Food and Agriculture Organization
of the United Nations

ANALYSING RESILIENCE FOR BETTER TARGETING AND ACTION

FAO RESILIENCE ANALYSIS No. 8

RESILIENCE ANALYSIS IN SENEGAL 2011

Cover picture: © FAO \ Seyllou Diallo

ANALYSING RESILIENCE FOR TARGETING AND ACTION

FAO RESILIENCE ANALYSIS No. 8

RESILIENCE ANALYSIS IN SENEGAL 2011

Food and Agriculture Organization of the United Nations
Rome, 2017

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the authors and do not necessarily reflect the views or policies of FAO.

© FAO, 2017

FAO encourages the use, reproduction and dissemination of material in this information product. Except where otherwise indicated, material may be copied, downloaded and printed for private study, research and teaching purposes, or for use in non-commercial products or services, provided that appropriate acknowledgement of FAO as the source and copyright holder is given and that FAO's endorsement of users' views, products or services is not implied in any way.

All requests for translation and adaptation rights, and for resale and other commercial use rights should be made via www.fao.org/contact-us/licence-request or addressed to copyright@fao.org.

FAO information products are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org.

This publication has been produced with the assistance of the European Union. The contents of this publication are the sole responsibility of FAO and can in no way be taken to reflect the views of the European Union

CONTENTS

FIGURES

TABLES

ACKNOWLEDGEMENTS

This report has been prepared by the Resilience Analysis and Policies team of FAO's Agricultural Development Economics Division (ESA). Special thanks go to Francesca Grazioli, Rebecca Pietrelli, Stefania Di Giuseppe, Lavinia Antonaci, Marco d'Errico and Luca Russo for their contributions of technical information, and to Rachele Santini, Tomaso Lezzi and Giorgia Wizemann for the formatting and layout of the publication. Alecia Wood completed the editing.
We would like to thank all the people who contributed to reviewing and commenting on the report, including Mr Vincent Martin and Mr Sonko Mamadou from FAO Senegal and the Agence Nationale de Statistique et de la Démographie.

ACRONYMS

ABS Access to Basic Services
AC Adaptive Capacity
ANSD Agence Nationale de Statistique et de la Démographie
AST Assets
CIA Conditional Independence Assumption
ESAM-II Enquête Sénégalaise Auprès des Ménages II
ESPS Enquête de Suivi de la Pauvreté au Sénégal
FA Factor Analysis
FAO Food and Agriculture Organization
FAOSTAT Food and Agriculture Organization of the United Nations Statistics Division
FCS Food Consumption Score
FHH Female-Headed Household
GDP Gross Domestic Product
GII Gender Inequality Index
HDI Human Development Index
HH Household Head
IMF International Monetary Fund
MHH Male-Headed Household
MIMIC Multiple Indicators Multiple Causes
PNDE Plan National de Développement de l'Elevage
PNIA Programme National d'Investissement Agricole
PRACAS Programme d'Accélération de la Cadence de l'Agriculture
PRN Programme de Renforcement de la Nutrition
PSE Plan Sénégal émergent
PSM Propensity Score Matching
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
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

The Republic of Senegal has experienced a higher economic growth with reference to other neighbour countries over the coast of West Africa, since its independence from France in 1960. However, in 2010, the country registered 46.7 percent of its population as being under the poverty line (WB, 2016). Moreover, the recent international financial crises, climate shocks and the slowdown in agricultural sector productivity have brought a nationwide downturn.

Senegalese households face a range of exogenous shocks, from low rainfall and drought to food price volatility, each of which affects their food security and resilience capacity. This report seeks to identify the main factors contributing to households' resilience and food security by using the Food and Agriculture Organization (FAO) Resilience Index Measurement and Analysis (RIMA), in this case the Resilience Index Measurement and Analysis II (RIMA-II), methodology. The RIMA-II pillars of resilience considered in this analysis are Access to Basic Services (ABS), Assets (AST), Social Safety Net (SSN) and Adaptive Capacity (AC).

Continuing on from the previous FAO Resilience Analysis and Policies (RAP) team report on Senegal in 2005, published in 2015 (FAO, 2015), this analysis uses data collected by the Agence Nationale de Statistique et de la Démographie (ANSD) for the Enquête de Suivi de la Pauvreté au Sénégal II (ESPS-II). The first part of the report analyses household resilience capacity in 2010 at the national and regional levels, at the urban level and also at the level of the household head's gender. The second part of the report portrays a dynamic analysis of resilience capacity and food security between 2005 and 2011; this indirect part of RIMA-II aims to see which pillars influenced changes in resilience and food security from 2005 to 2011.

Finally, the main findings have been analysed in terms of the key policies implemented or programmed by the Senegalese Government. This has been carried out in order to provide useful insights about how to relate resilience capacity and food security with practical policies.

KEY HIGHLIGHTS

1. **The resilience capacity of Senegalese households is strongly influenced by the ABS pillar, followed by AST.** Both in terms of resilience capacity and food security, the infrastructural wealth index and having good housing conditions (such as a safe roof, floor and solid walls) are the most important variables together with agricultural assets, such as cultivated land and livestock owned. The dynamic analysis confirms the infrastructural wealth index as one of the most important variables in explaining resilience capacity and food security growth over time, together with social programs, including access to markets and public transportation, and the value of the assets owned by the household.
2. At the regional level, the areas of Dakar, Thiés and Saint-Luis record the highest levels of resilience capacity, while Zinguinchor, Kolda and Kedougou are the regions that score the worst. In line with the official national poverty indexes, proximity to basic services, better housing conditions, different levels of education and literacy levels, and agricultural inputs – such as land owned and Tropical Livestock Units (TLU) – are the main factors that explain the difference in resilience capacity between each regions.
3. With reference to urban and rural areas, households located in urban areas are better off in terms of both resilience capacity and food security. As at the national and regional levels, ABS is the most important pillar in explaining resilience capacity. Urban households have better access to services, like markets, hospitals, schools and public transportation, as well as better housing conditions and higher infrastructural wealth index.
4. In terms of the gender of household heads, female-headed households (FHH) score better than male headed households (MHH) with reference to resilience capacity. However, this result could be biased owing to the location of households; looking at where households are located, the majority of FHH are, indeed, in urban areas, where resilience capacity is generally higher than rural areas. Generally, FHH are advantaged in terms of ABS and SSN. These findings highlight the important role of remittances in Senegal, especially for women. Indeed, FHH are the main receivers of money transfers.

POLICY IMPLICATIONS

These findings have been considered in light of the policies programmed and implemented by the Government of Senegal, both at the national and regional levels.

The main implication is that further policies should focus on rural areas when it comes to reinforcing infrastructure and access to basic services, given the key role of these services in resilience capacity and the differential between rural and urban areas. Moreover, investments in increasing public safety nets should be made, as well as those aimed to increase agricultural productivity, in terms of cultivated land and livestock owned by households.

A recent and relevant example of an adopted development model is the Plan Sénégal Emergent (PSE). This plan aims for long-term economic and social growth through social inclusion, the reinforcement of agriculture, and the strengthening of agribusiness. Modernization of the agricultural industry (including the livestock, fisheries and aquaculture sectors) is one of the plan's priorities; this is in line with the main findings of this report, especially with reference to food security in rural areas.

The livestock sector is also a priority in the Programme National d'Investissement Agricole (PNIA), which aims to increase the productivity and the competitiveness of the animal production chain; to bolster meat and dairy product transformation; and to maintain infrastructures and animal health.

Finally, even if the results of this analysis suggest that FHH are more resilient, many indicators still show that they also have lower access to education and food security, especially for those in rural areas. The Programme de Renforcement de la Nutrition (PRN) is focused on women and nutrition, especially pregnant women and mothers of young children. The implementation of this programme is focused on the regions of Kolda, Kédougou and Tambacounda, the first two of which score the worst in terms of resilience capacity.

In conclusion, the report highlights the main pillars contributing to household resilience capacity and the main sectors that should be targeted by policy makers in order to strategically improve Senegalese household resilience capacity and food security.


© FAO\Seyllou Diallo

© FAO\ Seyllou Diallo

1 PURPOSE OF THE ANALYSIS

This section introduces background information on Senegal, and explains in further detail the reasons for carrying out this resilience analysis.

The Republic of Senegal remains a lower middle-income country, even though it has experienced higher economic growth in the period since 1994 compared to other coastal West African countries (IMF, 2013). From 2006, it has faced an economic slowdown. The resulting reduction in growth rates, even though these rates remain positive in absolute terms, is attributable to insufficient levels of productivity in the agriculture sector; a slowdown across previous economic drivers, such as services and constructions; a high deficit in its balance of payments (FAO, 2015); as well as exogenous shocks related to the international financial and food crises.

46.7 percent of the total population was under the poverty line in 2010 (WB, 2016) and 15.5 percent of the population was still food insecure in 2013 (FAOSTAT, 2016). Moreover, in 2012, Senegal ranked 154 out of 187 countries and territories in relation to the Human Development Index (HDI), a development index that considers access to knowledge, a long and healthy life and a decent standard of living (UNDP, 2013). Agriculture is still the most important sector, employing around 46 percent of the population, and many recent policies have been implemented in order to reinforce this sector, especially in terms of food security. Indeed, food insecurity levels remained almost constant from 2005 to 2013, according to the Global Hunger Index (UNDP, 2013).

