Resilience analysis in Matam, Senegal, 2016

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ACRONYMS

ABS Access to Basic Services

AC Adaptive Capacity

ANSD Agence National de Statistique et de la Démographie

AST Assets

ESAN Enquête Nationale sur la Sécurité Alimentaire et la Nutrition

ESPS I Enquête de Suivi de la Pauvreté au Sénégal I

ESPS II Enquête de Suivi de la Pauvreté au Sénégal II

FA Factor Analysis

FAO Food and Agriculture Organization

FCS Food Consumption Score

FHH Female-Headed Household

GDP Gross Domestic Product

GIEWS Global Information and Early Warning System

HH Household Head

MIMIC Multiple Indicators Multiple Causes

RAP Resilience Analysis and Policies

RCI Resilience Capacity Index

RIMA Resilience Index Measurement and Analysis

RM-TWG Resilience Measurement Technical Working Group

RSM Resilience Structure Matrix

SE-CNSA Secrétariat Exécutif du Conseil National de Sécurité Alimentaire

SEM Structural Equation Model

SNSAR Stratégie Nationale de Sécurité Alimentaire et de Résilience

SRSD Service Régional de la Statistique et de la Démographie

SSN Social Safety Nets

TLU Tropical Livestock Units

UN United Nations

UNDP United Nations Development Programme

WB World Bank

WFP Word Food Programme

EXECUTIVE SUMMARY

Matam is one of the poorest regions of Senegal. Located in the northeast of the country, more than 45 percent of the population of Matam is under the poverty line (ANSD/SRSD, 2015). In this region, agriculture and pastoralism are the largest economic sectors, thus recent climatic changes strongly influence the number of malnourished people. Notwithstanding the numerous advances made in recent decades by the Government of Senegal in terms of increasing education rates and reinforcing numerous forms of infrastructure, such as roads, hospitals and schools, Matam still experiences infrastructure weakness and poor access to numerous basic services. Furthermore, Matam falls behind in a range of human development indicators in comparison to other Senegalese regions.

Nevertheless, a Food and Agriculture Organization (FAO) resilience analysis based on the Enquête de Suivi de la Pauvreté au Sénégal I (ESPS I) found Matam to be one of the most resilient regions within Senegal. While this result may be in line with the typically high levels of adaptive, transformative and coping capacities of the poorest regions around the world, this result still warranted further investigation. Therefore, an ad hoc survey was carried out by FAO Resilience Analysis and Policies (RAP) team in Matam between December 2015 and January 2016, with the support of the Agence National de Statistique et de la Démographie (ANSD). The resilience survey was conducted within 410 households within the districts of Ranérou, Matam and Kanel in Matam Region.

This report primarily aims to highlight the main pillars of resilience and their contributing factors at the household level using the second iteration of the FAO Resilience Index Measurement and Analysis (RIMA) methodology – Resilience Index Measurement and Analysis II (RIMA-II). The second part of the analysis studies the role of geo-climatic variables, shocks and other household characteristics in relation to food security and resilience capacity. Finally, the results are analysed in light of both the policies already implemented in Matam and future policies that could potentially be designed and implemented, taking into consideration those social and geographical groups that were shown to be less resilient in this report.

Key highlights

The main outcomes from the Matam RIMA-II quantitative analysis show that resilience is mainly positively affected by the resilience pillars of Access to Basic Services (ABS) and Adaptive Capacity (AC). In particular, **distance from health centres; access to schools** and **provision of basic services** (such as access to safe water and electricity) are particularly relevant for ABS. Meanwhile, **education** and the **ratio between active and non-active household members** play a major role for AC.

Livelihood analysis was determined by self-reported classification (i.e. families self-identifying their own livelihood strategy). Farmers and those using a mix of different livelihoods (which include many activities typical in urban environments) are the most resilient, while agro-pastoralists record the lowest level of resilience capacity. The resilience of farmers and those using a mix of different livelihoods is mainly attributable to education, better access to infrastructure, and the possibility of relying on a **communitarian support network**.

Based on the assumption that a household can be considered resilient if it manages to achieve a sound level of access to food, a regression analysis on food security determinants was run. Factors such as access to electricity, access to safe waste disposal, proximity to a traditional healer, wealth index and education have a positive and significant impact on the Food Consumption Score (FCS). Furthermore,

the presence of more open decision-making processes within the household's community and the perceived well-being of the household are also beneficial to the FCS. Finally, minor environmental stresses to agriculture and an abundance of rain have a positive effect on household FCS and weekly food expenditure.

Interestingly, social inclusion, measured as involvement of the community in the decision-making process and perceived well-being, emerges as a key determinant of food security and resilience. This result warrants further investigations to study the link between perceived well-being and resilience. This is especially relevant in a remote area such as Matam, which experiences a high migration rate and the consequent reshaping of the community and people's sense of belonging.

Important findings emerge from the qualitative analysis that was carried out along with the quantitative analysis through focus group interviews. The stronger the shock, the more likely the household will sell important assets, as reported in the qualitative assessment provided for Matam. There, 86 percent of households have some livestock, and numerous households reported to have sold part of their livestock in order to cope with shocks resulting from climate or from an increase in food prices.

The analysis showed that agro-pastoralist households have the lowest level of resilience compared to farmers and "mixed-livelihoods", also referred to as "others". This could be because they are 'mobile' and are mainly found in rural areas where there is limited access to basic services (electricity, water, healthcare services and schools/education). Their asset base also seems to be limited as the population of livestock has greatly declined since 2010, as households sold most of their livestock to cope with climate-related shocks and soaring food prices.

Any programme that will be implemented in Matam should aim at lifting 2/3 of the people in rural areas from below the poverty level- the majority of whom are agro-pastoralists. The programme should mainly focus on education – primary, secondary and tertiary or vocational education, looking at infrastructure development, curriculum development, remuneration or motivation, and improvement of facilities, as focusing on primary education alone cannot make a fundamental change in strengthening the resilience capacity and well-being of the population – and an increase in production per unit area of the main staple foods and commercial crops, as well as livelihoods diversification and income generation.

Policy implications

The main **policy indications** regard the provision of access to infrastructure. This is particularly relevant for those that guarantee access to electricity, education and health services. Investing in education should be at the centre of the development of all new policies; interventions in strengthening school infrastructure with the provision of buildings and teachers can guarantee positive outcomes for development and resilience in the long term. The provision of regular and accessible clinic services could ensure a healthier population, which, ultimately, would translate to a higher rate of participation in both educational courses and income-generating activities.

Greater social inclusion (by supporting the inclusion of marginalized groups) and strengthening local support networks (such as micro-credit groups, informal associations, and self-help groups) will reduce the adoption of negative coping strategies and risky behavior (i.e. the deterioration of assets).

Agro-pastoralists should be specifically targeted with policies and programmes aiming at strengthening their resilience. Investments should in particular be dedicated to raising their level of education and access

to basic services and infrastructure (in particular, productive infrastructures such as markets, roads and service providers including veterinarians, input provision, etc.). Despite their low resilience capacity, agro-pastoralists showed a high level of community support networks, making this the best group for a community-based social protection programme given they are already working closely together to address issues that affect them. Social protection-related interventions, including cash-based interventions, specifically targeting those populations also need to be strengthened. These would complement communitarian support networks, which are shown to have an important influence on their resilience level. The shock responsiveness and flexibility of such social protection programmes and/or systems should be built in upon commencement of such programmes to ensure that support can be scaled up in the event of climate-related and other types of shocks (in order to reach more beneficiaries or provide added handouts).

Interventions such as providing support to community-based civil society organizations and local media, and raising awareness on transparent decision-making processes at the community and local levels, as well as running information campaigns to build accountable institutions at the local level should be prioritized. These will contribute to improving social inclusion and the involvement of communities in the decision-making process, which are two dimensions that emerge in this analysis as determinants of resilience.

The provision of basic social services of adequate quantity and quality is key to improving resilience in the Matam region, particularly to ensure that the region, currently lagging behind in comparison to other Senegalese regions, catches up with other regions in terms of human development indicators. This is particularly the case for health-, education-, safe water- and electricity-related services, which have important social impacts, but also economic and productive impacts. Access (in particular for women and girls) to and the quality of education and health services are especially crucial.

Demography is a critical factor to explain househol resilience level, as highlighted by the relevance of the ratio of active to non-active population in households in the analysis. Demography-related interventions such as family planning, sexual and reproductive health, female empowerment, the education of girls, and raising awareness among youth might be important features of resilience enhancement strategies in the context of Matam.

The analysis shows that strong shocks are more likely to force households to sell important assets, such as livestock. In the face of recurrent shocks, particularly those are climatic and economic, it is important to develop strong information and early warning systems, including at these community level. These should combine multidimensional sources and be able to trigger early action to prevent and mitigate the impacts of shocks with a sound cost-effectiveness ratio.

