial for repairing damages, coping with disaster displacement, and being better prepared in the event of a flood. It also depends on the presence of people with specific needs, such as people with chronic illnesses or disabilities, or others who may have more difficulties moving, as well as on the presence of political or humanitarian support mechanisms or ranging from transport and shelter to social protection measures. In other words, disaster displacement risk depends on three different elements: hazard, exposure, and vulnerability. In the first place, the probability of being displaced due to a disaster is related to the nature of the hazard, in this case to flood events, their intensity and frequency. Exposure is related to the number and distribution of people, infrastructure, assets, and buildings in flood-prone areas, and so is subjected to the potential impacts of hazardous events. Vulnerability refers to the "conditions determined by physical, social, economic and environmental factors and processes which increase the susceptibility of an individual, a community, assets or systems to the impact of hazards" (UNGA, 2016). This element includes socioeconomic status, housing materials, access to resources and services, health conditions, and education opportunities. Assessing and understanding the three components of risk is crucial for policymakers and humanitarian organizations to design and implement strategies for reducing the risk of being displaced due to disasters.

In addition, to reduce flood and disaster displacement risk it is essential to better understand the impact of floods on local communities and design effective policy interventions tailored to the specific geographic and social context. Every context has its own specific characteristics, needs, and criticalities, and no one-size-fits-all solution is possible. This requires considering people's characteristics, access to and trust in information and early warning systems, experience, risk perception, and interactions to comprehensively grasp the social dynamics in place and the linkage between flood events and displacement patterns. At the same time, the effectiveness of policies, in terms of reducing disaster displacement risk and improving communities' preparedness, awareness, capacity, and response, should be tested with the support of simulation models. This would reduce the uncertainty related to the results of the implementation of different policies, leading to the identification of the most effective ones for the selected area. The results of the simulation model can support policymaking.

To address this issue and fill the research gap, an agent-based model, which will be described below, was developed to simulate people's behavior in different policy scenarios related to flood displacement risk reduction. The model considers household agents with specific properties such as income, risk awareness, and trust in early warning systems, and their interactions with the environment and other agents. Our pilot study area is located in Sudan, a region frequently affected by floods that trigger displacement. By comparing the results of different policy scenarios, our methodology provides insights into the potential impact of different policies on reducing flood displacement risk in the selected socio-geographic context. The results of our study can serve as a valuable tool for informing policy decisions aimed at reducing flood displacement risk.

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1 - Nansen Initiative Protection Agenda vol I, para. 16

2 - The Intergovernmental Authority on Development (IGAD) comprises the Countries of Djibouti, Ethiopia, Kenya, Somalia, South Sudan, Sudan, and Uganda.

Model description

An agent-based model (ABM) is a highly effective computational method for modeling complex systems. It can be used to analyze the actions and interactions of elements of the system, which are referred to as "agents." Agents can represent elements of the system at a variety of levels of abstraction, but in this case, they represent households. Thus, this model simulates the behaviors of a large group of households, their interactions, perceptions, and decisions in the context of flood displacement risk.

An agent-based model is a powerful tool for understanding human behavior in response to flood risks and for testing the effectiveness of different policy options. The model can inform policy decisions aimed at reducing the impact of floods on communities and displacement in emergency situations after floods occur. As a first implementation, this model is implemented in a pilot area in Sudan, located in the Bahri Locality, between 50 km and 80 km North of the capital Khartoum.

The area is frequently and extensively affected by flood events, which damage houses, buildings, infrastructure, and impact livelihoods. First-hand data were collected in the field, administering questionnaires to resident people, in order to have information about their households' characteristics, including size and composition, income, access to basic goods and services; their flood and displacement experience; and their risk perception. The data were used to inform the model itself to create a population in the model in line with real characteristics.

October 2020 situation in Eltomaniat, Sudan (Location 1)

January 2021 situation in Eltomaniat, Sudan (Location 1)

The model is flexible and adaptable, allowing for different scenarios to be tested and compared, and for being replicated in other socio-geographical contexts. The model is designed to simulate a range of flood scenarios, including different flood intensities, extensions, interarrival times, and durations. It includes also different levels of policy implementation, or modes, that can be tested (high-efficiency, partial-efficiency, low-efficiency). By simulating the behavior of individuals in response to these scenarios, the model generates a range of outcomes, such as the number of displaced people, statistics about the duration of displacement, the number of evacuated people, and the number of trapped people. The agent-based model is a powerful tool for understanding the complex dynamics of human behavior in response to flood risks, in different political and hazard scenarios. This methodology can help inform policy decisions aimed at reducing the impact of floods on communities and understanding the nexus between disasters and displacement patterns.

The model includes several key features.

Agents

The agent-based model is designed to simulate a population of households, where each one is represented by a unique set of properties. These properties include household size, composition, income level, risk awareness, trust in early warning messages, and fear of floods and displacement. These properties are dynamic, allowing for changes during the simulation to reflect the dynamic nature of human behavior. The agents are based on real households in the pilot area, where questionnaires were administered to collect data for the model. The model simulates their behavior in the context of flood risk, assessing the likelihood of displacement and its duration. The model also considers the interactions between agents, which can impact their decisions to evacuate in anticipation of a flood or move after the flood event occurs.

Environment

The model simulates a real geographical environment, representing a pilot study area located in Sudan, a few kilometers North of the capital Khartoum. The environment is composed of eight locations, including formal and informal settlements. Houses, critical facilities, and croplands are key components of the model environment. The role of the Nile River is crucial as it is the origin of floods affecting the area. Flood extension, flood depth, and related damages to buildings and assets are taken into account in the model simulations. The conditions of the environment affect people's decision to move out of their houses or not.

Policies

The model allows for the simulation of different policy scenarios, in which different combinations of policies related to flood displacement risk are assessed. Policies tested in the model are the Early Warning System (EWS), the Awareness Programme (AW), the Basic Income Programme (BI), the House Repair Programme (RP), and the Build Back Better Programme (BBB), which will be explained in more detail in the next paragraph. Also, combinations of policies are tested, to understand the best strategies for reducing flood and displacement risk in the Sudanese pilot study area. The effectiveness of these policies will be assessed by taking into account a number of metrics (see below), which give us the possibility to understand the impact of policies on flood displacement risk reduction.