Senegal's population has a significant proportion of youth, with 53.8 percent of the total population under 20 years of age (ANSD, 2011). Moreover, 42.9 percent of Senegalese people are younger than 15 years of age, implying a high dependency ratio (the ratio between the income earner over the non-labour force of the household), but also a significant potential for future economic growth.

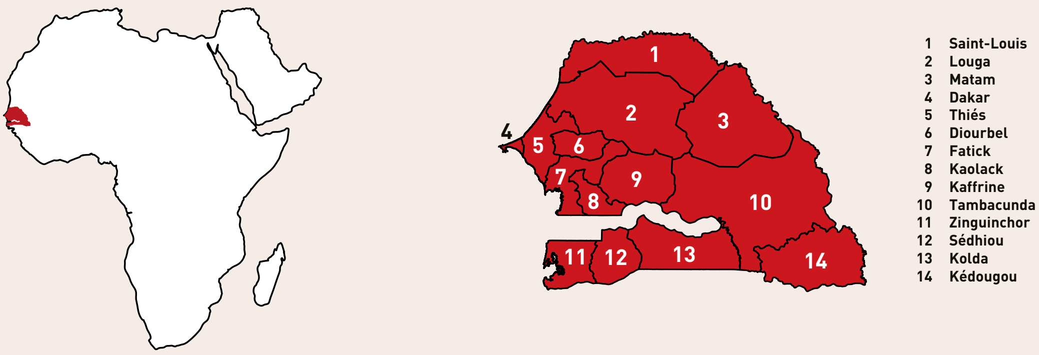
This analysis applies the FAO RIMA-II model, using data from the ESPS-II collected by the ANSD in 2011. The purpose of the analysis is to seek the most relevant dimensions of resilience in 2011. RIMA-II is composed of two parts – a descriptive analysis, which provides an overall image of the composition of resilience capacity, and a causal part that seeks to estimate the determinants of food security and resilience recovery. This report was designed to allow a comparison with the previous FAO RAP team report on the same topic (FAO, 2015), which was based on data from the Enquête de Suivi de la Pauvreté au Sénégal-I (ESPS-I) conducted in 2005, (ANSD, 2005). Here, the two datasets are compared, and this report forms part of a larger study that also includes a special case study on the Matam region (see Figure 1).

As the RIMA process has evolved over time from Resilience Index Measurement and Analysis I (RIMA-I) to RIMA-II, there are some minor differences between the FAO analyses of 2005 and 2011. The progression of RIMA-I to RIMA-II is presented in further detail in FAO (2016). Both RIMA-I and RIMA-II provide a sound description of resilience capacity, but RIMA-II – the most recent approach – allows for further analysis that was not possible with RIMA-I.

In the second part of this report, a dynamic analysis of resilience capacity and food security growth using both the 2005 and 2011 data is presented.

The report is structured as follows: Section 2 presents the methodology; Section 3 gives details on the data employed; Section 4 shows the analysis of resilience structure according to the national level, urban/rural localization, and household head (HH) gender. Section 5 shows the causal analysis with the dynamic comparison of the data from 2005 and 2011. Finally, Section 6 concludes with policy recommendations.

Figure 1. **The regions of Senegal (2011)**



Source: Author's own elaboration

© FLickr CC\ Jeff Attaway-


© FLickr CC\ Jeff Attaway

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.

The concept of resilience in this analysis is defined as per the definition from the Resilience Measurement Technical Working Group (RM-TWG):[1] "Resilience is the capacity that ensures adverse stressors and shocks do not have long-lasting adverse development consequences" (RM-TWG, 2014).

RIMA-II is comprised of two different parts; a descriptive measure and a causal measure of resilience. While further details on the methodology can be found in FAO (2016), it is important to stress here some key features of RIMA-II.

The descriptive part provides an in-depth analysis of the Resilience Capacity Index (RCI) covariates. This approach estimates the RCI with a two-stage procedure. Starting from observable variables, a set of pre-determined dimensions, referred to as pillars, are estimated. For this particular report, the following pillars have been adopted: ABS, AST, SSN and AC. Table 1 reports each pillar's definition and which variables have been utilized for the estimation.

In the second phase, the RCI is estimated through a Structural Equation Model (SEM) that is called Multiple Indicators Multiple Causes (MIMIC). MIMIC estimates resilience as determined by the four pillars; food security indicators are adopted as a measure of the outcome of resilience (i.e. higher food security corresponds to higher resilience capacity). Figure 2 represents graphically the two-stage procedure for RCI estimation.

The Food Security (FS) indicators utilized for the 2011 data are monthly food expenditure and the Food Consumption Score (FCS) (Table 2). The reason why these two indicators have been utilized is because food expenditure captures the monetary value of food consumption, while FCS focuses more on food dietary diversity and food frequency (WFP, 2008). In this way, it's possible to portray more aspects of household food insecurity. However, during the estimation phase, various food security indicators have been estimated and tested.

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

Table 1. **Resilience pillars and variables**

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 infrastructures.	House facilities;[2] Electricity; Improved water facility; Improved toilet facility; Improved waste disposal facilities; Distances in minutes from school, hospital, water source and market.
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;[3] Land; Tropical Livestock Units (TLU).[4]
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.	Net national transfers; international transfers; network index.
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; Employment ratio; Participation index;[5] Literacy level; School frequency.

TThis MIMIC methodology creates two resilience outcomes; the RCI and the Resilience Structure Matrix (RSM). The RCI allows for households to be ranked according to their resilience capacity; the RSM describes the weights of each pillar and variables in determining the RCI, thus providing a map of the actual situation of household resilience and suggesting which aspects of resilience may require urgent interventions.

Population profiles can be adopted to further disaggregate the analysis, such as gender of household head, urban vs rural status, or geographical localization.

The second part of RIMA-II looks at determinants of food security and resilience recovery, and at the role of shocks. In order to properly carry out this part, two datasets are required. In this case the available datasets were not designed as panel datasets, therefore a Propensity Score Matching (PSM) technique was adopted in order to allow for comparisons. Further detail on this process can be found in Section 5.

To ensure clarity, the RCI has been rescaled to range from 0 to 100. This aids the interpretation of the findings and facilitates the comparison among different household profiles.

2 The figure for house facilities is created through factor analysis (FA) using a list of variables indicating whether the house has a safe roof, walls, floor and a separate kitchen.

3 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.

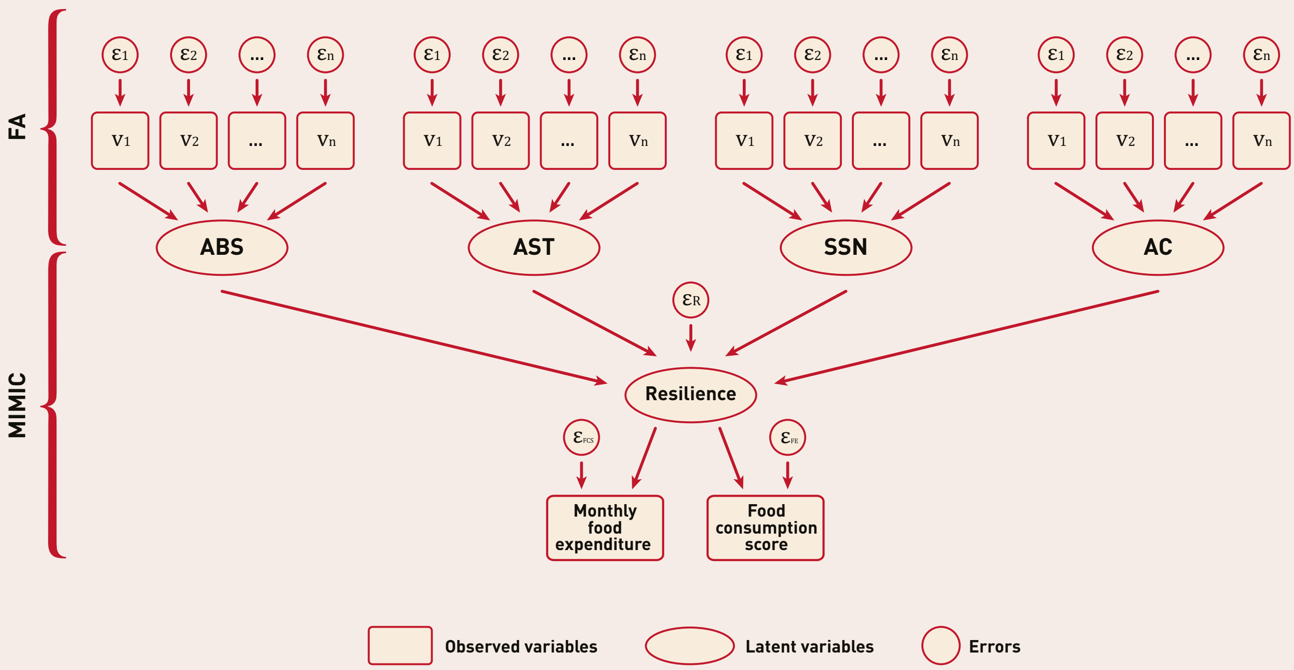
4 TLU standardizes different types of livestock into a single unit of measurement. The conversion factor adopted is: 1 camel; 0.5 cattle; 0.6 horses/donkeys/mules; 0.1 sheep/goats; 0.01 chickens; 0.2 pigs.