The Matam region experiences only one rainy season per year. Adequate rains in quantity and geo-spatial distribution are therefore critical as they influence the complete 12 months of annual agro-pastoral production. Interventions to improve land and water conservation, restore degraded land and increase water harvesting, should also be prioritized for their direct influence on the livelihoods of farmer, agro-pastoralist and pastoralist communities. Such interventions also prevent shocks and mitigate their impacts in case of low rainfall. Investments in climate resilient agricultural best practice, including but not limited to drought-tolerance, quality seed system and pasture area rehabilitation, is also crucial to maximize production levels in this context of limited rainfall.

Strategies to diversify livelihoods and income sources should be promoted and supported, as the analysis shows that households with a mix of different livelihoods (which include many urban activities) are typically more resilient. Reducing the overall livelihood risk profile is key, which means also diversifying into off-farm activities and other activities that are not dependent on climate factors.

Finally, the adoption of natural resources management training would enable better maintenance of the environment. As a consequence, sustainable soil and vegetation utilization could be put in place, which ultimately may reduce land degradation.

1. Purpose of the analysis

This section introduces background information on the Matam region, and explains why resilience analysis has been carried out in this region of Senegal.

Despite the economic growth experienced by Senegal in the last thirty years, a high proportion of the Senegalese population still lives below the poverty threshold, and 15.5 percent of people were still food insecure in 2013 (FAOSTAT, 2016).

Senegal is one of the most stable countries in Sub-Saharan Africa, from both political and economic perspectives. After the country became independent from France in 1960, it has experienced an increasing democratization of its institutions. In 2015, Senegal become the second fastest growing economy in West Africa after Côte d'Ivoire (WB, 2016), with an economic growth rate of 6.5 percent. Still, numerous human development indicators for the country need improvement. Senegal ranks 154 out of 187 in terms of the Human Development Index (HDI), even if in the last 35 years this figure grew at an annual rate of 1.2 percent, implying a constant path of improvement. Life expectancy in 2014 was 66.4, while in 1980 was 47.3, and the female labor force made up 45 percent of the total in 2014, while in 1990 was 41.8 percent (WB, 2016).

Senegal has successfully improved its access to education in recent decades, going from a 68 percent primary school enrolment rate in 2000 to 81 percent in 2010.[1] However, this sector still needs substantial interventions, especially in rural areas and in the case of young girls. However, from the Enquête de Suivi de la Pauvreté au Sénégal II (ESPS II), ANSD found that 66.2 percent of household sheads (HHs) never received formal education since they were outside the target age range of recent policies pursuing education for all. In particular in remote rural areas, Koranic schools are often the preferred option, however these are not considered part of the formal education system.

However, economic and social inequality is particularly evident in terms of geography, especially between rural and urban areas; in rural areas, two out of three people live under the poverty line, while in urban agglomerates such as Dakar the ratio is one out of four (WB, 2016), suggesting that major interventions should be focused on rural areas.

FAO had previously undertaken a resilience analysis of Senegal in 2015 using two datasets provided by the ANSD, that is the ESPS I and ESPS II mentioned previously (ANSD 2005 and ANSD 2011, the results of which provided a clear framework for resilience interventions. One of the key findings of the analysis was the so-called Matam Paradox (explained in further detail below), which gave rise to this present analysis given its unusual nature.

In 2012, more than 45 percent of the entire population of Matam (58 462 households) was below the poverty line (ANSD/SRSD, 2015) and in 2014 around 38 percent was classified as food insecure (WFP, 2014). The average food share (share of food expenditure out of total household expenditure) in Matam is 52 percent, which this translates to high exposure to food price volatility. Moreover, since 2010,

[1] See World Bank data at: http://data.worldbank.org/indicator/SE.PRM.ENRR?locations=SN

Matam has been the Senegalese region with the highest rate of malnourished people, making up between 14.1 and 18.8 percent of its population since 2011 (WFP, 2014).

Matam is located in northeast Senegal, covering one seventh of the area of the whole country. Its economy is still strongly linked to the agricultural sector, which employs more than 70 percent of the population and contributes to more than 40 percent of the regional Gross Domestic Product (GDP). The agriculture industry is still based on traditional techniques and is rain-fed, making it very vulnerable to climatic changes and dependent upon seasonal rainfall distribution and volume. In the case of climatic shocks, such as drought or floods, this dependence on traditional farming methods can lead to higher rates of malnutrition and food insecurity. Therefore, Matam is characterized by a wide rainfall variability and is the region most affected by droughts (USAID, 2016). In the event of climatic shocks, such as droughts (from 2006 to 2011 (WFP, 2014)) and floods (in 2009 and 2012 (WFP, 2014)), this can translate to higher rates of malnutrition and food insecurity.

47.3 percent of the Matam population is younger than 15 years old. Rates of scholarization increased in the last twenty years, especially in remote areas, where the primary education enrolment rate rose to 88.2 percent in 2013 (ANSD/ SRSD, 2015). However, for higher levels of education, such as the *cycle secondaire* ('secondary school') the enrolment rate remains at just 14.54 percent. Among the main issues related to the lower rate of education in Matam compared to the national rate, the most relevant and region-specific are the lack of teachers and infrastructure, and the difficulty providing consistent education to nomadic groups, especially in the Ranérou district (ANSD/SRSD, 2015).

Moreover, Matam is the least populated region of Senegal (with 3.8 percent of the total Senegalese population), with a high rate of migration to other regions or cities within Senegal, primarily to Dakar, and of emigration outside the country (ANSD, 2011). The region is divided into three districts: Matam, Ranérou and Kanel.

[insert here map of Senegal with Matam region colored here]

The Matam Paradox originated when, despite all the above-mentioned factors, Matam emerged as one of the most resilient regions in Senegal during the resilience analysis carried out using ESPS I and ESPS II (FAO, 2016). This motivated a proper analysis to be designed specifically for the Matam scenario.

The region bears strong potential for economic growth given its mines, agro-pastoral resources and the increasing number of cash remittances arriving to Matam from workers who have left for Dakar and outside the country to seek work.

This analysis applies the FAO RIMA-II model, using a dataset collected ad hoc by the FAO RAP team and ANSD, carried out between December 2015 and January 2016. This additional survey will be referred to hereafter as the FAO-ANSD survey.

RIMA-II conceives resilience as composed of the following resilience pillars: ABS, Assets (AST), Social Safety Networks (SSN) and AC. Other indicators (established with the collaboration of ANSD) were included, such as the perception on the involvement of each household in the decision-making process of the village, perceived well-being and coping strategies for dealing with shocks. This information can be used to

understand the governance mechanisms within the community, as well as acting as a proxy of the inclusiveness of local institutions.

Data have been collected using Computer Assisted Personal Interviewing (CAPI) technologies. In addition to the data collected through the FAO-ANSD survey, geo-climatic data from a different dataset – the Global Information and Early Warning System (GIEWS) Earth Observation[2] – have been utilized in order to control for climatic changes and the effect of seasonality.

In addition to quantitative data, this report includes qualitative data collected through focus groups and open-ended interviews regarding the perceived main area of vulnerability at household and community levels, as well as the strategies employed to respond to shocks.

This report is structured as follows: Section 2 presents the methodology; Section 3 gives details on the data employed; Section 4 shows the descriptive analysis of resilience structure; Section 5 shows the causal analysis, wherein food security indicators and geo-climatic variables are utilized; finally, Section 6 concludes with policy recommendations.

2. Resilience measurement

This section introduces the FAO resilience measurement framework. It describes the RIMA-II approach and provides details on the resilience pillars and variables used in the analysis.

RIMA-II is based on the definition provided by the Resilience Measurement Technical Working Group (RM-TWG):[3] "Resilience is the capacity that ensures adverse stressors and shocks do not have long-lasting adverse development consequences" (RM-TWG, 2014).

The RIMA-II methodology is made of two parts:

- the descriptive measure gives a description of household resilience capacity and contributing factors through the estimation of the Resilience Capacity Index (RCI) and Resilience Structure Matrix (RSM). These can be used to rank and target households for policy design and implementation; and
- the causal measure of resilience provides a causal analysis of the determinants of resilience and food security, including the effects of shocks and geo-climatic variables.

RCI and RSM are estimated using a two-stage procedure. A set of pre-determined dimensions, referred to as pillars, are estimated through Factor Analysis (FA) from observed variables (see Figure 1). RIMA-II employs four pillars: ABS, AST, SSN and AC (FAO, 2016b). Table 1 reports each pillar's definition and which variables have been utilized for the estimation. In the second step, the RCI is estimated using the Multiple Indicators Multiple Causes (MIMIC) model (see Table A9).

[2] Global Information and Early Warning System on Food and Agriculture (GIEWS) monitors the condition of major food crops across the globe to assess production prospects. To support the analysis and supplement ground based information, GIEWS utilizes remote sensing data that can provide a valuable insight on water availability and vegetation health during cropping seasons. See:
www.fao.org/giews/earthobservation/country/index.jsp?lang=en&code=SEN

[3] The RM-TWG has been established under the Food Security Information Network (FSIN).

The RCI was rescaled in order to range from 0 to 100. This helps the interpretation of the findings and facilitates the comparison of different household profiles.

In an attempt to avoid endogeneity,[4] income is not directly included in the estimation models. Nevertheless, all the income-generating variables are included in the model in order to properly account for the households' income generating capacity.