Metrics

The model tracks several key metrics related to flood displacement risk. In other words, the impact of policy scenarios is assessed by taking into account specific parameters and comparing them. The metrics considered for comparing policies are the following:

- the average total number of displaced households (post-event) in simulated 30-year scenarios;
- the number of displaced households (post-event) at the end of the simulation (30th year);
- the number of displaced households (post-event) disaggregated by displacement duration;
- the average total number of evacuated households (pre-event) in simulated 30-year scenarios;
- the average total number of trapped households in simulated 30-years scenarios, due to insufficient income to move, or obstacles to movement, such as vulnerabilities (people with chronic illness and disabilities in the household) and responsibility to protect properties (house, croplands, livestock).

As mentioned, these metrics are used to compare the potential impact of different policies that can be implemented to reduce flood displacement risk in the area.

Policy scenarios

A Solution Space Workshop took place in December 2021, bringing together representatives from various organizations, namely IGAD (Intergovernmental Authority on Development) and ICPAC (IGAD Climate Prediction and Applications Centre), PDD (Platform on Disaster Displacement), CIMA (International Centre for Environmental Monitoring), GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit), IDMC (Internal Displacement Monitoring Centre), UNDRR (United Nations for Disaster Risk Reduction), IOM (International Organization for Migration, and IFRC (International Federation of Red Cross and Red Crescent Societies). One of the goals of the workshop was to facilitate the discussion on policies and strategies to reduce and mitigate risks associated with disaster displacement in the IGAD region, both in the immediate aftermath of a disaster and in the long run.

During the workshop, participants identified several priority policies in the context of risk reduction in the IGAD region. To begin with, five different policies were chosen to be tested individually as well as in various combinations using the agent-based model. These five policies were selected based on their relevance to flood displacement risk reduction and the feasibility of their implementation in the model. Other relevant policies can and will be examined in the future.

Early Warning System (EWS)

This policy scenario involves the implementation of an Early Warning System to alert residents to potential flooding, based on flood forecasting. Providing Early Warning is a means to provide residents with enough time to evacuate safely and avoid displacement after the flood event occurs. People who live in flood-prone areas and who receive the Early Warning can decide whether to evacuate, leaving their houses before the flood event occurs, or not. The decision is made according to asset availability, level of confidence in the Early Warning message, and obstacles to movement, like the presence of people with disabilities or chronic illness in the household.

Different Early Warning Systems can be tested: a high-efficiency one, with low false alarm and false negative rates; a partial-efficiency one, in which false alarms and false negative rates may occur; a low-efficiency one, in which floods are often not correctly forecasted (false alarm and false negative rates are higher).

Basic Income Programme (BI)

This policy scenario involves the implementation of a basic income programme to provide financial support to residents who live in the selected area. In particular, this policy is meant to significantly reduce the number of households with income below the poverty line, and, consequently, the number of trapped populations. In that sense, it is expected to have an impact on their decision to evacuate preventively or to move after the event occurs, impacting displacement patterns in the area.

Awareness Programme (AW)

This policy scenario involves the implementation of an awareness programme to educate residents about flood risks, enhancing their capacities to cope with flood risks and ways to reduce the likelihood of displacement. The awareness policy may include educational programs at schools for youths, training for citizens, advertising campaigns, or the sharing of relevant information and procedures in an accessible and comprehensible way. The programme is designed to increase residents' understanding of the risks they face and encourage them to take action to protect themselves and their homes.

House Repair Programme (RP)

This policy scenario involves the implementation of a house repair programme to address the structural damage of houses in flooded areas. By implementing this programme, the government repairs flood-damaged houses to restore them to their pre-disaster condition. Thus, households that do not have enough economic resources would be supported in repairing the damage and enabling residents to come back sooner. The average duration of displacement could thus be reduced.

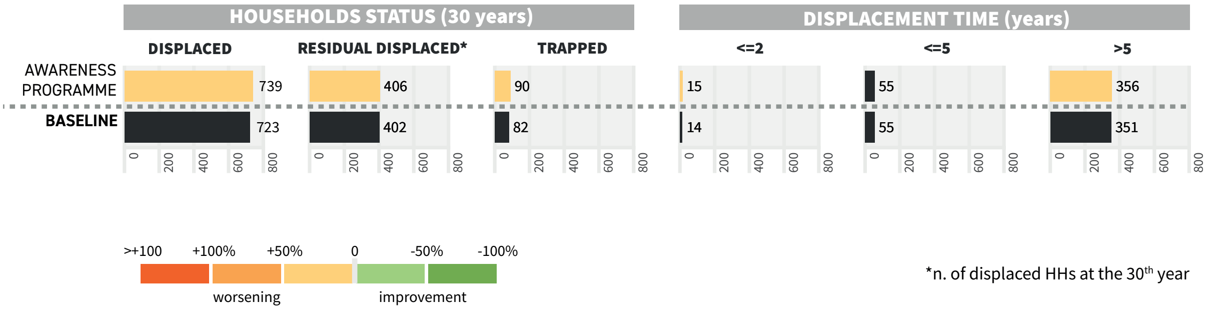
Build Back Better Programme (BBB)

This policy scenario involves the implementation of a Build Back Better programme. The goal is to improve the overall quality of housing in the pilot area and to provide residents with better living conditions. This policy would reduce the number of informal settlements, such as tents, reducing the likelihood for inhabitants to have high damage to their residences due to floods.

To assess the potential impact of different policy interventions on flood displacement patterns we test each policy scenario independently and in combination with others. This allows us to simulate the behavior of people and to track the number of displaced, evacuated, and trapped households under different policy combinations. Analyzing the results provides valuable insights into the effectiveness of different policy interventions in reducing flood displacement risk. Decision-makers can use this information to make more informed decisions by considering the advantages and disadvantages of each policy scenario and allocating resources more effectively to reduce the impact of floods on communities.