5 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.

Table 2. **Food security indicators**

Food security indicators	Definition
Monthly food expenditure ($)	Monetary value, expressed in US dollars, of food items purchased by the household in the last 30 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).

Figure 2. **Resilience index and pillars**



Source:
Author's own elaboration

© FAO/Jane Hahn

3 DATA

This section describes the dataset employed in the resilience analysis and introduces both strengths and limitations of the dataset. Additional data sources on covariate shocks are also introduced.

Data employed in this analysis are from the ESPS-II implemented by the ANSD of Senegal in 2011. ESPS-II follows a previous enquiry, ESPS-I, carried out from 2005 to 2006. ESPS-I was employed in the FAO RAP 2015 report on resilience in Senegal in 2005 (FAO, 2015), and has been employed for the dynamic analysis on resilience capacity and food security growth in this report.

The ESPS-II survey involved 17 890 households. Within this sample, one-third received the complete questionnaire, while the remaining two-thirds received a shorter version. In the RIMA-II analysis, the final sample utilized is composed of those households that received the complete questionnaire, which is effectively 4 953 observations. This sample is representative at the national and regional levels.

In this report, households are the main unit of analysis. The definition of a household adopted here is: "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" (FAO, 2015b).

The ESPS-II questionnaire included 19 modules both at the individual and household levels, collecting information on numerous aspects of livelihood such as: education, healthcare, employment, access to services, food production and consumption, levels of expenditure, religion, shocks and the community's opinions on their own situation and the role of public institutions in their lives, providing useful ground for the RIMA-II analysis.

© FAO \ Swiatoslaw Wojtkowiak

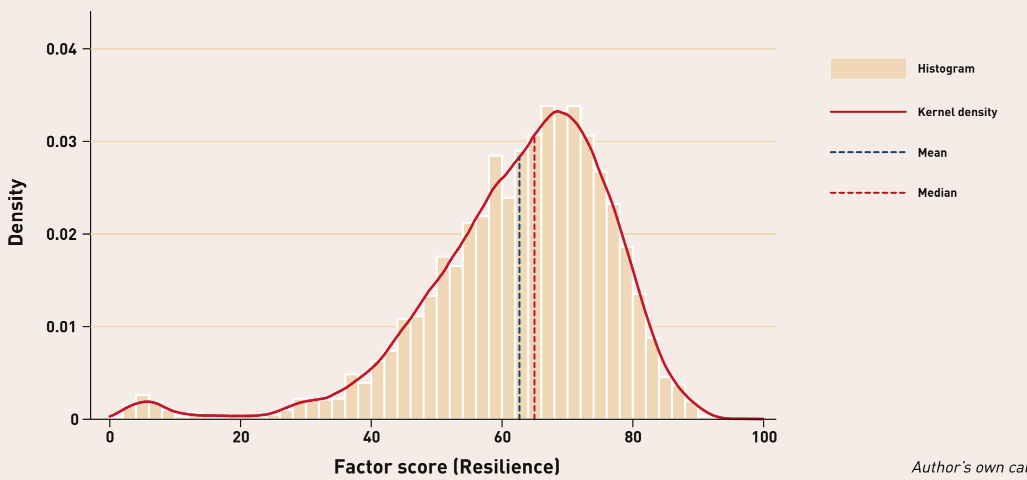
4 DESCRIPTIVE RESILIENCE ANALYSIS

This section provides the resilience analysis results. First, it describes the analysis of RSM in Senegal in 2011, spelling out the relevance of each pillar in explaining the RCI. Then, it presents the results disaggregated by region, urban status, and gender of HH, identifying and explaining existing differences in resilience capacity between different profiles of households.

4.1 ANALYSIS AT THE NATIONAL LEVEL

There are no significant peaks that might suggest particularly advantaged or disadvantaged sub-groups of population. In fact, the majority of households score an RCI close to the average level (scoring 56.44). Figure 3 shows the histogram together with the kernel density estimate of the RCI at the national level, with no significant peak in the curve.

Figure 3. **Resilience in Senegal (2011)**



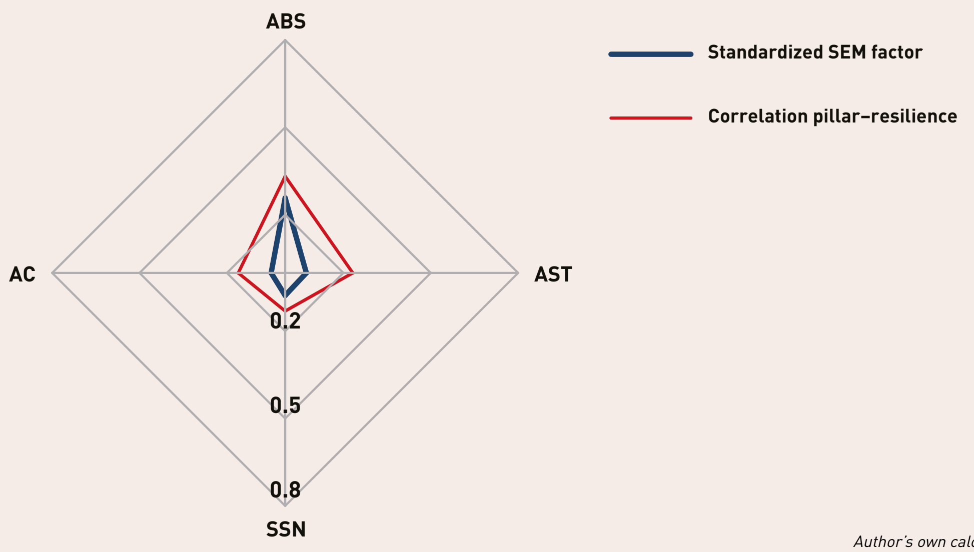
Source:
Author's own calculation from Senegal 2011

ABS is the pillar that most significantly explains resilience, followed by AST. While AC an SSN play a less influential role. Figure 4 shows the loadings of the components on the RCI as well as the correlations between the index and the pillars.

In terms of ABS, the **infrastructure wealth index** and **safe walls**, **roof and floor** are the most important variables (see Figure 5). ABS portrays the household's capacity to meet certain needs, such as having a safe house, with a safe water supply, toilet, waste disposal and electric lights, or the distance, in minutes, from facilities such as schools, hospitals, markets, asphalted roads and so on. Generally, all these factors have an important impact on family livelihood (ANSD, 2011). At the national level, in Senegal, 62.3 percent of families live in *maisons basses* (modern buildings with terraces and no upper levels), 20.6 percent in cases (traditional buildings, usually with circular or rectangular shape, built with mud or straw with a conical or pyramidal roof made of branches covered with straw), and 1.6 percent in barracks (ANSD, 2011).

Cultivated land (measured in hectares) and the value of **livestock** owned are the two variables that are more relevant to AST (see Figure 6). While there has been a general negative trend in the share of the population and labour force involved in agriculture (there was a 5.05 percent reduction from 2000 to 2015 (FAOSTAT, 2016)), the Senegalese population still strongly relies on agriculture; it was the main means of livelihood for 70.31 percent of the workforce in 2010. In addition, it is important to consider that agriculture productivity is facing a significant slowdown in recent years, mainly due to vulnerability to climate shocks, lack of safe access to water irrigation, and volatility of prices especially in rural and more remote areas (SE-CNSA, 2015).

Figure 4. **RSM - Loading of factor (SEM) and correlation among pillars in Senegal (2011)**

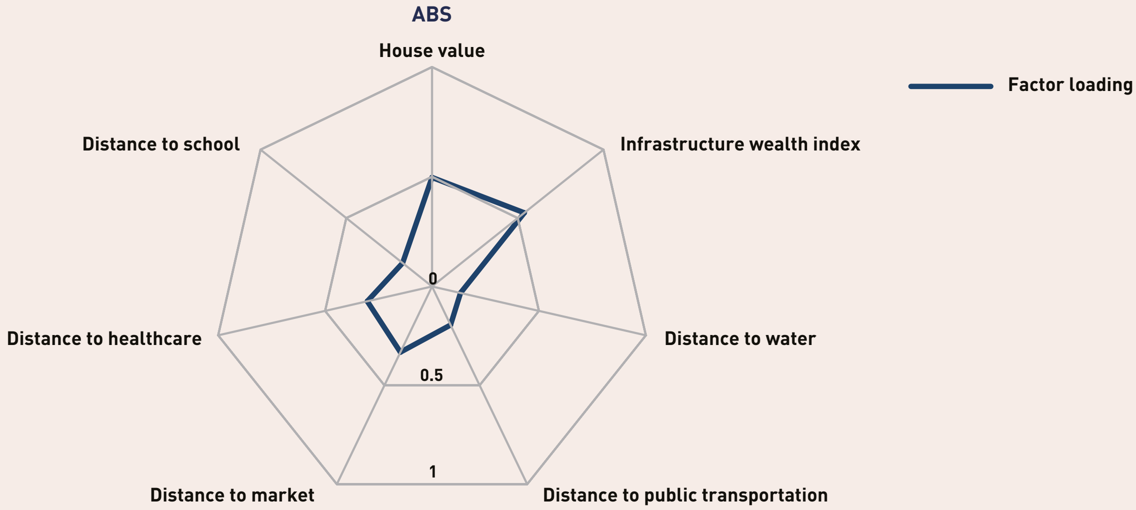


Source: Author's own calculation from Sénégal 2011

The variables mostly contributing to AC are education and the literacy level of the HH. Education proves to be a key element for the household RCI (Figure 8), although the analysis of the dataset shows that only 32.10 percent of HHs have been to school.