The list of variables to be included in the estimation procedure was discussed and agreed on together with FAO Senegal, ANSD and Secrétariat Exécutif du Conseil National de Sécurité Alimentaire (SE-CNSA).

Table 1 Resilience pillars

Pillars of resilience	Definition	Variables
ABS	ABS shows the ability of a household to meet needs, such as accessing toilets, water and electricity, and distances in minutes from markets, schools and other types of infrastructure.	Electricity; improved toilet facility; improved waste disposal facilities; proximity index to school, hospital, water source, market, healthcare, traditional healer and public transportation.
AST	AST are the key elements of a livelihood. Productive assets (mainly land and livestock) enable households to produce consumable or tradable goods. Non-productive assets (house, appliances) are an important determinant of household well-being.	Wealth index;[5] land in hectares; Tropical Livestock Units (TLU);[6] harvested crops; agricultural asset index.
SSN	SSN measures the ability of households to access timely and reliable assistance provided by international agencies, charities and non-governmental organizations, as well as help from friends and relatives.	Cash transfers; in-kind transfers being part of a credit group; support of relatives in case of financial distress; amount of loans.

[4] Endogeneity occurs when an estimation model seeks to measure a phenomenon through its indicators, i.e. the risk of causality between the independent and dependent variables (FAO, 2016b).

[5] Wealth index is created through FA using a list of dummy variables depending on whether the household owns items such as a bed, fan, television, computer, mobile phones, and so on.

[6] TLU standardizes different types of livestock into a single unit of measurement. The conversion factor adopted is: 1 camel; 0.5 cattle; 0.6 horses/donkeys/mules; 0.1 sheep/goats; 0.01 chickens; 0.2 pigs.

AC	AC is the ability of a household to adapt to a new situation and develop new sources of livelihood. Having active and educated members, for example, may decrease the negative effects of a shock on a household.	Education; dependency ratio;[7] participation index;[8] literacy level; community influence in decision making; perceived well-being.[9]

The causal part of RIMA-II employs two food security indicators: FCS and weekly food expenditure (see Table 2). Food expenditure captures the monetary value of food consumption, while FCS focuses more on dietary diversity and meal frequency (WFP, 2008).[10] The combination of food security indicators provides a sound understanding of the food security situation. However, other food security indicators were tested during the course of this analysis, which offered similar results.

Table 2 Food security indicators

Food Security indicators	Definition
Weekly food expenditure	Monetary value, expressed in US dollars, of food items purchased by the household in the last 7 days.
FCS	A score calculated by summing the weighted frequency of consumption of different food groups consumed by the household during the 7 days before the survey. The standard food groups and weights (in parentheses) are the following: main staples (2), pulses (3), vegetables (1), fruit (1), meat and fish (4), milk (4), sugar (0.5), oil (0.5) and condiments (0) (WFP, 2008).

[7] The dependency ratio is calculated as the ratio of the number of people in working age to the number of people who are not employable within the family.

[8] The participation index is built through FA, using dummy variables assuming value 1 or 0 depending on whether or not the household has received a salary, or received income from agricultural, farming or other activities.

[9] Perceived well-being has been calculated through FA using a list of variables considering a scale from 0 to 4 in terms of how often the HH feels relaxed, active, interested, etc.

[10] Indeed, food expenditure can show how households cope with changes in food market prices, which have been very volatile in recent years, throughout the whole country. Only 40 percent of food items retained the same or had reduced prices in Matam between 2013 and 2014 (WFP, 2014).

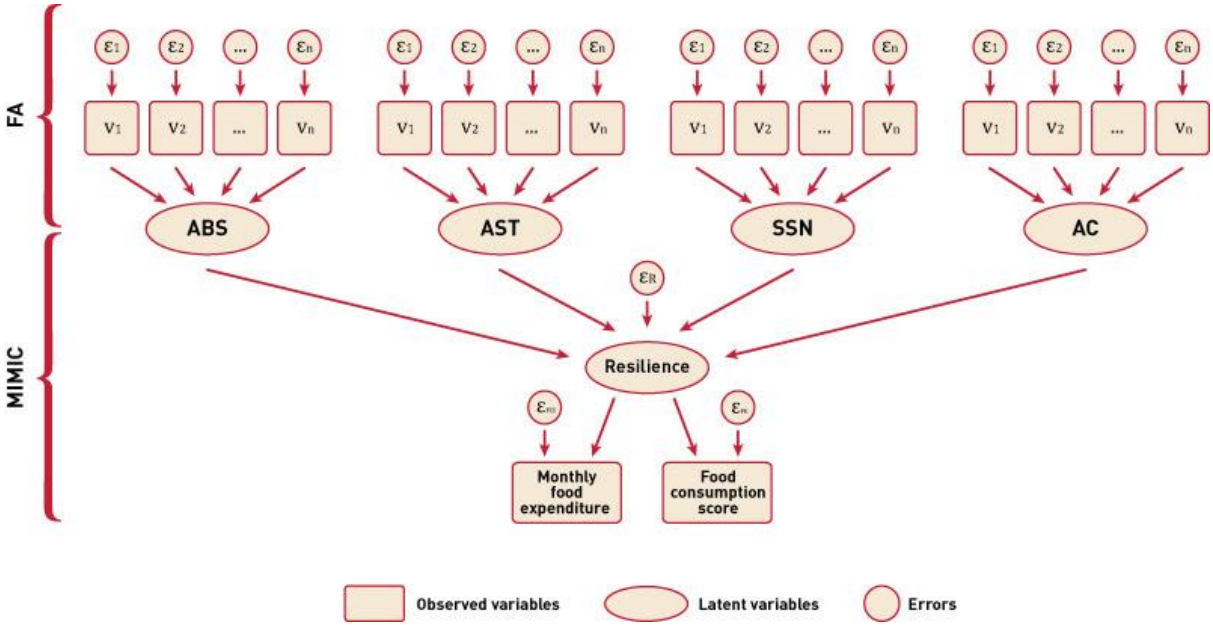

Figure 1 Resilience index and pillars

3. Data

This section describes the dataset employed in the resilience analysis, based on the FAO-ANSD survey carried out in the Matam region in December 2015 and January 2016. This section also introduces both the strengths and limitations of the dataset. Additional data sources on covariate shocks and geo-climatic variables are introduced as well.

For this analysis, the ad hoc FAO-ANSD household survey was designed and implemented in the Matam Region during November 2015 and January 2016. The primary purpose of the survey was to capture households' resilience capacity through the implementation of a multi-dimensional questionnaire. As a result of the mixed-method approach adopted by FAO,[11] a qualitative data collection was carried out in a sub-sample of villages; focus groups and community discussions were held in order to provide a deeper understanding of which shocks are the most damaging, of the community's decision process, and of the most urgent needs as perceived by the households.

The total sample counts 410 observations and is representative at the regional level; the household selection was made in collaboration with ANSD; the sampling framework utilized was that used for the Senegal National Census in 2014.

The FAO-ANSD survey investigates numerous aspects of household livelihoods, collecting information on detailed household characteristics, productive and non-productive assets, dwelling characteristics, education and health levels, social networks and social safety nets, including credit history, access to basic services such as schools or markets, food and non-food consumption and income-generating activities. The questionnaire was created by FAO in collaboration with ANSD. The most context-specific sections have been designed during workshops with field staff, as in the case of the Coping Strategy Index.

The definition of 'household' employed in the analysis created by the FAO RAP team is the following: "*a household is formed by all the people living in the same hut or home, related or not by blood lines (family) and sharing food, food expenses, income and other household assets for at least 6 of the 12 months preceding the interview. Therefore, the membership of the household is defined on the basis of the usual place of residence".*

All the interviews were carried out using a tablet computer and the Open Data Kit technologies for data collection and data entry; each enumerator was equipped with a tablet. The adoption of new technology reduces the time needed for interviews, lowers the rate of data collection errors, reduces data entry errors and provides for adequate quality control of data collection almost in real time.

The qualitative data collected in the field through focus groups was aimed at exploring the main constraints to resilience capacity at the community level and which coping strategies are implemented. The qualitative investigation was carried out from the 29th of December 2015 to the 9th of January 2016, conducting eight focus groups and ten in-depth interviews. These interviews covered previous situations of household vulnerability, the most frequent shocks faced, and which coping strategies were adopted in response.

[11] The mixed-method approach (d'Errico, Lee and Reidy, 2013) integrates quantitative and qualitative data collection tools, based on the assumption that none of these approaches can suffice alone for providing a clear understanding of resilience.

The shocks considered are both covariate (affecting the entire community) and idiosyncratic (affecting the household only). While the latter were collected through the quantitative household questionnaire, this analysis employs geo-climatic variables at the district level in order to include climatic shocks. Geo-climatic variables were provided by GIEWS, data for the last 30 years from the Normalized Difference Vegetation Index (NDVI)[12], the ASI (Agricultural Stress Index),[13] and data on rainfall variation.[14]

4. **Descriptive** resilience analysis

This section provides the resilience analysis results. Firstly, it describes the analysis of the RSM in the region of Matam, elaborating on the relevance of each pillar in explaining the RCI. Then, it presents the results disaggregated by urban status, gender of HH and livelihood, identifying and explaining existing differences in resilience capacity between different household profiles.