Simulation results

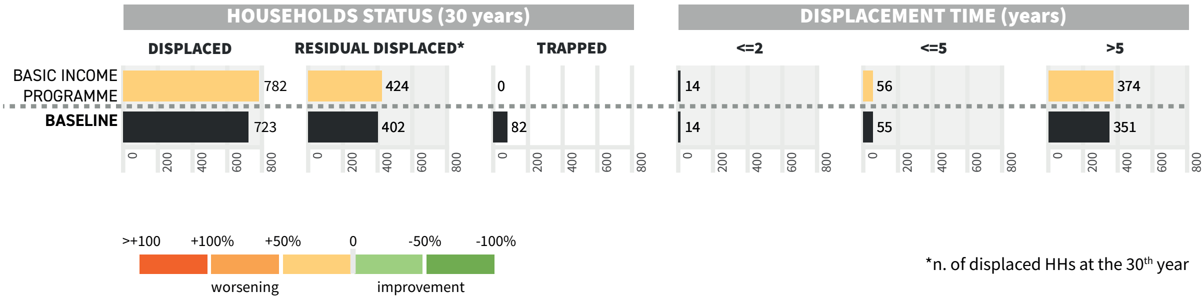
Awareness Programme (AW)



*n. of displaced HHs at the 30th year

The graphic above presents a comparison between the baseline situation, where no policies are in place, and a scenario where only an Awareness Programme is implemented.
The comparison reveals that there is little difference between the two scenarios, suggesting that the Awareness Programme alone does not have a significant impact on the displacement dynamic and additional measures may be necessary. The number of households trapped and displaced are similar in the scenarios with and without the Awareness Programme. There is even more similarity between the two scenarios in terms of displacement duration. As it is possible to note in the last three columns, the numbers of people displaced for less than or equal to two years (<=2), for less than or equal to five years (<=5), and for more than five years (>5) are almost the same.
It is worth noting that the impact of households' risk awareness would likely be most visible in the decision to evacuate after receiving an Early Warning message. However, in this scenario, there is no Early Warning System in place, making it impossible to measure the impact of increased awareness on the total number of evacuated people.

Basic Income Programme (BI)



*n. of displaced HHs at the 30th year

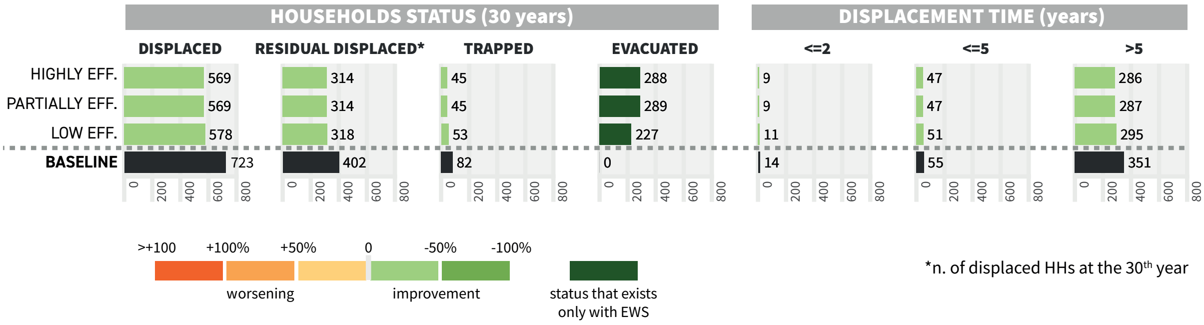
The graphic above compares the baseline situation, in which no policies are in place, to a scenario in which only the Basic Income Programme is implemented.

The most significant difference between the two scenarios is the number of trapped households, which is reset to zero when the Basic Income Programme is in place. This is because all households receive economic support from the government, which reduces the likelihood of not having enough resources to move, thereby preventing people from becoming trapped.

While the Basic Income Programme has a positive impact on the number of trapped people, it does not have a significant impact on the overall displacement dynamics. In fact, the total number of displaced households tends to be higher when the Basic Income Programme is in place. This can be explained by the fact that households with more economic resources can repair flood damage to their homes more quickly and are more likely to return home more frequently, thereby increasing their exposure to future flood events and the likelihood of future displacements. Households with higher incomes may have the means to invest in preventive measures, such as flood-proofing their houses or permanently relocating to safer areas. However, these strategies have not been tested in the current model and may be explored as a future step of the research.

Overall, these findings suggest that the Basic Income Programme alone is not sufficient to effectively reduce disaster displacement risk, except for addressing the number of trapped households, which is reset to zero in this scenario. Additional measures may be necessary to reduce the overall number of displaced households post-event. Indeed, the aim is not to reduce pre-event evacuations but to reduce the number of households forced to move after the event occurred, in emergency situations. evacuations but to reduce the number of people forced to move after the event occurred, in emergency situations.

Early Warning System (EWS)