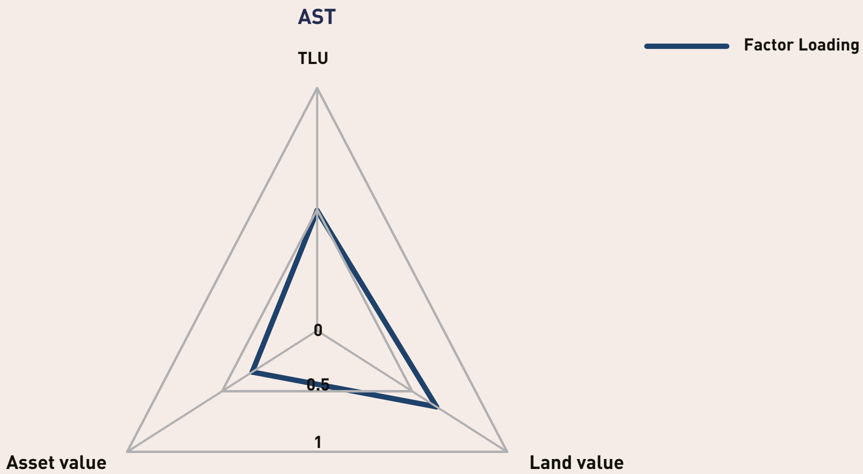
Net national and international monetary transfers play a key role in determining SSN (see Figure 7). Senegal experienced both internal and external migration in recent decades. Almost 5 percent of the Senegalese population lives outside the country; the most common destinations are other West African regions, followed by France and Italy (Randazzo and Piracha, 2014).

Figure 5. **Resilience structure - Variable weights in ABS in Senegal (2011)**



Source: Author's own calculation from Sénégal 2011

Figure 6. **Resilience structure - Variable weights in AST in Senegal (2011)**

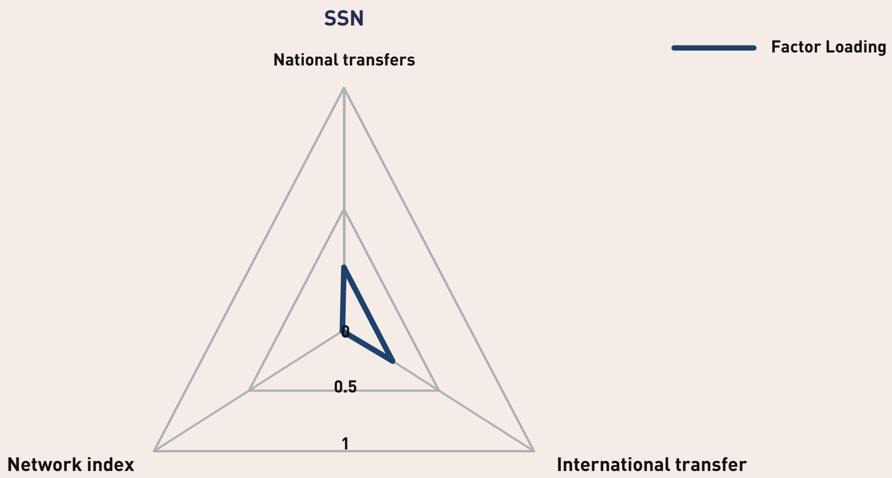


Source: Author's own calculation from Sénégal 2011

It is difficult to determine the exact figures in relation to international monetary transfers, since part of these is not officially tracked. However, data suggest that total national remittances went from US$ 305 million dollars in 2001 to US$ 1 288 million dollars in 2008. The Enquête Sénégalaise Auprès des Ménages II (ESAM) provided by ANSD (ANSD, 2015) shows that households receiving remittances increased their per capita expenditure by around 60 percent more than households that did not receive any remittances, which confirms the results in this analysis about the relevance of transfers in terms of the RCI. The above-mentioned figures refer both to formal and informal transfers (i.e. received either through public administration units or through family or relatives).

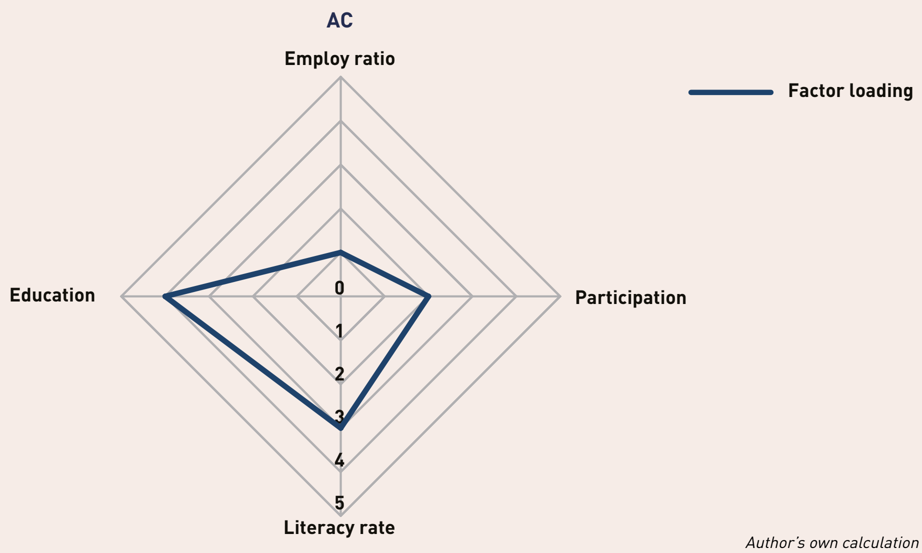
However, the coverage provided by formal safety nets remains limited, reaching only 13 percent of the population (WB, 2015).

Figure 7. **Resilience structure - Variable weights in SSN in Senegal (2011)**



Source: Author's own calculation from Sénégal 2011

Figure 8. **Resilience structure - Variable weights in AC in Senegal (2011)**



Source: Author's own calculation from Sénégal 2011

There have been many policies implemented to help especially the poorest groups, such as the Bourses de Sécurité Familiale, which provides cash transfers to those households that send their children to school on a regular basis. However, it seems this programme has not sufficed household needs, given the lack of formal safety nets in particular in rural and remote areas.

In conclusion, the most relevant variables for the RCI at the national level are the infrastructure wealth index and safe walls, roof and floor in terms of ABS, and cultivated land in terms of AST.

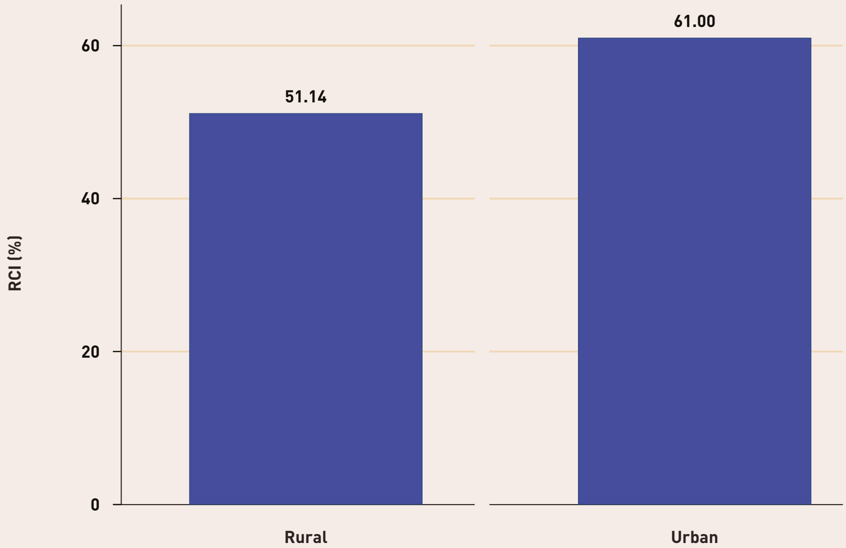
4.2 ANALYSIS BY GEOGRAPHICAL LOCATION: URBAN STATUS

Urban or rural localization plays a significant role for households in Senegal. On one side, the agricultural sector still accounts for 17.5 percent of Senegalese gross domestic product (GDP) (FAO, 2015) and 46 percent of the labour force (WB, 2016). On the other, Senegal is experiencing increasing urbanization (Kane, 2013). This internal migration has its roots in rural areas' lack of food, adverse climate conditions, and high rate of unemployment (ANSD, 2002).