4.1 Analysis at the macro level

The most relevant pillar for the Matam region is ABS, followed by AC. SSN and AST have a minor role in explaining the RCI (see Figure 2).[15]

[12] The NDVI is a graphical indicator that can be used to assess whether the target being observed contains live green vegetation or not. See: www.star.nesdis.noaa.gov/smcd/emb/vci/VH/vh_browse.php

[13] The ASI helps show how 'stressed' crop areas are by combining vegetation condition and temperature variables. See: www.fao.org/geonetwork/srv/en/metadata.show?id=12691

[14] Rainfall variability at a time scale from years to days is as much a characteristic of climate as the total amounts recorded. Low values, however, do not necessarily lead to drought, nor is drought necessarily associated with low rainfall. Agricultural drought occurs when water supply is insufficient to cover crop or livestock water requirements. In addition to reduced rainfall, a number of factors may lead to agricultural drought, some of them not always obvious. See: mars.jrc.ec.europa.eu/mars/About-us/FOODSEC/Data-Distribution

[15] The radar graphs reported in this analysis represent the relevance of shocks or variables using their correlation with the RCI (for the pillars) and the pillars (for the variables).

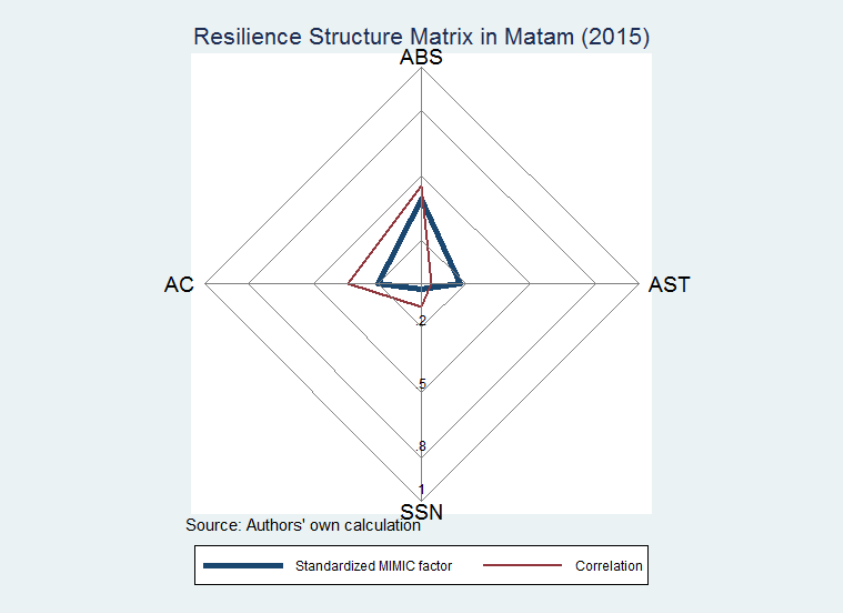

Figure 2 RSM – Loading and correlation of factor (SEM) in Matam (2016)

The most important variables for ABS are the **distance to healthcare centres**, the presence of **electricity** in the house, **distance to schools** and distance to a drinkable **water** source (see Figure 3, showing the correlation between ABS and the observed variables). In relation to access to electricity, 46 percent of the sample analysed has access to electricity, while at the regional level, official statistics show that the population with access is only 13 percent (see Table A3 in annex for sample statistics and ANSD/SRSD, 2015 for regional statistics). Senegal has generally good access to drinkable water compared to other Sub-Saharan countries (ANSD/SRSD, 2015), however, the Matam region is an exception. Only the district of Matam has enough drinkable water to satisfy demand, while Ranérou and Kanel cannot meet the water needs due to the lack of investment in managerial and technical skills in the sector (ANSD/SRSD, 2015).

Lack of infrastructure and difficult access to existing infrastructure are two keys weaknesses for household resilience. ABS uses distances to services as a proxy for accessibility. The outcomes showed in Table A3 in the annex depict a situation of great difficulty in services utilization. Matam is characterized by inadequate road networks, which contributes to the region's isolation and reduces access to even basic services like hospitals or high schools (ANSD/SRSD, 2015).

The second main relevant pillar of resilience is AC. AC is mainly influenced by the number of years spent in **education, literacy level and the dependency ratio. Therefore, access to education, which ultimately can translate into being able to actively contribute to supporting a household, is a key aspect of resilience for the Matam region**. This is a key finding, which correlates with recent efforts put in place by Senegalese institutions. Education is still inaccessible to a large proportion of people in Senegal, especially in a poor region like Matam, even if the national rate of receiving an education is increasing (ANSD/SRSD, 2015). Moreover, Gallopín (2006) shows that the higher the literacy rate, the higher the adaptive capacities; meaning that having a high literacy rate increases the capacity to react and adapt to perturbation and shocks in order to maintain the same level of well-being.

In the sample analysed in this report, the average years of education within the household is two (see Table A3 in the Annex). However, in the last ten years, the amount of school infrastructure built increase by almost 250 units thanks to public investments and remittances from emigrants (ANSD/SRSD, 2015). In addition, more teachers have been hired in order to reduce the ratio of students to educators, considering that in Matam there are still only around 3 300 teachers for every 86 850 students (ANSD/SRSD, 2015). In conclusion, many efforts towards improving education are ongoing, but more work is still needed in this area.

Other relevant aspects of AC are how much the **community** can influence the public sector in order to gain improved services and how much the whole community is involved in the **decision-making process** (see Figure 6). Generally speaking, these indicators look at the participation of the population in the decision-making processes. It is interesting to note that these indicators are collected through self-reported perception of inclusion. The results indicate that people are more resilient when they can actively contribute to community life. Most likely, this ultimately translates to a broader sense of communitarian life, which includes relying on each other in the case of difficulties.

AST is the third most relevant pillar of resilience. Figure 4 shows that the most important components are the **wealth index**, amount of **agricultural output harvested**, **cultivated land** and **agricultural asset index**. The agricultural sector remains an important source of income and component of resilience for numerous households in Senegal (ANSD, 2011) even though ithas recently faced a range of challenges, from the high urbanization rate that draws the workforce away from work in agricultural operations, to the climatic disasters affecting the country. However, Matam is one of the regions with the highest employment ratio in the sector, with around 70 percent of households involved in farming activities (WFP, 2014).The relevance of cultivated land in terms of resilience capacity has been also found in the 2011 resilience report on Senegal (FAO, 2016), confirming its pivotal role in rural areas.

Finally, SSN does not have a significant role in determining the actual level of resilience in the Matam region. As always, it is important to mention that this is a cross-section analysis which does not look at long-term dynamics; something that is not relevant in December 2015 may become fundamental in supporting resilience if explore using panel data analysis, which would be able to observe resilience dynamics over time rather than in a specific point in time. Being part of a **credit group, having obtained the desired amount of credit,** and the possibility of financial assistance from **relatives** are the most important components of SSN (see Figure 5). Having formal or informal access to financial credit is crucial to household survival in many Senegalese regions, especially in rural areas where climate shocks can strongly influence agricultural output, as in the case of Matam. For most of the rural economy, the tendency to access informal credit in case of crop failure may turn into a negative coping strategy that compromises household capacity to return its previous level of well-being (Fadiga and Fadiga-Stewart, 2004). This is the case in many Sub-Saharan countries, where farmers pre-sell their crop to sellers and face enormous difficulties when crop failure does occur. This is closely correlated with the other relevant indicator of SSN – the importance of relatives as an informal safety net may indicate the chronic lack of institutional social safety nets, especially in remote areas (Fadiga and Fadiga-Stewart, 2004). Indeed, institutional social security only reaches 13 percent of the Senegalese population (OECD/WB, 2015) with the majority of beneficiaries residing close to the Dakar region.

SSN and social protection in rural areas of Senegal have received increasing attention in the relevant literature and from policy makers, given their key role in reducing poverty and vulnerability (Ndiaye *et*

al., 2015). Moreover, since the recent economic downturn experienced in Senegal after the financial and food price crises of 2008, a parallel set of informal financial institutions has spread in particular where formal credit institutions were not accessible to the poor (Fadiga and Fadiga-Stewart, 2004).