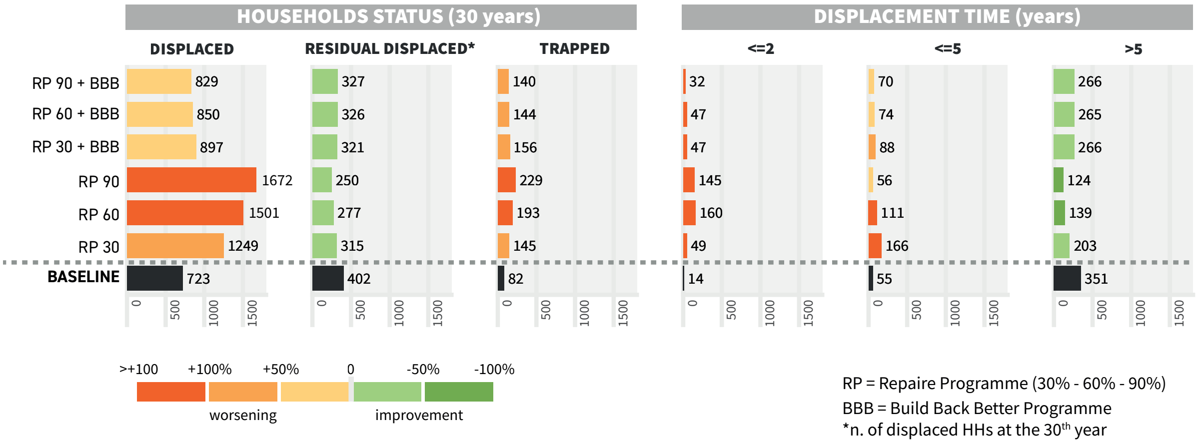


*n. of displaced HHs at the 30th year

The graphic above compares the baseline situation, in which no policies are in place, to three different Early Warning Scenarios. The first one represents a scenario in which a low-efficiency Early Warning System is implemented, which is characterized by a high rate of false negatives (situations in which actual events are not forecasted, not allowing people to be alerted and to evacuate preventively) and a high rate of false alarms (situations in which a wrong Early Warning message is emitted and people potentially evacuated when not necessary). In addition, in the low-efficiency scenario, the level of people's trust in the authority's message is generally low, leading to a lower number of people actually deciding to evacuate after receiving an alert. The second scenario represents a partial-efficiency Early Warning System, characterized by better false negative and false alarm rates and overall higher trust in the Early Warning message. The last scenario represents a high-efficiency Early Warning System, where actual events are almost always correctly forecasted and very few false positive events occur. In this scenario, the level of people's trust is high, leading to a higher number of households deciding to evacuate in case they are alerted.

The graphic shows that implementing an Early Warning System, even if it has low efficiency, is a strategy to significantly reduce the number of households displaced after the flood event and to have a high number of households evacuated before the event occurs. Note that in the graphic the status evacuated represents the number of people who trusted the Early Warning message and decided to evacuate before an event that actually happened. It is also worth noting the gap between the low-efficiency EWS and the other two EW modes. Implementing a partial-efficiency EWS or a high-efficiency EWS would significantly reduce the number of people displaced after the event and increase those evacuating beforehand.

House Repair and Build Back Better Programmes (RP + BBB)



RP = Repaire Programme (30% - 60% - 90%)
BBB = Build Back Better Programme
*n. of displaced HHs at the 30th year

The graphic above compares the baseline situation, where no policies are implemented, with six different scenarios. In the first three scenarios, a House Repair Programme (RP) is implemented at three levels: 30%, 60%, and 90% of damaged houses are repaired. In the other three scenarios, the House Repair Programme is combined with the Build Back Better Programme (BBB), which focuses on reducing the vulnerability of informal buildings to flooding, using better materials.

The results show a significant increase in the number of displaced households when only the House Repair Programme is implemented. This might be attributed to the fact that individuals whose houses were repaired by the authorities returned to their previously affected places of residence earlier. Consequently, they are more likely to be impacted by future flood events, potentially leading to a higher total number of displaced households in these scenarios. Even if it is not assessed in this scenario, it is worth considering that households with higher incomes could be able to implement additional strategies to reduce their risk of displacement at the next flood event.

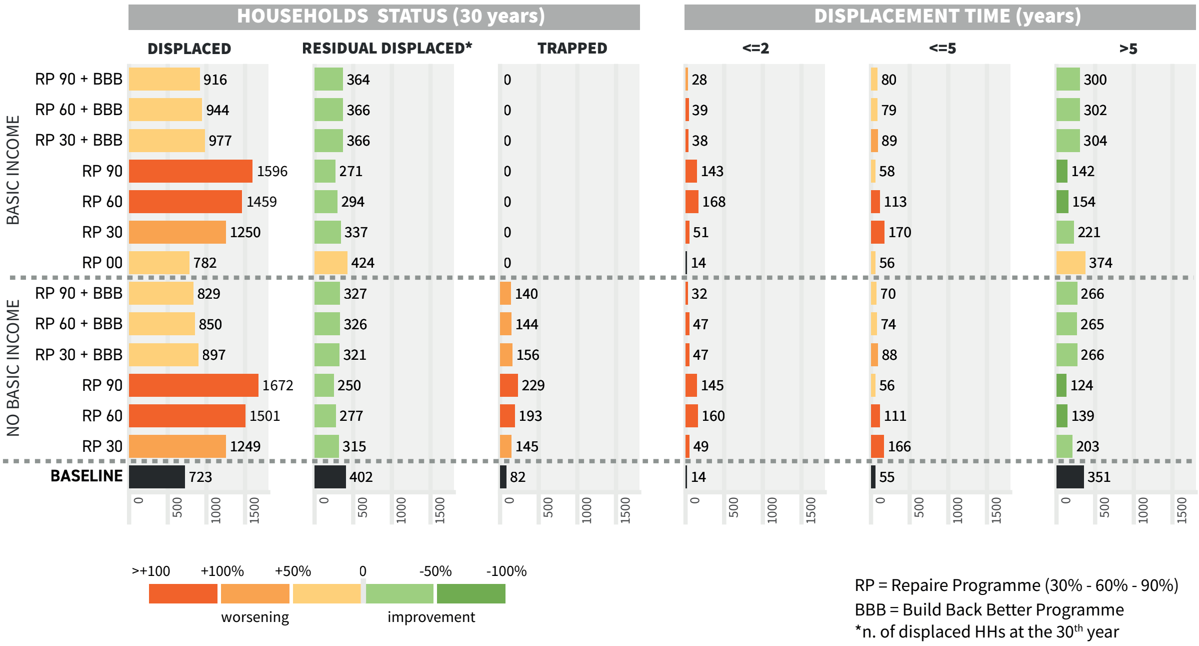
The higher total number of displaced households in these scenarios suggests the need for additional interventions, such as flood-proofing, to complement the House Repair Programme.