While this urbanization process has brought about economic growth especially for the middle class living in urban areas, it has nonetheless not brought about benefits for the poorest groups, especially those in rural areas (IMF, 2013). ANSD (2011) shows that 74.3 percent of domestic migrants moved to cities, while 25.7 went to rural areas in 2011.

Households located in urban areas are more resilient on average than those located in rural areas. Localization has therefore a significant role in explaining differences in resilience, in line with the results of the recent FAO analysis of resilience in Senegal during 2005 (FAO, 2015). While urban households score an average RCI of 61, rural households score 51.13 (see Figure 9).

Figure 9. **RCI over urban status in Senegal (2011)**



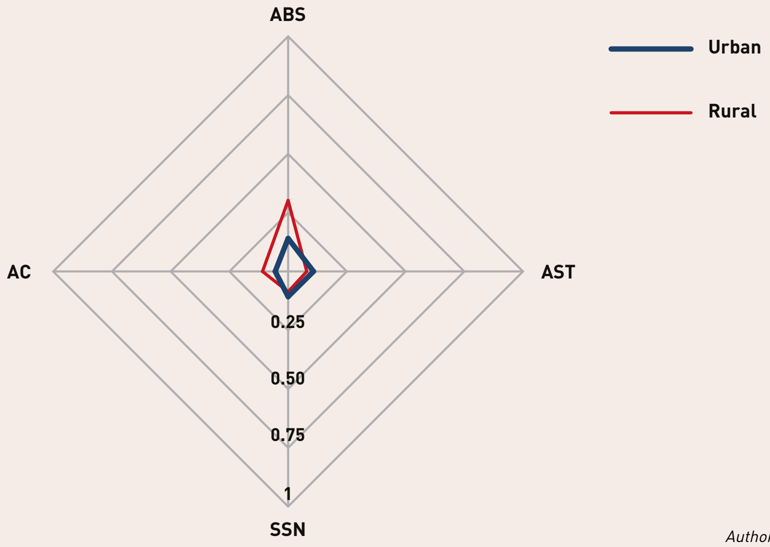
Source:
Author's own calculation from Sénégal 2011

Figure 10 shows the correlation between the pillars and the RCI over urban status. **AC and ABS are the most relevant pillars for rural households; however, while AC is positively correlated to resilience, ABS shows a negative correlation.** This could explain the difference in the RCI between these two sub-groups of the population: rural households have, in general, worse access to basic services (see Table A3).

Urban households are generally closer (in walking distance) to numerous services, such as schools, markets, asphalted roads and health centres (see Table A3). Similarly, the infrastructural wealth index is higher in urban areas; this index is constructed considering the presence of safe water, lights, toilets, waste disposal systems at the household level.

The comparative advantage of urban households in terms of ABS is confirmed in ANSD (2011), which shows that 81.71 percent of urban households have access to electricity for lighting compared to only 22.14 percent in rural households.

Figure 10. **RSM - Pillar weights over urban status, Senegal (2011)**



Source:
Author's own calculation from Sénégal 2011

AST is more important for urban households than rural households, mainly driven by the per capita value of assets. However, rural households have much higher access to agricultural assets; this is logical given that agricultural assets are expected to be less relevant in an urban environment. Table A3 shows that TLU is higher in rural areas (3.69 versus 0.32), with the same difference for cultivated land (3.43 vs 0.35), which is almost ten times higher in rural areas than urban areas. On the contrary the total value of assets owned is higher for urban households.

AC is less important for urban households. Families living in urban areas have higher values for all the variables, with the exception of the number of working people per household. This could be due to the fact that in rural areas, people start working at a younger age than in cities, thus increasing the number of family members working per household. Moreover, families in rural areas tend to be larger in number, and in the agriculture sector it is more likely for children and women to take up working roles than in other non-agricultural sectors (ANSD, 2011).

The capacity to read and write in at least one language is higher in urban areas, in line with the education level there; 46.2 percent of urban HHs have attended at least one school level, in comparison to the 15.8 percent in rural areas. This is in line with ANSD (2011), which reports that 85.1 percent of rural HHs never frequented a school (not taking into consideration Koranic schools) while in urban areas those HHs that have not attended school is around 55.3 percent.

Urban households have lower participation index figures, that is, they have fewer sources of income. This may be an indicator of less variability in income sources due to higher work specialization.

They also rely more on SSN than rural households. Urban households report higher levels of net national transfers, meaning that a large part of the population that migrate from rural areas tend to send money back to where they are from.

International transfers are one of the most important components of Senegalese GDP (WB, 2015), as mentioned above. Urban households show a greater volume of receipts of international transfers. Rural households score a higher network index, recording 0.70 compared to 0.60 for urban areas. As mentioned previously, the Senegalese population still strongly relies on agriculture and livestock rearing activities for their livelihood, which is taking place in a state of chronic vulnerability caused by unstable seasonal rains or climate shocks. Therefore, in environments prone to climate and price[6] shocks, participation in a network of associations, groups or cooperatives could be a sound coping strategy and an informal mode of insurance. Rural households are generally more exposed to climate risks and shocks, given that a higher percentage of their income is generated from agricultural activities compared to urban households. This is also due to food stock price fluctuations, providing a rational reason for them to be involved in a higher number of groups, for example cooperatives, religious groups, non-profit organizations and so on.

There are many policies already implemented by the Government of Senegal specifically aiming at decreasing these delta between urban and rural households. These include the Stratégie Nationale de Sécurité Alimentaire et de la Résilience (SNSAR); the Programme d'Accélération de la Cadence de l'Agriculture (PRACAS) is aimed at increasing rain-fed rice production and reaching self-sufficiency in rice by 2017.

In addition, in 2004, Senegal adopted the Law on agriculture, forestry and livestock production (LOSAP) with the aim to strengthen the agriculture sector through higher incomes for rural households, higher levels of food security, and a move towards sustainable development. The final aim of the LOSAP is to make agriculture the leading sector for sustainable economic growth.

Still, results portrayed in this section show that further rural policies should be implemented, especially for facilitating access to services such as schools, hospitals, public transportation and asphalted roads, as well as for increasing access to education and formal social safety nets, especially in more remote and agricultural areas.

4.3 ANALYSIS BY REGION

Dakar, Thiés and Saint-Luis are the three regions with the highest levels of resilience (respectively, 65.27, 64.12 and 61.29), while Zinguinchor, Kolda and Kedougou have the lowest levels (scoring 48.1, 47.04 and 46.97, respectively. See Figure 12).

Some differences exist when the RCI ranking of the regions from 2005 is compared to their ranking in 2011. An administrative reform in September 2008 created three new regions – Kaffrine, Kédougou and Sédhiou. These regions were formerly and respectively part of the Koalack, Tambacounda and Kolda regions during the analysis of 2005. Therefore, this could be the cause of the slightly different rankings between 2005 and 2011.

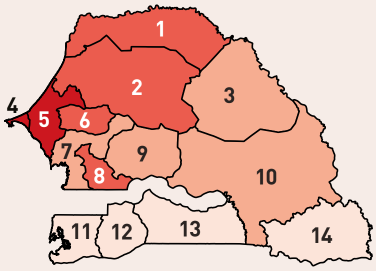
The RCI results are in line with many other development indicators, for example the poverty incidence score (see Figure 11), which is highest for the Kolda, Kédougou and Zinuinchor regions (respectively, between 67 and 73 percent) and lowest for the Dakar region, where it is only 26 percent (IMF, 2013). Moreover, ANSD (2011) delta Senegalese regions into three categories according to the poverty incidence indicator: very strong poverty rates (higher than 60 percent) in Kolda, Sédihou, Kédougou, Tambacounda, Kaffrine, Ziguinchor, Fatick and Koalack; strong poverty rates (between 40 percent and 60 percent) in Diourbel, Matam and Thiès; and less strong poverty rates (less than 40 percent) in Dakar, Louga and Saint Louis. This general categorization is also represented in Table A5, especially in terms of ABS and AC.

6 Especially in the case of agricultural products, which are highly dependent on world price fluctuations, as shown during the 2007-2008 food price crisis.