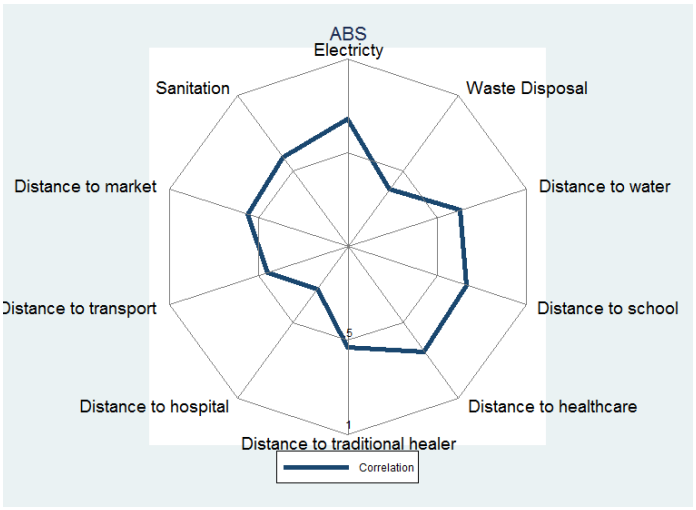

Figure 3 Resilience structure – Variable weights in ABS in Matam (2016)

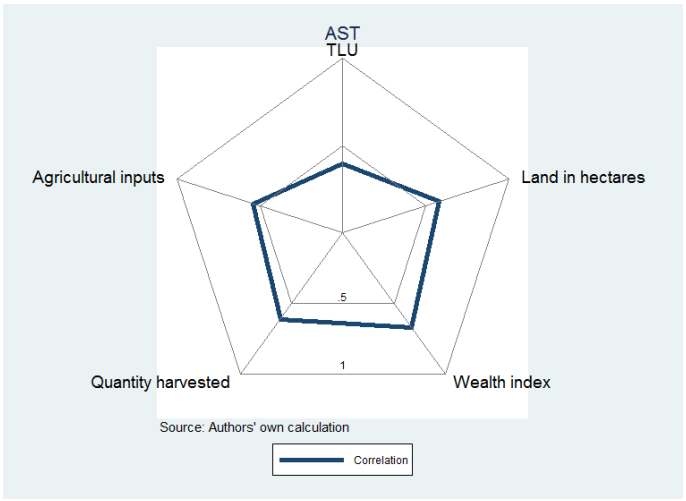

Figure 4 Resilience structure – Variable weights in AST in Matam (2016)

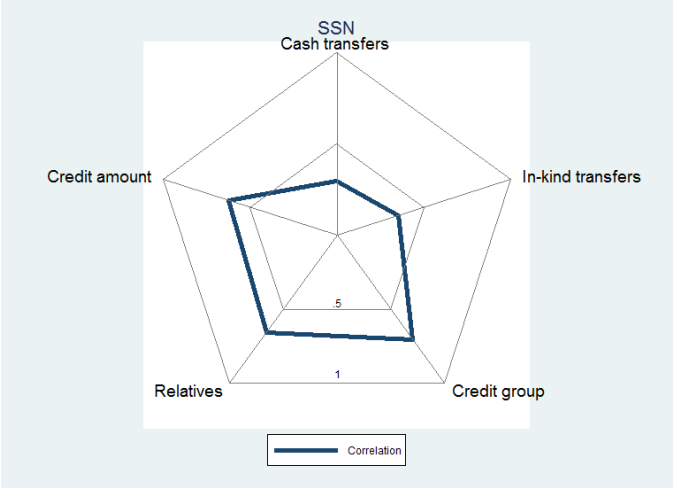

Figure 5 Resilience structure – Variable weights in SSN in Matam (2016)

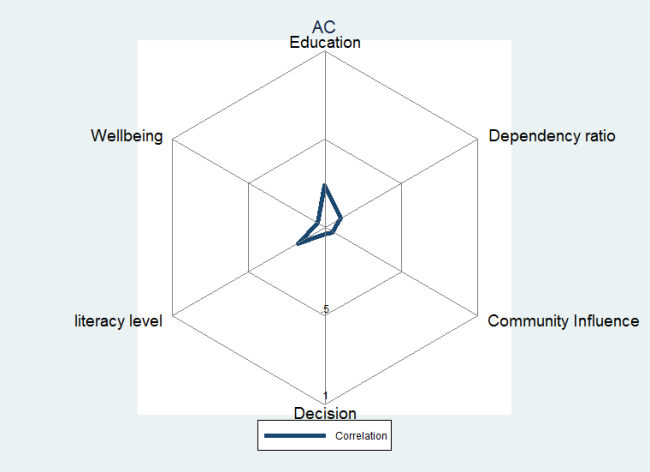

Figure 6 Resilience structure – Variable weights in AC in Matam (2016)

4.2 Resilience at the livelihood level

In this analysis, household livelihoods are self-reported by the person interviewed; there are three categories – agro-pastoralists, farmers and mixed-livelihoods (which includes households relying on fishing, households' defining themselves as urban, and households describing themselves as 'other' that do not fit into any of these previous categories). The sample is almost homogeneously divided among these three categories; 33 percent are agro-pastoralists, 35 percent are farmers and 32 percent fall into the mixed-livelihood category.

Mixed-livelihoods and farmers have nearly the same level of resilience capacity (55.9 percent and 55 percent respectively) while agro-pastoralists are a bit behind (51.1 percent). This result may be partially prompted by the typical urban effect (see other RIMA reports, such as Mauritania 2015 (FAO, 2016c) and Senegal 2005–2011 (FAO, 2016). That is, 35 percent of mixed-livelihood households defined themselves as "urban" (i.e. involved in urban activities); in fact, 62 percent of them are engaged in typical urban professions, such as pharmacists, taxi drivers, and so on.

Figure 7 RCI by livelihood in Matam (2016)

AC and ABS are the most relevant pillars of resilience, although the resilience capacity ranking suggested by Figure 7 and Figure 8 is mainly driven by AC, which is definitely more relevant for mixed-livelihoods and farmers.

Education again plays a major role in explaining different levels of resilience and should be regarded as a major policy indication. The average number of years spent in the education system for agro-pastoralists is 1.4, while for both farmers and mixed-livelihood it is on average 2.3. Also, mixed-livelihoods show the lowest level of illiterate members per household, with an average of 5 members, against the 9 for agro-pastoralists and 8 for farmers (see Table A6 in Annex). Access to education is still limited in Senegal because of a lack of investment, high school-related fees, and lack of birth certificates which can prevent children from formal school enrolment in more remote territories (USDOL, 2014). Two main policies have be recently implemented in the Matam region in 2011 and 2012, the Projet d'Alphabétisation des Jeunes Filles et Femmes au Sénégal (PAJEF) and the Nutrition Enfance et Sécurit'Alimentaire (NESA). PAJEF is focused on the enrolment of young girls through the utilization of mobiles phones as tools for learning, while NESA is focused on both alphabetization and proper nutrition for young girls and young mothers.

Farmers and mixed-livelihoods have generally better access to basic services (compared to agro-pastoralists); 24 percent of agro-pastoralist households have access to electricity, compared to 53 percent for farmers and 63 percent for mixed-livelihoods (Table 6). Similarly, 9 percent of agro-pastoralists report having access to waste disposal, while farming and mixed-livelihoods have respectively 22 percent and 27 percent. A possible explanation is that such limited access to basic services can play a key role in determining the agro-pastoralists (low) level of resilience, and even a marginal increase in services access can impact more on this group than the others.

In line with the relevant literature (Bradley and Grainger, 2004; Fadiga and Fadiga-Stewart, 2004), the role of the community as an informal safety net is more important among the less resilient groups; when agro-pastoralist households were asked about how involved the whole community is in the decision-making process, they reported the highest levels of involvement compared to the other two groups, (Table A4). Ndyaye *et al.* (2015), shows how community-based organizations in rural areas of Senegal are mainly made up of the most vulnerable members of society.

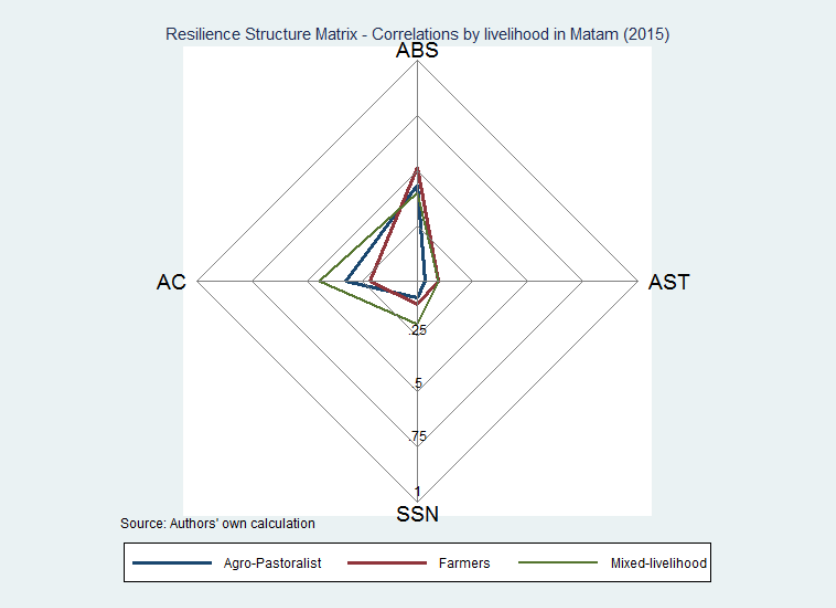

Figure 8 RSM – Correlations by livelihood in Matam (2016)

5. Causal resilience analysis

This section provides the results of the inferential analysis of resilience. It first explores the effects of shocks and geo-climatic variables on resilience capacity. Then, it presents the most important factors that correlate with food security.