Furthermore, the number of trapped people also increases as the percentage of houses repaired through the House Repair Programme rises. This is due to the fact that while the authority supports the reconstruction, it does not provide economic assistance to the households, for example for relocation out of the risk areas. Consequently, people whose houses have been repaired may return to their homes in at-risk areas but have reduced income due to flood damage to their livelihood. When subsequent flood events occur, these people may lack the economic assets to move and ultimately may be at higher risk of being trapped.

Regarding displacement duration, the majority of displaced people stay out of their habitual places of residence for more than five years in the baseline scenario. However, a diagonal shift can be observed: when 30% of damaged houses are repaired, the majority of displaced people stay out of their houses for less than five years; when 60% or 90% of damaged houses are repaired, the majority of displaced people have shorter displacement durations of less than two years, as their homes are more habitable and conducive to living.

When the Build Back Better Programme is implemented together with the House Repair Programme, better results are observed. If the authority builds back better during the reconstruction process, houses become less vulnerable to future flood events and are consequently less damaged. As a result, the number of displaced households is reduced when the BBB programme is in place as well. However, in the event of damage to these improved houses, the recovery time would be longer, leading to longer-term displacements. For example, concrete houses are less vulnerable to floods than mud bricks houses, but, if they are damaged, they need more time for reconstruction.

Basic Income, House Repair and Build Back Better Programmes (BI + RP + BBB)



RP = Repaire Programme (30% - 60% - 90%)
BBB = Build Back Better Programme
*n. of displaced HHs at the 30th year

The graphic above compares the baseline situation, where no policies are implemented, with 13 different scenarios. Following the baseline, the first group of scenarios represents the implementation of the different modes of the House Repair Programme (repair of 30%, 60%, 90% of damaged houses), alone and in combination with the Build Back Better Programme. The second group replicates the same set of scenarios, including also the Basic Income Programme.

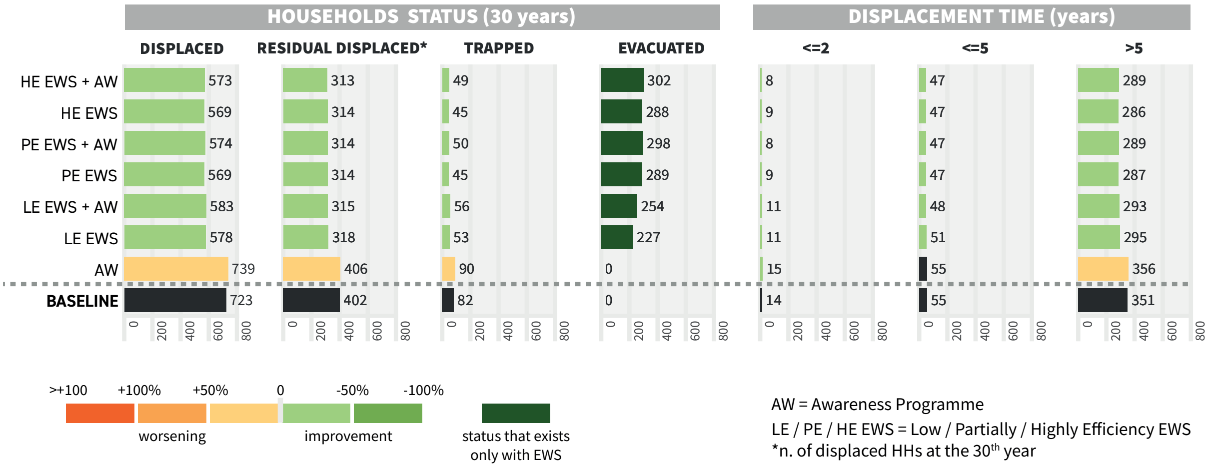
The Basic Income Programme provides economic support to households, particularly those struggling to meet the poverty line. By implementing this programme, a significant reduction in the number of households vulnerable to being trapped can be achieved.

However, the dynamics change when the House Repair Programme is in place too. While the RP focuses on reconstructing houses after floods, it does not provide economic support to households. Consequently, residents whose houses are repaired might return to their houses earlier but still have their livelihoods compromised due to flood-related damage, having an impact on their income as well. In the face of subsequent flood events, these households will have a higher probability of lacking the necessary economic resources to evacuate. In other words, the RP alone tends to increase people's risk of becoming trapped in the long term.

However, the introduction of the Build Back Better programme can counteract this. The BBB reduce not only the extent of house damage but also the households' vulnerability to floods. The absence of a BBB programme leads to an increase in the number of displaced households, regardless of their income level. This is driven by the fact that people recover more quickly from the flood event, prompting earlier returns to their homes, and subsequently exposing them to a higher frequency of being affected by floods.

Displacement duration decreases as the percentage of repaired houses increases. Conversely, it increases if the Build Back Better Programme is implemented, because damages to non-informal settlements take longer to be repaired.

Early Warning System and Awareness Programme (EWS + AW)