Figure 11. **Maps of resilience Index and poverty rate in Senegal (2011)**

Resilience index

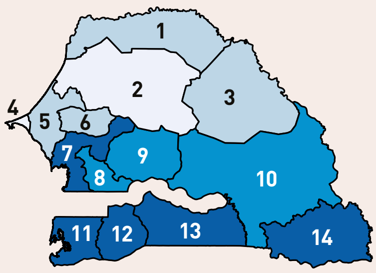
47-52%	
52-57%	
57-62%	
62-67%	



1	Saint-Louis	61.3%
2	Louga	60.7%
3	Matam	56.7%
4	Dakar	65.3%
5	Thiés	64.1%
6	Diourbel	57.8%
7	Fatick	53.3%
8	Kaolack	60.1%
9	Kaffrine	54.3%
10	Tambacunda	53.5%
11	Zinguinchor	48.1%
12	Sédhiou	51.9%
13	Kolda	47.0%
14	Kédougou	47.0%

Poverty rate

25-38%	
38-51%	
51-64%	
64-77%	



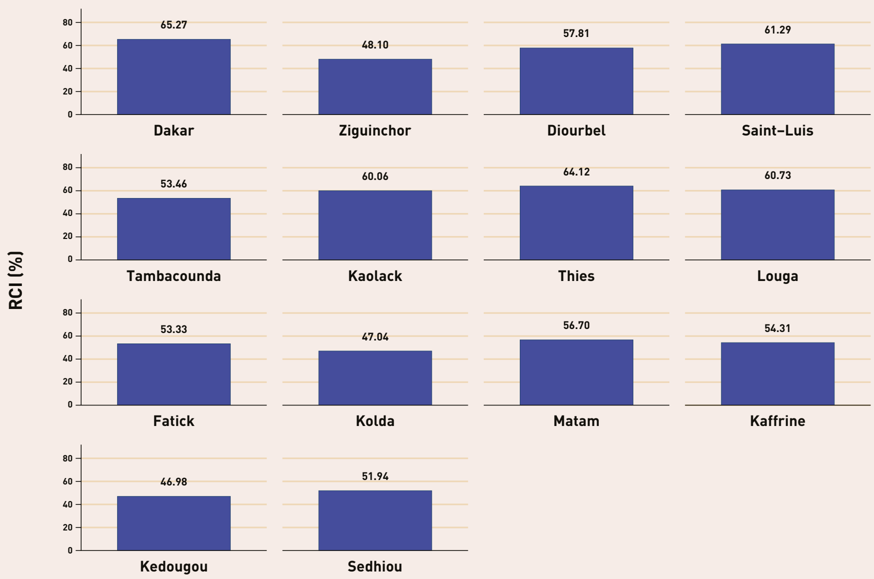
1	Saint-Louis	39.5%
2	Louga	26.8%
3	Matam	45.2%
4	Dakar	26.1%
5	Thiés	41.3%
6	Diourbel	47.8%
7	Fatick	67.8%
8	Kaolack	61.7%
9	Kaffrine	63.8%
10	Tambacunda	62.5%
11	Zinguinchor	66.8%
12	Sédhiou	68.3%
13	Kolda	76.6%
14	Kédougou	71.3%

Source: Author's own calculation from Sénégal 2011

Localization (i.e. whether a household is located in an urban or rural area) is not just relevant for individual regions across Senegal; it also plays a role in terms of specific regions and where the household is located within that region. Those interviewed in Dakar are located 100 percent in urban areas; Thies has 63.87 percent of its sample in urban areas; while Saint Luis is more balanced with 49.32 percent in urban areas. This territorial distribution can further explain why some regions have a higher RCI; those with the highest percentages of households located in urban areas have generally better access to services, cultural capital and social safety nets than those located in rural zones.

The analysis of AST supports this finding – those regions with generally higher agricultural and livestock assets are those performing worse in terms of RCI (see Table A1). As in Table A5, the region of Matam registered the highest level of TLU, while Tambacounda, Fatick, Kaffrine, Kolda and Kedougou – two of the most disadvantaged regions in terms of RCI – have on average the largest areas of cultivated land.

Figure 12. **RCI over regions in Senegal (2011)**



Source:
Author's own calculation from Sénégal 2011

As expected, the Dakar region scores the highest level of RCI. It is the region where the capital city is located, and generally scores better across any development indexes (ANSD, 2011) compared to other regions. This positive result for Dakar can be explained by the general proximity of each service (schools, health centres, etc.) to households, the presence of the best housing commodities, as well as the best access to services such as electricity, safe water, safe toilets and waste disposal systems, as supported by the figures in Table A5.

Moreover, Dakar is the main recipient of public expenditure (IMF, 2013); poorer regions like Zinguinchor, Kolda and Kedougou receive in comparison, for instance in the case of public health spending, respectively 5.4, 3.6 and 3.8 percent of the total amount of national healthcare expenditure. This can lead to lower access to public services, as shown in Table A5, lower housing standards and longer walking distances to water sources, markets and health facilities, as is the case for Zinguinchor, Kolda and Kedougou, which explains the lower scores for ABS.

In terms of AC, Kedougou, one of the three most hindered regions in terms of the RCI, has the highest participation index, indicating that household members rely on numerous source of income. This can be considered as an indicator of a possible coping strategy in an uncertain environment – as the RCI suggests – the more income sources, the lower the risk of income shortfalls.

Remittances, notably those delivered internally within Senegal, are relevant especially for those regions scoring a lower level of RCI, such as Zinguinchor. This suggests that in these areas, numerous people have left to move to wealthier regions and are sending money back to where they moved from (see Table A5). Nonetheless, in terms of SSN, the network index is particularly high in Kedougou and Ziguinchor, suggesting that a higher instability and dependency on agriculture and livestock activities is related to a higher probability that the household will join other networks as a coping strategy to counteract the lack of other institutional safety nets.

In conclusion, the results provided by the analysis of the RCI at the regional level suggest that policies aimed to increase food security and household resilience should focus especially on the regions that are more disadvantaged. This should be carried out by diverting the majority of public investments from the region of Dakar towards those regions with the lowest levels of ABS or rural development, as in the case of the Stratégie Nationale de Sécurité Alimentaire et de Résilience (SNSAR) or PRACAS.

4.4 ANALYSIS BY HOUSEHOLD HEAD GENDER

FHH are on average more resilient than MHH. This in line with what was previously found in the FAO resilience report for Senegal in 2005 (FAO, 2015).

Figure 13 shows that FHH register an average RCI of 59.8, while MHH score an average of 55.3. In the sample analysed, 74.76 percent of households are headed by a man, while 25.25 percent are headed by a woman.

However, this resilience difference can be explained in part by the fact that FHH are **mainly located in urban areas**. 74.56 percent of FHH in the analysed sample are in urban areas, while only 25.44 percent in rural ones. As previously mentioned, localization is a key driver of resilience.

Therefore, FHH perform very well in terms of ABS and SSN, which is in line with the results shown in Table A2. Generally, FHH are better located for accessing services like water, markets, schools and healthcare centres, and record lower levels of TLU and hectares of cultivated land. Urban localization of FHH is crucial to understanding why they have better access to basic services and lower access to agricultural assets.

However, the gender of the HH is still important in terms of explaining resilience. For example, this is relevant in relation to SSN, given the key role played by remittances and transfers in the Senegalese economy (Randazzo and Piracha, 2014). Typically, men leave their original place of residence to seek better economic opportunities elsewhere. This means that women are often left in charge of the household, but that they are also those managing remittances, which could explain the high relevance of SSN in terms of FHH resilience capacity.

AST, in terms of TLU and cultivated land has higher levels for MHH (see Table A2). This could be because of, firstly, the higher proportion of FHH in urban areas. Secondly, because of the fact that generally women are not entitled to own their own land and are more likely to own or manage small-medium livestock such as poultry or goats. For this reason, livestock has been recently addressed by numerous policies at the rural level, for example, the Plan National de Développement de l'Elevage (PNDE) has been implemented and involves improvement of animal productivity, animal safety, access to livestock markets, and the institutional framework.

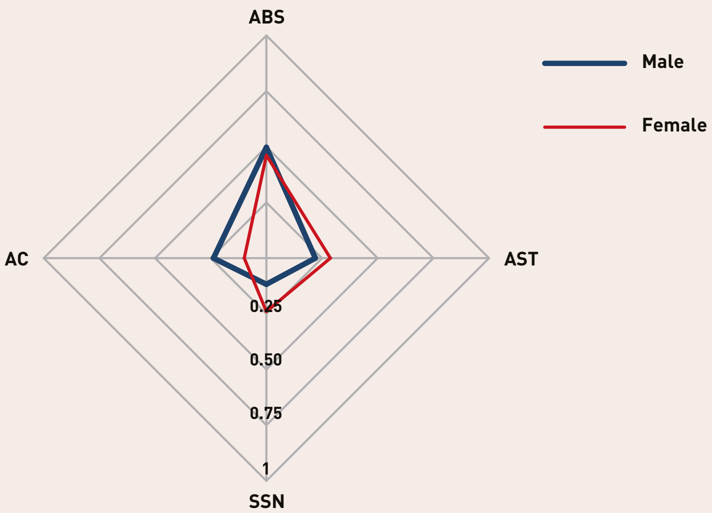
The difference between genders on AC is another important finding. MHH register a higher level of AC than FHH, and AC is also more relevant in explaining the RCI for MHH (see Figure 14). Indeed, FHH have lower levels of education as well as of literacy levels (57.4 percent of MHH can read and write, versus 28.6 percent of FHH). This is in line with the main literature, wherein in Senegal only 4.6 percent of women have reached at least a secondary level of education, while for men this is around 11 percent.

Labour market participation is strongly related to education, especially for women (Ayanaoui, 1996). FHH score worse than MHH when it comes to employment, with an average employment ratio of 27 percent in comparison to 34.4 percent of their male counterpart.