The focus of this section is to understand the causal relationship between RCI shocks and geo-climatic variables and food security indicators. This part of RIMA-II looks at determinants of food security and resilience. There is a serious shortage of data, given that the most suitable arrangement for such an

analysis would have been to use a panel set. Still, interesting findings emerge from a normal OLS (Ordinary Least Square) methodology employed against cross-sectional data.

5.1 Resilience and food security determinants analysis

The basic assumption of resilience analysis is that one household can be considered resilient if it manages to return to the same level of stability after a shock has occurred (according to this analysis of food security). Therefore, this analysis looks at key determinants of food security by employing a set of outcome indicators (FCS, household food expenditure per capita and dietary diversity). These are regressed against a set of determinants, such as a vector of variables that are employed in RIMA-II; a vector of shocks (covariates and idiosyncratic) that may (or may not) have influenced the food security level; and a vector of geo-climatic variables that are employed as an indicator for climatic shock.

Food security is typically determined by four elements: accessibility, availability, sustainability and utilization. There are many ways of looking at food security. In this report, two food security indicators have been used that look at different aspects of the four key dimensions mentioned above: FCS and weekly food expenditure. FCS is able to capture the variability of food items consumed, while food expenditure looks at food quality under the assumption that, *coeteris paribus*, the same dietary diversity can be achieved via different levels of expenditure and, thus, quality.

The following formula is adopted for each food security indicator employed in the descriptive part of the analysis:

$$\boldsymbol{FS}_i = \alpha + \boldsymbol{\beta R}_i + \boldsymbol{\delta S}_i + \gamma G_i + \boldsymbol{\vartheta X}_i + \varepsilon_i \qquad (2)$$

Where FS_i is a vector of food security indicators[16]; R_i is the vector of all observed variables employed for the estimation of the pillars; S_i is the vector of all the shocks experienced and reported by the households, while G_i is the vector of geo-climatic variables. Finally, X_i is the vector of control variables and ε_i the error term (see Table A7 in Annex).

The climatic indexes utilized are the NDVI, ASI and rainfall levels. NDVI measures the 'greenness' of ground cover (FAO, 2016), which indicates a situation of stress for a low score of NDVI or of healthy vegetation in the case of a higher score. Therefore, higher levels of NDVI are expected to be positively correlated with both the RCI and food security indicators. ASI considers the climate's dry periods both temporally and spatially, where the higher the ASI, the more the area is affected with climatic stress. Finally, the rainfall index measures precipitation for each 10 days of the month.

Idiosyncratic shocks are self-reported shocks that the household recalls happening during the 12 months before the interview. Exposure to shocks can affect the household's RCI as well as their food security. These shocks are utilized as a vector of dummies.

[16] Results are consistent for both food security indicators, FCS and weekly food expenditure. However, the model is better specified with FCS, therefore only FCS results have been analysed in more in detail.

For the X_i vector of control variables, there are household characteristics, such as gender of the HH, age of the HH, the number of children per HH, urban status, and the household size in terms of number of members.

Many of the variables employed in the resilience analysis proved to be statistically significant in determining food security (see Table A8 in Annex).

For ABS, better access to electricity and waste disposal and a close distance to a traditional healer have positive effects on food security. Only 47 percent of households in this sample have access to electricity and less than 20 percent are located in an area with a safe disposal system. Access to electricity can mean access to food storage, the ability to use a computer and internet, better security, access to battery chargers, and possibility of studying, reading and being in contact with a broader network of communities around the world. Another factor affecting FCS is the proximity to the traditional healer. Considering that Matam suffers a constant shortage of specialized and official doctors, the role of the traditional healer is key for the population. For example, there is only one nurse for every 3 000 inhabitants and until 2006 Matam had only one hospital, meanwhile there are no hospitals in the Kanel and Ranérou districts (ANSD/SRSD, 2015).

With reference to AC, a substantial increase in FCS occurs owing to the perceived well-being of the household as well as how inclusive the community decision-making process is. Well-being is measured using a scale from 0 to 4, recording how often the interviewee feels happy, calm and relaxed, active and strong and rested in the previous week (where 0 represents 'never' and 4 'always'). This is in line with similar analysis implemented through RIMA-II, where AC emerged as one of the key aspects of food security; people who perceive themselves to have a higher level of well-being are more willing to spend money on food and increase their variety of food consumed (FAO, 2016).

Most importantly, education confirms its key role in determining food security. Kuenzi (2006) mentions a study conducted in northern Senegal, where those people who studied in non-formal education systems were more likely to contribute to the social and political life of the community. In the sample analysed here, 22 percent of the people interviewed declared to have received a non-formal type of education.

In terms of AST, higher levels of wealth index are associated with a higher FCS. On the contrary, the amount of crops harvested per capita has a small but significant negative impact. This could be explained by the fact that those households carrying out agriculture are mainly located in rural areas, which are also poorer than the urban ones. Indeed, from 23 to 28 percent of households involved in agriculture are considered food insecure (WFP, 2014), often because of weak agricultural productivity due to poor management of water resources, soil degradation and lack of effective and innovative agricultural assets. In order to further explore this possibility, a variable was included in the regression analysis in order to control for livelihood strategies; it shows that the farmer livelihood is negatively associated with food security.

The role of the community is a key element for Senegalese households. Community-based social protection could be a powerful mechanism to reduce vulnerability and poverty in rural areas. The positive and significant coefficient for community highlights that households in scenarios with a more democratic decision-making process have higher level of FCS.

Senegal has been strongly affected by climatic shocks in the last ten years. This is why it is important to include these geo-climatic variables when considering food security and resilience capacity at the household level. Indeed, in 2011, a drought put more than 800 000 persons in a state of high food insecurity (WFP, 2014), especially in the regions of Zinguichor, Kolda and Matam.

The stronger the shock, the more likely the household will sell important assets, as reported in the qualitative assessment carried out in Matam. There, 86 percent of households have some livestock, and the majority of families reported to have sold part of their livestock in order to cope with shocks related to the climate or to increases in food prices. This is in line with the national findings, where from 2010 to 2013, the amount of livestock own by households decreased especially in regions like Louga and Matam, moving from an average TLU of 7.9 in 2010 to an average of 5.5 in 2013 (WFP, 2014).

NDVI and ASI may be employed as early warning mechanisms, and can be detected remotely via satellites. This analysis shows that, last year, the level of **NDVI** has a positive and significant effect on FCS (i.e. greener ground cover is associated with a higher FCS for the households). This could be explained by numerous factors First of all, a greener ground implies higher levels of rainfall, and thus also a higher level of agricultural productivity. Indeed, a large part of agricultural production in Senegal is derived from rain-fed land, which also experiences a lack of safe access to water irrigation, especially in remote and rural areas (SE-CNSA, 2015). Better levels of agricultural productivity could increase the FCS in two ways, leading to an increase in income for those households involved in agriculture, and increasing food accessibility. An example of NDVI and ASI distribution within the country is portrayed in Figure 9 and Figure 9.

In line with the current literature (Rojas *et al*., 2011; Rojas *et al*., 2015), ASI is statistically significant and negatively influences the FCS, since **ASI** is a measure of droughts and the stress to vegetation (i.e. the higher its level, the lower the availability of cultivable land). As previously mentioned for the NDVI, Senegal still has large areas that efficient irrigation systems do not reach, so lack of rainfall and drought can strongly affect household livelihoods, especially in areas such as Matam where the cultivation of millet, sorghum or peanuts is still rain-fed, labour intensive and often involves low quality seeds and fertilizers (ANSD/SRSD, 2015).

Only two self-reported idiosyncratic shocks were found to significantly and negatively affect the FCS; storms and the threat of domestic violence. The mutual link between domestic violence and food security is well documented (Coates *et al.,* 2010; Ribeiro-Silva *et al.*, 2016), however as this is a quite sensitive topic it is frequently is underreported and, therefore, not easy to assess for lack of data.

While the negative effect of a storm on food security is quite straightforward to interpret, there is still room for a further elaboration. A positive aspect of self-reported shocks is that they most likely actually took place; however, sometimes it is difficult to maintain consistency with the definitions adopted for what constitutes a 'storm' when carrying out surveys. Therefore, this finding can be broadly interpreted as the negative effect of natural threats on household resilience.