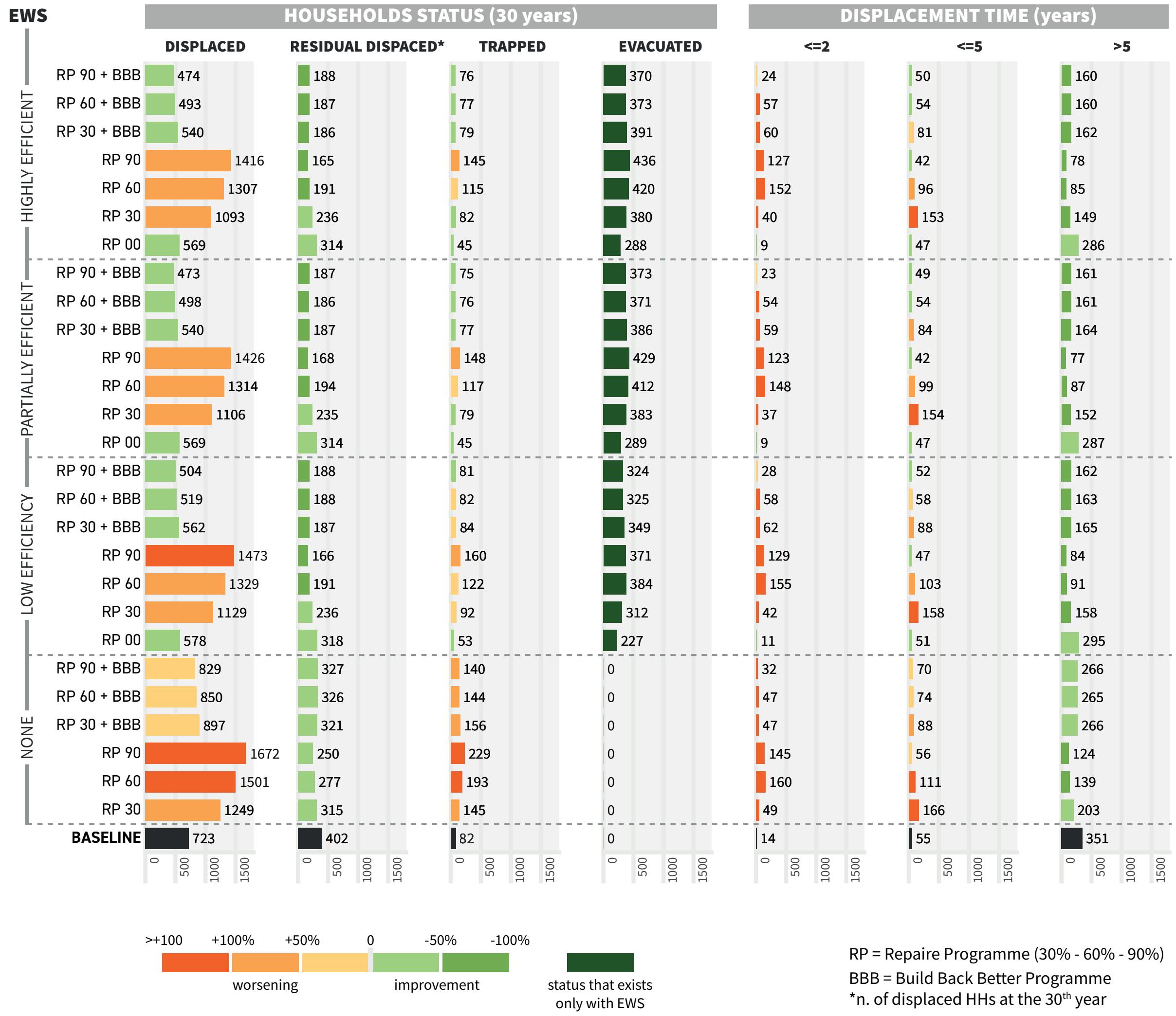


The graphic above presents a comparison between the baseline situation, where no policies are implemented, and seven different scenarios. Following the baseline, an assessment is conducted for a scenario in which only the Awareness Programme is implemented. Then, three pairs of scenarios are examined, in which different levels of Early Warning Systems (low-efficiency, partial-efficiency, high-efficiency) are implemented, both with and without the Awareness Programme.

The graphic indicates that the presence of various levels of Early Warning Systems doesn't lead to a significant divergence in outcomes. This suggests that without sufficient economic support to households, individuals may be willing to evacuate but lack the necessary resources to do that, resulting in being trapped in the affected areas.

On the other hand, the implementation of an Awareness Programme is beneficial in increasing the number of evacuated people. This may be because individuals who have a better understanding of the risks and are more informed about their situation are more likely to take proactive actions and evacuate when necessary. So, when an Awareness Programme is combined with an Early Warning System the effectiveness of evacuations can be enhanced, in terms of saving human lives.

Early Warning System, House Repair and Build Back Better Programmes (EWS + RP + BBB)



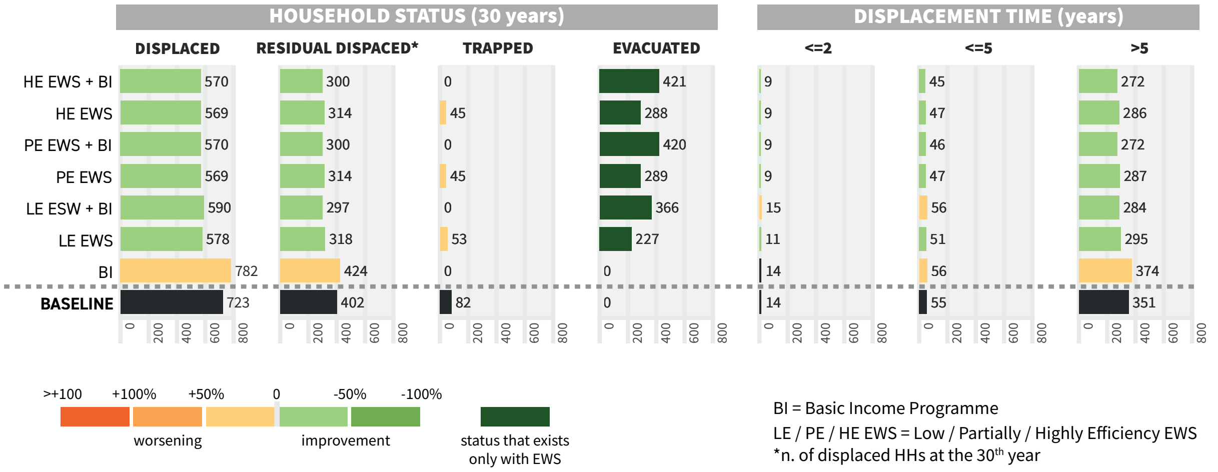
RP = Repaire Programme (30% - 60% - 90%)
BBB = Build Back Better Programme
*n. of displaced HHs at the 30th year

The graphic above presents a comparison between the baseline situation, where no policies are implemented, and other 27 different scenarios. These scenarios encompass various combinations involving different modes of Early Warning System (none, low-efficiency, partial-efficiency, high-efficiency), House Repair Programme, and Build Back Better Programme.