Figure 13. **RCI over HH gender in Senegal (2011)**

Source:
Author's own calculation from Sénégal 2011

Figure 14. **Pillar weights over HH gender in Senegal (2011)**



Source:
Author's own calculation from Sénégal 2011

Senegalese women's participation in the labour market in 2010 was 61 percent, while the male labour force participation rate was 88 percent (WB, 2016). In 2012, Senegal ranked 115 out of 148 countries in terms of the Gender Inequality Index (GII) (UNDP, 2013); the GII measures gender inequalities in three important aspects of human development – reproductive health, measured through the maternal mortality ratio and adolescent birth rates; empowerment, measured through the proportion of parliamentary seats occupied by females and the proportion of adult females and males aged 25 years and older with at least some secondary education; and economic status, expressed as labour market participation and measured through the labour force participation rate of female and male populations aged 15 years and older(UNDP, 2016).

Since 2005 to the present time, the number of FHH has increased nationally from 20 percent to 27.4 percent. Marital status is an important element in explaining this scenario; while 94.41 percent of male household heads are married (including monogamous and polygamous marriages), only 55.64 percent of female household heads are married. Accordingly, the proportion of women heading a household without a companion (including divorced, widowed and single women) is 44.2 percent, versus the 5.6 percent of men heading households without a companion. This could mean that it is more likely to have a FHH if there are no men present who could be in charge of the household.


© FAO \ Marco Longari


© FAO\Marco Longari

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.

In this section, two sub-groups of households that were interviewed during the 2005 ESPS-I and 2011 ESPS-II surveys in Senegal are compared in order to explore the main drivers of change with respect to RCI and food security across the two points in time.

The first part the analysis involves the difference in resilience between 2011 and 2005. RIMA-II was estimated employing the same set of variables, in order to allow for cross-time comparison. The second part of the analysis looks at food security changes over time and explores the determinants of change.

The datasets for the comparison part are taken from the ESPS-I and ESPS-II surveys. The two datasets have not been collected as panel data, so they cannot be treated as such. Consequently, and in order to allow for a comparison over a period of time, a PSM approach was followed. PSM is a widely used technique in non-experimental studies (Heckman *et al.*, 1998; Dehejia and Wahba, 1999; Dehejia and Wahba, 2002; Imbens, 2000; Caliendo and Kopeinig, 2005). PSM matches observations based on a given vector of characteristics. In this exercise, a vector of socio-economic household characteristics has been adopted in order to estimate a probit model for each household. This ultimately translated into the prediction of a score for each household, against which the two distributions (from 2005 and 2011) have been compared. The final dataset counts 2 661 matched observations.

In this study, there is no treatment nor any treated population; as a consequence there is no pre-existing outcome variable (i.e. whether a household has or has not been the recipient of some sort of programme) that can be employed in a model and associated with determinant variables. This variable was therefore created by dividing the population in high and low resilience capacity classes based on the RIMA-I analysis for 2005 and the RIMA-II analysis for 2011.

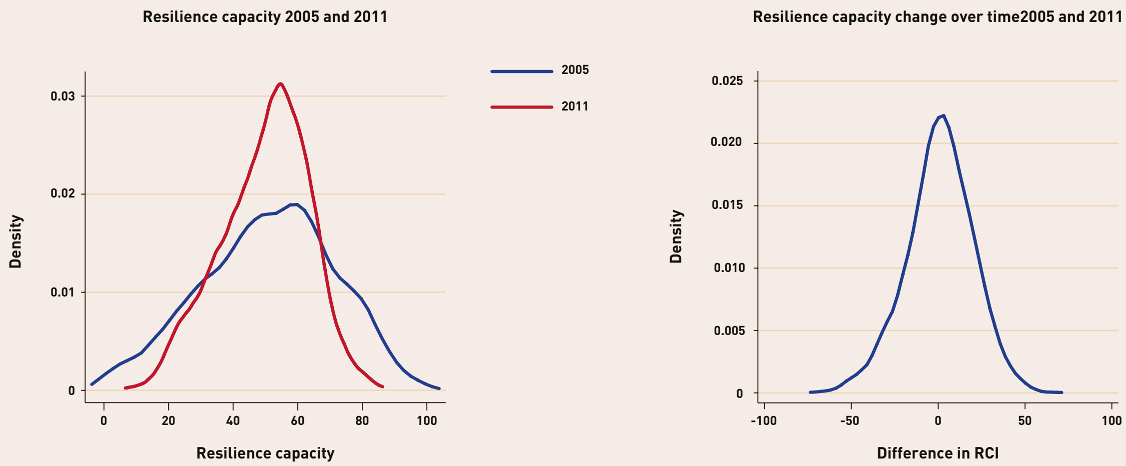
The clear assumption of this approach (the Conditional Independence Assumption, or CIA) is a clear limitation; however, saying that a resilience capacity status can be associated with specific values of observed variables seems to be reasonable. Based on this assumption, it is therefore possible to draw some causal inference on the determinants of the change in resilience capacity.

Evidence from dynamic analysis shows that resilience and food security growth are especially driven by better **infrastructure**; greater access to both **productive and non-productive assets**; better access to **market** and **public transportation**; sound **safety networks**; and a positive **literacy** level (see table A4).

5.1 CHANGES IN RESILIENCE CAPACITY OVER TIME

Resilience capacity increased by 1 percent between 2005 and 2011. This can be seen in Figure 15, which reports both the distributions of the RCI for 2005 and 2011, and the distribution of the difference between the two distributions.[7]

Figure 15. **RCI over time and RCI delta between 2005 and 2011**



Source:
Author's own calculation from ESPS I and II

The difference between the two distributions is statistically significant (based on the Student's t-tests (Welch, 1947). However, the increase in RCI of 1 percent is not significant in itself, and the study design's limitations suggest caution should be taken in running ordinary least square analysis.

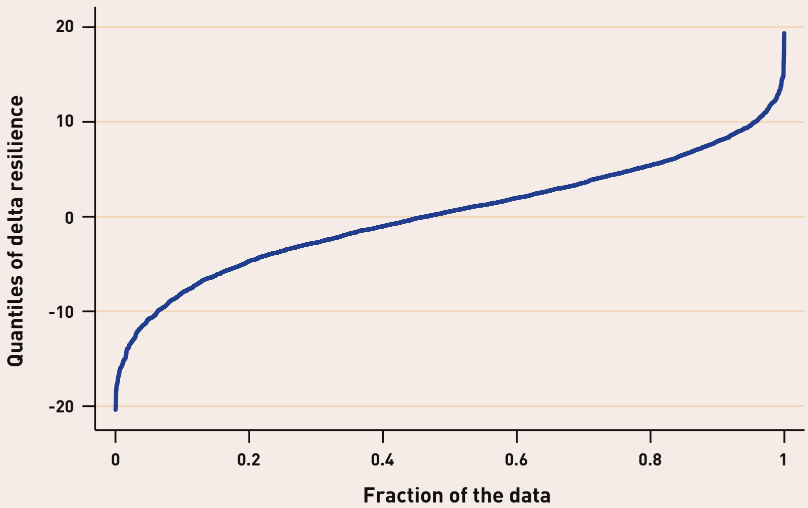
While resilience capacity increased on average, it is interesting to focus on the two tails of the distribution as can be seen in Figure 15: those that suffered a reduction in resilience and those that gained an important increase.

In order to have a further look at the major quantiles of the distribution, Figure 16 explores how they are distributed.

Figure 16 clearly shows that, from the beginning of the distribution to (approximately) the 25th quantile, there is a strong reduction in resilience capacity (from -20 percent to -5 percent); on the contrary, from the 75th there is a strong increase. The following analysis will therefore be focused on these two sub-samples of the population.

[7] Note that the scales of the two x-axes are different.

Figure 16. **Quantiles of resilience growth in Senegal 2005/2011**



Source: Author's own calculation from Sénégal 2011

The hypothesized model is designed as follows:

$$\Delta Res_{i,t_1-t_0} = \alpha + \beta_1 X_{i,t_0} + \beta_2 Z_{i,t_0} + \beta_3 W_{i,t_0} + \varepsilon_i \quad (1)$$

Where the difference in resilience capacity for the household i is given by a set of socio-economic characteristics (X); a set of geographical and social status characteristics (Z); a vector of variables that were formerly employed as covariates of resilience (W); a constant part (α) and the error (ε). Note that every adopted regressor is expressed at time 0 (i.e. 2005) provided that the assumption is that variables in 2005 contributed to the growth (or loss) in resilience capacity. In (1) there are control variables for regions (given geographical heterogeneity), rural or urban status (given the relevance that being or not being in a rural area has in determining household resilience), and marital status (given the social relevance that this – especially for women – may have).

A certain degree of heteroscedasticity was found that was resolved with obtaining bootstrap standard errors (Mooney and Duval, 1993).

The quantile regressions on the lower quantiles (25) on the median (50) and on the higher quantiles (75) show few differences, but interesting findings, in Table A6. **The infrastructure index** always influences the increase in resilience capacity. The effect varies if one looks at the lowest or highest quantiles as compared to the median. This means that the better the household's infrastructure index, the better the chances that the household will record a higher RCI in 2011 than the one in it recorded in 2005.

The **value of house assets**[8] **owned by the household** plays a relevant role in each quantile. It is especially relevant to the higher quantiles and the median ones; this is supported by the literature, which always correlate high-value assets with the better-off population group.