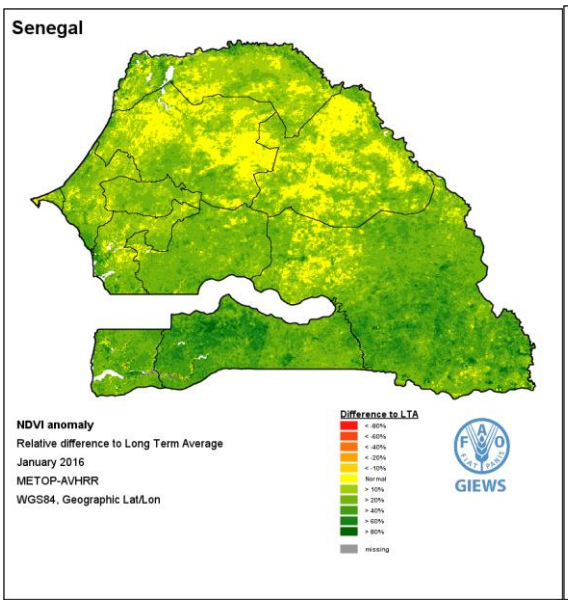

Figure 9 NDVI in Senegal, January 2016

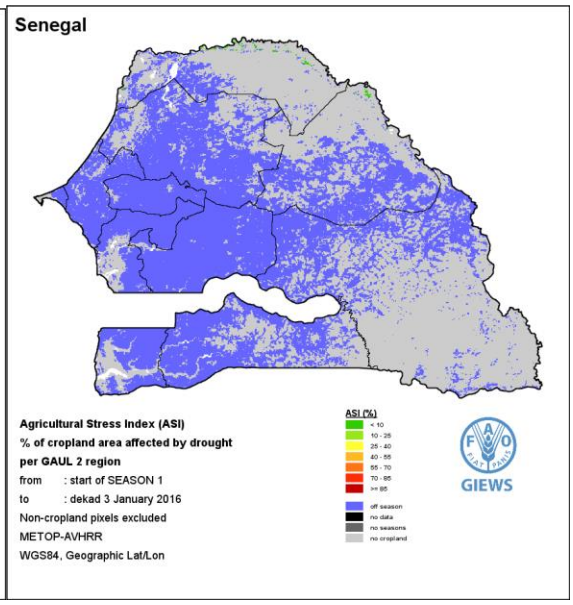

Figure 10 ASI in Senegal, January 2016

Matam is a region with a high proportion of youth, with more than 58 percent of the population younger than 20 years of age (ANSD/SRSD, 2015). Still, the higher the number of children per household, the lower the FCS. This can be explained by the fact that children require the investment of time and resources by a family, and that even if child labour is still present in Senegal, especially in rural areas (around 85.9 percent of working children are employed in the agricultural sector (USDOL, 2014), the potential income they are able to provide is not enough to counter balance the effect on the RCI. In Matam, the average number of children born alive for women aged 40–49 years old is 6.3 (ANSD/SRSD, 2015), while in this dataset this figure sits at 5, in line with regional demographics.

6. Main conclusions from the analysis and policy implications

This section summarizes the main findings of the resilience analysis implemented using the RIMA-II methodology, provides final assessments, and delivers relevant implications for policy design and implementation, in comparison with policies already programmed or implemented by the regional Government of Matam.

This analysis has employed the RIMA-II methodology in order to measure the resilience capacity of households in the Matam region in Senegal, and to understand how food security is influenced by resilience factors, shocks and geo-climatic scenarios. The datasets used have been collected by the FAO RAP team with the help of ANSD from December 2015 to January 2016. This report looks at resilience in order to design a comparison between different livelihoods, and in order to provide an adequate foundation for policy implications.

The main result is that household resilience capacity is mainly influenced by ABS and AC. In terms of ABS, proximity to healthcare, schools and drinkable water sources, and having access to electricity, are the

most important variables. For AC, the variables that influence this pillar the most are education, to what extent the community is able to influence public policies, and the involvement of the community in the decision-making process.

The analysis follows on to look more deeply into the three main livelihoods for residents of the Matam region; agro-pastoralists, farmers and mixed-livelihoods. Agro-pastoralists are those households with the lowest level of RCI, while mixed-livelihoods scored the highest. This could also be due to the geographical location, since the mixed-livelihood category mainly relates to households located in urban areas. Indeed, the RCI for agro-pastoralists and farmers are mainly influenced by ABS and AC, while for mixed-livelihoods the order is inverted. This is explained by the fact that agro-pastoralists and farmers are more dependent on access to basic services both for their jobs (such as water or markets) than mixed-livelihoods, which are more reliant on education and other components of AC.

The second part of the analysis focuses on inference causality between household food security and resilience variables, shocks and geo-climatic indicators. Focusing particularly on the FCS, the analysis shows that household food security is positively and significantly influenced by having access to electricity and safe waste disposal, as well as being close to traditional healers. Education and wealth index play a pivotal role in increasing food security, as do expenditure in non-food items and participation in the decision-making process. On the other side, the number of children per household and the agricultural asset index are negatively correlated with food security.

Given the importance of the agriculture sector in Matam, future policies should address improving agricultural productivity in order to bolster household food security and resilience capacity. Given that higher agricultural productivity will lead to improved income, this approach is important in order to relax the already heavy reliance on informal social safety nets, which at the moment are key for households' survival. This is especially so in rural areas, where public interventions and other official forms of social insurances are not present.

Geo-climatic variables have been useful in explaining food security, since both the NDVI and ASI are statistically significant and one is positively (vegetation health) and the other negatively (incidence of drought) correlated with food security. Further analysis will consider data collection in different periods of the year, in order to overcome the effect of seasonality on the data and to have a broader variation of geo-climatic data.

Given the results obtained from this analysis, further policies should be focused on increasing access to basic services, especially electricity, water and safe waste disposal, as well as on continued efforts by private and public stakeholders to increase education, especially for young girls.

Finally, given the economic and social importance of the agricultural sector in Matam, investing in the modernization of agriculture and increased agricultural productivity will lead to less dependence on food imports, thus the region will be less affected by food price shocks. Indeed, in the last five years, the increase in food prices affected two thirds of households located in rural areas and 40 percent of those located in urban areas (WFP, 2014).

The analysis showed that agro-pastoralist households have the lowest level of resilience compared to farmers and mixed livelihoods. This could be because they are "mobile" and are mainly found in rural areas where there is limited access to basic services (electricity, water, healthcare services and

schools/education). Their asset base also seems to be limited as the population of livestock has greatly declined since 2010 as households sold most of their livestock to cope with climate-related shocks and soaring food prices.

Any future programmes implemented in Matam should aim at lifting two thirds of people in rural areas out of their current position below the poverty level – the majority of whom are agro-pastoralists. Programmes should mainly focus on education (primary, secondary and tertiary or vocational education, looking at infrastructure development, curriculum development, remuneration or motivation, and improvement of facilities; focusing on primary education alone cannot make a fundamental change in strengthening the resilience capacity and well-being of the population), increase in production per unit area of the main staple foods and commercial crops, livelihoods diversification and income generation.

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Annex

Table A3 Variables employed in RIMA – Matam Region

	mean	sd	min	max
Electricity	0.466	0.499	0.000	1.000
Waste Disposal	0.198	0.399	0.000	1.000
Water closeness index	0.889	0.200	0.000	1.000
School closeness index	0.873	0.138	0.000	1.000
Healthcare closeness index	0.864	0.165	0.000	1.000
Traditional healer closeness index	0.887	0.157	0.000	1.000
Hospital closeness index	0.777	0.215	0.000	1.000
Transport closeness index	0.868	0.183	0.000	1.000
Market closeness index	0.886	0.170	0.000	1.000
Toilettes	0.717	0.451	0.000	1.000
TLU per capita	0.333	0.898	0.000	9.093
Land per capita	0.064	0.129	0.000	1.000
Wealth Index	0.557	0.216	0.000	0.988
Harvest per capita	16.312	36.691	0.000	315.000
Agricultural Asset Index	0.081	0.167	0.000	0.871
Monthly cash transfers	1.112	4.123	0.000	38.264
Monthly in-kind transfers	0.070	0.363	0.000	4.831
Credit group	0.123	0.329	0.000	1.000
Relatives	0.493	0.501	0.000	1.000
Credit amount	26.329	69.985	0.000	434.824
Income participation index	0.549	0.410	0.000	1.834
Education	2.241	2.430	0.000	18.000
Dependency ratio	1.740	1.972	0.000	12.000
Community influence	2.217	1.194	0.000	4.000
Social Involvement[17]	2.507	1.507	0.000	4.000
Illiteracy rate	-7.589	4.804	-33.000	0.000
Wellbeing index	0.457	0.167	0.000	1.000
ObservationsN	410			

[17] This variable reports the involvement of the local community in the decision making process.