Regardless of the level of the Early Warning System, the presence of the House Repair Programme alone, without the Build Back Better Programme, increases the count of displaced households. This indicates that while repairing damaged houses helps people return to their homes, the lack of measures to improve the structural vulnerability of houses leaves them more susceptible to future flood events.

In terms of evacuations, a more effective Early Warning System contributes to increase the number of households being evacuated, and this effect is amplified when the House Repair Programme is also in place. However, when the Build Back Better Programme is implemented in addition, the number of evacuated households decreases. This is due to the fact that improved housing structures are less vulnerable to floods, resulting in houses being less frequently damaged by floods in a significant way. Nevertheless, this positive reduction in property damage might inadvertently lead to decreased risk awareness among residents. This diminished awareness could influence evacuation decisions, particularly in scenarios with fewer instances of significant damage. The lack of an awareness-raising policy could consequently contribute to a reduction in evacuation occurrences over time.

Early Warning System and Basic Income Programmes (EWS + BI)



The graphic above presents a comparison between the baseline situation, where no policies are implemented, and other seven different scenarios. Following the baseline, an assessment is conducted for a scenario in which only the Basic Income Programme is implemented. Then, three pairs of scenarios are examined, taking into account the different modes of the Early Warning System (low-efficiency, partial-efficiency, high-efficiency), both with and without the Basic Income Programme. The implementation of an Early Warning System alone or in combination with the Basic Income Programme has similar impacts in terms of the number of households displaced and displacement duration.

Early Warning Systems by themselves are effective as they cut the number of trapped households by about half. However, implementing an EWS in combination with the Basic Income Programme has the best impact. Indeed, in this scenario, the number of trapped households is reset to zero, as people under the poverty line receive enough support to make it possible for them to move in the event of a flood.

Concerning evacuation, the best results are achieved by coupling the EWS with the Basic Income Programme. In these scenarios, people have more resources to move to safer places, resulting in a significant increase in the number of people who can actually evacuate before the flood once an alert is emitted, and save their lives.

Conclusions

This report presents an analysis of various policy investments and their potential impact on the number of trapped, evacuated, and displaced households in selected flood-prone areas in Sudan. The analysis underscores the following insights.

The Basic Income Programme stands out for its capacity to reduce the vulnerability of individuals to flood risks by offering economic support, enabling them to move away from flood-prone areas, and reducing their risk of being trapped. However, its effectiveness in reducing vulnerability depends on how individuals use the support. In environments with limited resources, targeted relocation funds may present a more practical solution to ensure the income is used to move out of harm's way. This finding emphasizes that income support strategies must be carefully tailored to the specific needs and dynamics of the affected communities.

The Early Warning System (EWS) emerges as a pivotal element in flood displacement risk management. Its primary role is to reduce exposure by providing timely alerts, facilitating timely evacuations, and potentially saving lives. Even a basic or imperfect EWS, while not ideal, is found to be effective in enhancing evacuations. This finding suggests that an EWS, even if constrained by limited resources, can still be a good investment for governments. Integration of the system with awareness and education initiatives is crucial to ensure that warnings are understood and acted upon.

The Awareness Programme contributes to vulnerability reduction by enhancing risk perception. However, its success is contingent on having an EWS in place to trigger actual evacuations. This illustrates that understanding the risks is not enough; individuals must also have actionable information at the right time. In resource-constrained settings, governments might consider integrating awareness campaigns with existing education or community outreach programmes.

The House Repair Programme presents a paradox: it reduces displacement duration but can increase exposure by encouraging a premature return to flood-prone areas. This underscores the need for holistics approaches, not viewing house repair in isolation. The Repair Programme should be coupled with measures that either reduce structural vulnerability or provide economic support to mitigate the risk of people becoming trapped.

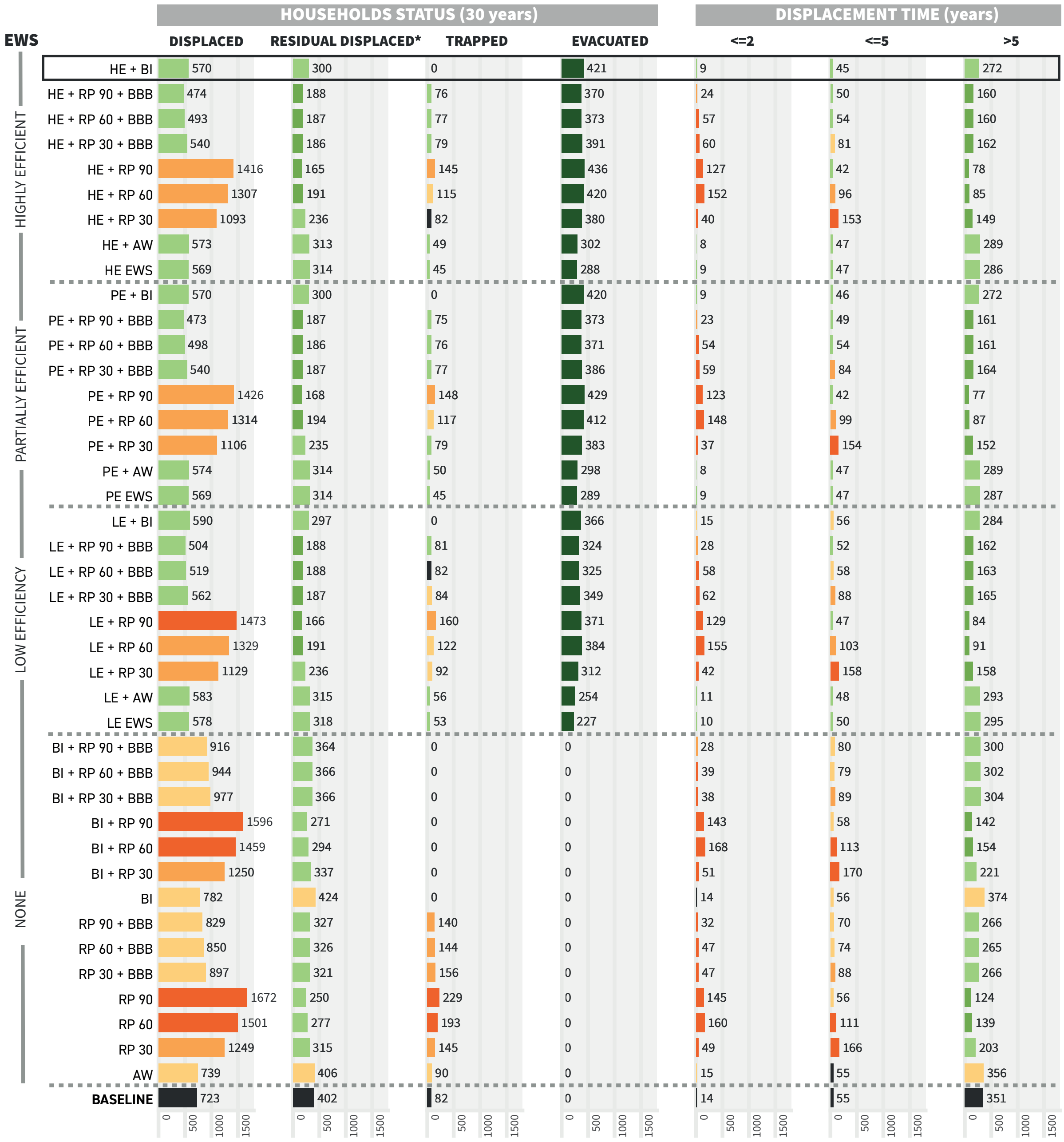
The combination of House Repair and Build Back Better Programmes reduces structural vulnerability over time but does not alter exposure levels. This combination highlights the need for a long-term view focused not just on recovery but on resilience-building. Investments in improvement, although possibly more costly, may prevent recurring damage in the future.

A comprehensive approach integrating EWS, BI, RP, and BBB appears to be the most effective overall strategy, resource-constrained governments should prioritize scalable plans, aiming for incremental improvements in Early Warning System, targeted income support, and long-term housing resilience. The nuanced interdependencies among these policies mean that isolated actions might have unintended consequences, emphasizing the need for careful planning and adaptability.

When the implementation of a comprehensive approach is unfeasible, combining an Early Warning System with the Basic Income Programme appears as the best investment. The Early Warning System is crucial to provide people with timely and adequate information for safe evacuations, while the Basic Income Programme has a powerful effect on reducing the number of trapped households.

In conclusion, the findings of this report based on the decision-making model provide nuanced guidance for policy investment choices in flood-prone areas. They underscore the importance of understanding the specific needs and vulnerabilities of communities and crafting interventions that are both strategic and adaptable. Whether seeking to reduce exposure or vulnerability, or both, governments are encouraged to consider not only immediate needs but also long-term resilience. This careful approach to policy design and implementation can help ensure that interventions are effective, sustainable, and aligned with the realities and constraints of the communities they aim to protect.

ANNEX
Comparison between all the policy scenarios



EWS		HOUSEHOLDS STATUS (30 years)				DISPLACEMENT TIME (years)		
		DISPLACED	RESIDUAL DISPLACED*	TRAPPED	EVACUATED	<=2	<=5	>5
HIGHLY EFFICIENT	HE + BI	570	300	0	421	9	45	272
	HE + RP 90 + BBB	474	188	76	370	24	50	160
	HE + RP 60 + BBB	493	187	77	373	57	54	160
	HE + RP 30 + BBB	540	186	79	391	60	81	162
	HE + RP 90	1416	165	145	436	127	42	78
	HE + RP 60	1307	191	115	420	152	96	85
	HE + RP 30	1093	236	82	380	40	153	149
	HE + AW	573	313	49	302	8	47	289
	HE EWS	569	314	45	288	9	47	286
PARTIALLY EFFICIENT	PE + BI	570	300	0	420	9	46	272
	PE + RP 90 + BBB	473	187	75	373	23	49	161
	PE + RP 60 + BBB	498	186	76	371	54	54	161
	PE + RP 30 + BBB	540	187	77	386	59	84	164
	PE + RP 90	1426	168	148	429	123	42	77
	PE + RP 60	1314	194	117	412	148	99	87
	PE + RP 30	1106	235	79	383	37	154	152
	PE + AW	574	314	50	298	8	47	289
	PE EWS	569	314	45	289	9	47	287
LOW EFFICIENCY	LE + BI	590	297	0	366	15	56	284
	LE + RP 90 + BBB	504	188	81	324	28	52	162
	LE + RP 60 + BBB	519	188	82	325	58	58	163
	LE + RP 30 + BBB	562	187	84	349	62	88	165
	LE + RP 90	1473	166	160	371	129	47	84
	LE + RP 60	1329	191	122	384	155	103	91
	LE + RP 30	1129	236	92	312	42	158	158
	LE + AW	583	315	56	254	11	48	293
	LE EWS	578	318	53	227	10	50	295
NONE	BI + RP 90 + BBB	916	364	0	0	28	80	300
	BI + RP 60 + BBB	944	366	0	0	39	79	302
	BI + RP 30 + BBB	977	366	0	0	38	89	304
	BI + RP 90	1596	271	0	0	143	58	142
	BI + RP 60	1459	294	0	0	168	113	154
	BI + RP 30	1250	337	0	0	51	170	221
	BI	782	424	0	0	14	56	374
	RP 90 + BBB	829	327	140	0	32	70	266
	RP 60 + BBB	850	326	144	0	47	74	265
	RP 30 + BBB	897	321	156	0	47	88	266
	RP 90	1672	250	229	0	145	56	124
	RP 60	1501	277	193	0	160	111	139
	RP 30	1249	315	145	0	49	166	203
	AW	739	406	90	0	15	55	356
	BASELINE	723	402	82	0	14	55	351

AW = Awareness Programme
BBB = Build Back Better Programme
BI = Basic Income PRogramme
LE / PE / HE EWS = Low / Partially / Highly Efficiency EWS
RP = Repaire Programme (30% - 60% - 90%)
*n. of displaced HHs at the 30th year

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