Table A4 Variables employed in RIMA –Agro-pastoralists

	mean	min	max
	Agro-pastoral	Agro-pastoral	Agro-pastoral
Electricity	0.248	0.000	1.000
Waste Disposal	0.095	0.000	1.000
Water closeness index	0.830	0.000	1.000
School closeness index	0.847	0.000	1.000
Healthcare closeness index	0.812	0.000	1.000
Traditional healer closeness index	0.836	0.000	1.000
Hospital closeness index	0.757	0.000	1.000
Transport closeness index	0.819	0.000	1.000
Market closeness index	0.832	0.000	1.000
Toilettes	0.489	0.000	1.000
TLU per capita	0.701	0.000	8.340
Land per capita	0.085	0.000	1.000
Wealth Index	0.567	0.062	0.969
Harvest per capita	21.758	0.000	187.500
Agricultural Asset Index	0.102	0.000	0.829
Monthly cash transfers	0.787	0.000	12.078
Monthly in-kind transfers	0.123	0.000	4.831
Credit group	0.117	0.000	1.000
Relatives	0.526	0.000	1.000
Credit amount	42.831	0.000	434.824
Income participation index	0.613	0.000	1.834
Education	1.364	0.000	7.667
Dependency ratio	1.934	0.167	12.000
Community influence	2.212	0.000	4.000
Decision	2.869	0.000	4.000
Illiteracy rate	-8.927	-22.000	-1.000
Well-being index	0.470	0.149	1.000

Table A5 Variables employed in RIMA – Farmers

	mean	min	max
	Farmer	Farmer	Farmer

Electricity	0.527	0.000	1.000
Waste Disposal	0.226	0.000	1.000
Water closeness index	0.913	0.000	1.000
School closeness index	0.876	0.000	0.992
Healthcare closeness index	0.871	0.000	1.000
Traditional healer closeness index	0.900	0.250	1.000
Hospital closeness index	0.761	0.000	1.000
Transport closeness index	0.881	0.000	1.000
Market closeness index	0.898	0.000	1.000
Toilets	0.829	0.000	1.000
TLU per capita	0.196	0.000	9.093
Land per capita	0.081	0.000	0.751
Wealth Index	0.576	0.000	0.988
Harvest per capita	21.766	0.000	250.000
Agricultural Asset Index	0.093	0.000	0.871
Monthly cash transfers	0.990	0.000	32.612
Monthly in-kind transfers	0.055	0.000	1.812
Credit group	0.130	0.000	1.000
Relatives	0.527	0.000	1.000
Credit amount	24.523	0.000	434.824
Income participation index	0.661	0.000	1.834
Education	2.390	0.000	8.700
Dependency ratio	1.624	0.222	12.000
Community influence	2.185	0.000	4.000
Decision	2.610	0.000	4.000
Illiteracy rate	-8.151	-33.000	0.000
Well-being index	0.442	0.000	1.000

Table A6 Variables employed in RIMA – Mixed-Livelihood

	mean	min	max
	Mixed-livelihood	Mixed-livelihood	Mixed-livelihood
Electricity	0.626	0.000	1.000
Waste Disposal	0.275	0.000	1.000
Water closeness index	0.926	0.250	1.000
School closeness index	0.899	0.500	1.000
Healthcare closeness index	0.910	0.667	1.000
Traditional healer closeness index	0.925	0.500	1.000

Hospital closeness index	0.815	0.000	1.000
Transport closeness index	0.907	0.333	1.000
Market closeness index	0.929	0.667	1.000
Toilets	0.832	0.000	1.000
TLU per capita	0.099	0.000	1.820
Land per capita	0.025	0.000	1.000
Wealth Index	0.527	0.000	0.988
Harvest per capita	4.538	0.000	315.000
Agricultural Asset Index	0.046	0.000	0.672
Monthly cash transfers	1.588	0.000	38.264
Monthly in-kind transfers	0.032	0.000	1.933
Credit group	0.122	0.000	1.000
Relatives	0.420	0.000	1.000
Credit amount	11.083	0.000	347.859
Income participation index	0.359	0.000	1.272
Education	2.990	0.000	18.000
Dependency ratio	1.667	0.000	10.000
Community influence	2.260	0.000	4.000
Decision	2.015	0.000	4.000
Illiteracy rate	-5.565	-27.000	0.000
Well-being index	0.460	0.149	1.000

Table A7 Observed variables- Descriptive statistics for controls, shocks and geo-climatic variables in Matam (2016)

	Mean
Age of HH	53.120
FHH	0.215
Nonfood expenditure	669.000
Significant Shock	0.220
Children per household	0.401
Milieu	0.541
Agro-past dummy	0.327
Farmer dummy	0.354
Mixed-Livelihood dummy	0.320
Household size squared	155.400
Flood	0.115
Drought	0.076

Crop disease	0.007
Livestock death	0.259
Business failure	0.012
Food price shock	0.059
Input price shock	0.012
Water	0.081
Crop fail	0.246
Accident	0.022
Illness	0.068
Clashes	0.002
Death	0.024
Displacement	0.005
Storm	0.029
Stored Food loss	0.022
Job loss	0.005
Fire	0.005
Fish	0.007
Threat of thieves	0.534
Threat of domestic violence	0.042
Average NDVI last year	0.293
Average ASI last year	4.591
N	410

Table A8 The correlates of FCS in Matam (2015)

VARIABLES	(1) FCS	(2) Weekly Food Expenditure
ABS		
Electricity	**6.265****	9.769**
	(2.996)	(4.411)
Waste disposal	**6.038***	4.579
	(3.167)	(4.663)
Water closeness index	0.350	18.43*
	(6.956)	(10.24)
School closeness index	-0.441	-17.45
	(9.783)	(14.40)
Healthcare closeness index	-8.204	1.315

	(9.967)	(14.67)
Traditional healer closeness index	**13.90***	7.166
	(8.102)	(11.93)
Hospital closeness index	-1.591	-12.09
	(5.820)	(8.569)
Transport closeness index	13.19	11.49
	(8.730)	(12.85)
Market closeness index	8.725	27.58*
	(9.917)	(14.60)
Toilets	-3.548	-7.691
	(3.724)	(5.483)
AST		
TLU per capita	0.716	1.965
	(1.318)	(1.940)
Land per capita	6.115	-5.397
	(10.40)	(15.32)
Wealth index	**37.20*****	21.29**
	(5.938)	(8.742)
Harvest per capita	**-0.0678***	-0.0597
	(0.0377)	(0.0555)
Agricultural Asset Index	-6.148	-19.66*
	(7.529)	(11.08)
SSN		
Monthly cash transfers	-0.341	0.575
	(0.273)	(0.401)
Monthly in-kind transfers	-3.232	1.699
	(3.094)	(4.555)
Credit group	-6.082	0.494
	(3.749)	(5.519)
Relatives	1.901	-0.808
	(2.567)	(3.779)
Credit amount	0.0236	-0.0332
	(0.0169)	(0.0249)
AC		
Income participation index	1.376	6.386
	(3.477)	(5.120)
Education	**0.977***	0.661
	(0.546)	(0.803)
Dependency ratio	-1.519*	-0.272
	(0.790)	(1.162)
Community influence	0.533	0.978
	(1.189)	(1.750)
Decision	**2.878*****	0.159

	(1.012)	(1.489)
Well-being index	**27.95*** **	33.70***
	(7.366)	(10.84)
CONTROLS		
Age of HH	0.000674	0.333***
	(0.0833)	(0.123)
FHH	1.069	2.788
	(2.741)	(4.035)
Nonfood expenditure	**0.00464** **	0.0237***
	(0.00184)	(0.00270)
Significant Shock	-3.950	0.762
	(3.284)	(4.835)
Children per household	**-24.16*** **	5.972
	(8.368)	(12.32)
Milieu	-1.605	6.066
	(2.652)	(3.905)
Agro-past dummy	-	-
Farming dummy	**-5.739***	-6.344
	(3.025)	(4.454)
Other livelihood dummy	-3.857	-13.74***
	(3.441)	(5.066)
Household size squared	-0.00217	0.00551
	(0.00520)	(0.00766)
SHOCKS		
Flood	4.605	-9.389
	(3.920)	(5.771)
Drought	-1.984	-7.785
	(5.019)	(7.389)
Crop disease	-15.16	12.51
	(13.51)	(19.89)
Livestock death	3.618	1.998
	(3.214)	(4.731)
Business failure	0.575	-4.917
	(12.07)	(17.77)
Food price shock	-8.270	5.453
	(5.968)	(8.787)
Input price shock	-8.581	-0.757
	(11.01)	(16.22)
Water	-7.489	11.46
	(5.136)	(7.561)
Crop fail	-3.705	9.755**
	(3.276)	(4.824)
Accident	9.943	15.28

	(8.311)	(12.24)
Illness	-3.409	-3.065
	(4.651)	(6.848)
Clashes	-37.56	53.21
	(25.16)	(37.04)
Death	-3.860	21.71*
	(8.337)	(12.27)
Displacement	-3.652	10.40
	(16.08)	(23.67)
Storm	11.81****	-2.078
	(6.981)	(10.28)
Stored Food loss	-11.59	17.16
	(8.512)	(12.53)
Job loss	10.59	-38.71*
	(15.46)	(22.76)
Fire	-26.41	14.14
	(16.28)	(23.97)
Fish	-3.826	28.17
	(14.13)	(20.81)
Threat of thieves	-1.519	-4.410
	(2.653)	(3.906)
Threat of domestic violence	12.19****	-10.55
	(6.019)	(8.862)
GEO		
Average NDVI last year	**332.4*****	-68.86
	(63.67)	(93.73)
Average ASI last year	**-3.944*****	0.0908
	(0.738)	(1.086)
Constant	-59.60***	-14.50
	(21.53)	(31.70)
Observations	410	410
R-squared	0.486	0.476

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A9 MIMIC results

	Resilience
ABS	0.39***
	(0.0658)
AST	0.117***
	(0.058)
SSN	.0216
	(0.0562)
AC	.2011***
	(0.0557)
Gross Food expenditure	.5039***
	(.0609)
Food Consumption Score	.8024***
	(0.079)
Chi2	4.53
P value	0.2
RMSEA	0.035
CFI	0.989
TLI	0.966
Observations	414

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1