[8] Some examples of house assets included in this index are: mattresses, table, chairs, wardrobe, sofa, carpet, radio, mobile phone, television, computer, and car.

On the other hand, better **access to the markets**[9] positively correlates with a growth in resilience capacity especially for those households in the lowest quantiles. The poorest population rely significantly on agriculture and having better access to the market system means two important points: having a better chance to sell products (which in turns can increase income-generating activities, ultimately increasing the effectiveness of coping strategies) and better access to food items, which translates to better quality of life and – in the case of an emergency – the possibility to reduce the exposure to shortage of food.

Access to public transportation is mainly relevant for the highest part of the distribution. This may correlate to the different style of life between the lowest and highest quantiles. That is, for those in the bottom part of the distribution, having access to public transportation was not as relevant as other variables (assets and infrastructure, for instance). Meanwhile, this played a relevant role for those were already in the better part of the distribution.

Interestingly, a more elderly HH is associated with a reduction in resilience capacity. This could be due to the fact that after a certain age, the HH does not work anymore (or works less efficiently) and so the family loses the main breadwinner who, in turn, must be supported by other household members who are actively employed.

Household size negatively affects the possibility of increasing resilience over time, suggesting that having many people in the household increases the needs of the household without adequate compensation in income-generating activities. However, the square of the size goes in the opposite direction and indicates a positive effect on household resilience growth. Likely this relates to the marginal increase in average household needs related to the greater opportunity for income diversification, since more people inside the same household can take on more work.

Expenditure on health and on **non-food items** has a negative effect on the growth of resilience. While this finding is a bit counterintuitive and controversial, this may relate to the occurrence of shocks and/or health problems that may have undermined household capacity to increase resilience.

The **number of assets related to the house** (e.g. television, refrigerator, beds) has a statistically significant and positive impact on increasing resilience over time. While this finding is not particularly surprising, it is still interesting to observe the different extents of the effect on different quantiles. Household assets have a greater impact on the highest quantile and a clearly minor effect on the lowest quantiles.[10]

The larger the area of land owned, expressed in hectares, then the lower the increase in resilience in the highest quantiles (while it has no effect over the rest of the distribution). Land is quite homogenously distributed among this sub-sample of the population. This, together with the above-mentioned finding, does not mean that land is not necessary for resilience but, rather, that access to cultivable land is an already present element of resilience. Therefore, there are other aspects of resilience that can be proven to be more effective in increasing household resilience capacity. Furthermore, this could be explained by the fact that those who have access to land are usually living in rural areas, which in terms of the RCI score always means they are worse off than households located in urban areas. This is confirmed by the fact that being located in an urban area in 2005 increases the household resilience growth in every quantile.

[9] Access to market is approximated by the distance to the nearest market. The variable is built in the following way: the higher the value of the variable, the greater the access.

[10] Student t-test confirmed the statistical validity of the difference between the coefficients of the 25th and 75th quantiles.

Finally, **being part of numerous associations**, captured by the network index, both positively and significantly increases resilience over time. This finding is supported by the entire literature on social protection.

Therefore, the main drivers of Senegalese households' resilience capacity are infrastructure; wealth index (i.e. access to safe water, toilets and electricity); distances to markets and to public transportation; social networks; and the value of assets owned by the household.

5.1 CHANGE IN FOOD EXPENDITURE LEVELS OVER TIME

The same analytical process was carried out for food security. When analysing the delta between food expenditure levels in 2005 and 2011, the assumption is that an increase in the difference between 2005 and 2011 food expenditure levels indicates an improvement in 2011 food security levels, since households can afford to devote more resources towards food purchases.

In this case, (1) can be rewritten employing a food security indicator:

$$\Delta FS_{i,\,t_1-t_0} = \alpha + \beta_1 X_{i,\,t_0} + \beta_2 Z_{i,\,t_0} + \beta_3 W_{i,\,t_0} + \varepsilon_i \qquad (2)$$

Where changes in food security over time depend on a vector of socio-economic variables; a vector of control variables; a vector of the variables employed in the resilience analysis; plus the error term.

Bearing in mind that food security is commonly conceptualized as resting on three pillars – availability, access, and utilization – analysts use proxy measures for different aspects of food security (Barrett, 2010). The most commonly adopted are caloric intake; dietary diversity, through the Shannon or Simpson indexes; and food consumption score. In this study, food expenditure was adopted as a proxy measure for access to food security. Food expenditure has been employed in many applied econometric studies (Masters, 2009; Barrett, 2010; Lo *et al.*, 2012) and effectively captures the geographic heterogeneity of food security. However, the limitations of food expenditure as food security indicators must be acknowledged – for example, the fact that it depends on the survey respondent's recollection of expenditure (Rose and Charlton, 2002; Barrett, 2010) – and thus further investigations should take place.

Literacy level has a positive impact on the difference in food expenditure between 2005 and 2011. The literacy level of household members could significantly influence expenditure on food in numerous ways: it can lead to better wages and to more reliable jobs or sources of income (see Table A7). Also, a higher level of education is associated with greater adaptive capacity; in case of job loss it is easier for a well-educated person to find another (similar or different) source of income.

Having a house with better and more **solid walls**, **safe water**, an **adequate roof** and **access to electricity** positively influences food expenditure over time. Similarly, the **network index** has a positive statistically significant effect on the levels of food expenditure in the long run. This is true especially in **rural areas**, where being part of different groups (credit groups, religious groups, non-profit organizations, cooperatives, and so on), could act as a social safety net in case of economic downturn or climate shocks affecting agricultural production. The network index suggests that a household can rely on a certain number of associations; the higher the number, the more this network might function as a mode of informal insurance in case the household is in need. Eventually, this could translate into greater food security over time.

The number of **assets owned** by the household has a positive effect on the increase in food expenditure level. It can be assumed that the number of assets owned could be used as a proxy for household wealth being therefore linked to household well-being. Owning a range of assets can effectively mean broadening the possibility of assets smoothing, which ultimately increases coping capacity.

Expenditure on items different from food and on assets for the house both negatively affected the growth of food expenditure in 2011. This could be due to a simple substitution strategy, where better-off households allocate more resources to non-food items once they have reached food security.

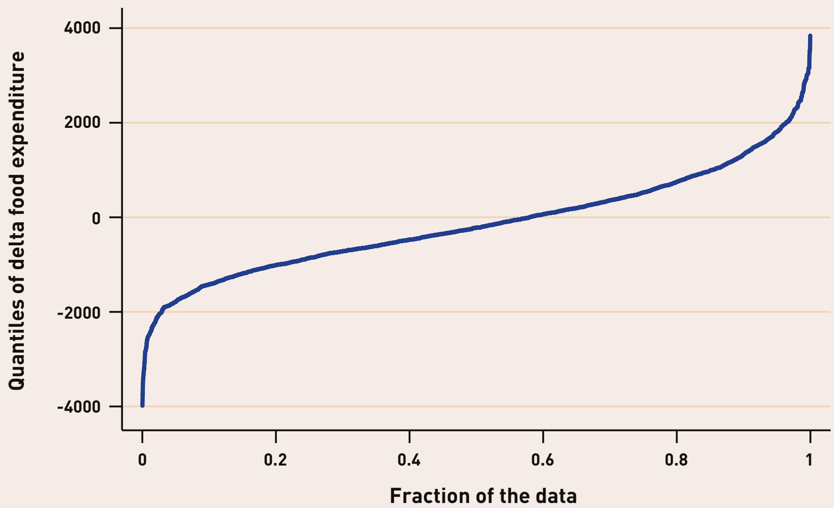
The equation (2) can be further disaggregated by looking at the quantile distribution. This has been done in order to capture the main determinants of food security changes over time in the bottom and in the upper part of the distribution.

$$Q25\ \Delta FS_{i,t_1-t_0} = \alpha + \beta_1 X_{i,t_0} + \beta_2 Z_{i,t_0} + \beta_3 W_{i,t_0} + \varepsilon_i \quad (3)$$

$$Q75\ \Delta FS_{i,t_1-t_0} = \alpha + \beta_1 X_{i,t_0} + \beta_2 Z_{i,t_0} + \beta_3 W_{i,t_0} + \varepsilon_i \quad (4)$$

Here, the analysis is focused on the first and last 25 quantiles. A quantile plot strongly supports this research theme, demonstrating a clear quantile distribution curve in Figure 17.

Figure 17. **Quantiles of food expenditure growth in Senegal 2005/2011**



Source:
Author's own calculation from Sénégal 2011

Figure 17 offers an interesting insight, showing that the largest increase in food security is concentrated in the last quantiles, while the greatest reduction in food security is more focused on the initial 15 to 20 quantiles. Based on this analysis, a quantile regression was employed to better evaluate (3) and (4) on the median, the first 25 and the last quantiles (see Table A8). Similar to the analysis of the RCI, bootstrap standard errors were obtained.

Those households that are in the first quantile comprise those families for which in 2005 food expenditure was higher than in 2011, meaning that their level of food security decreased over time.

Better housing and better infrastructure significantly increase resilience, with a greater effect on those in the highest quantiles.

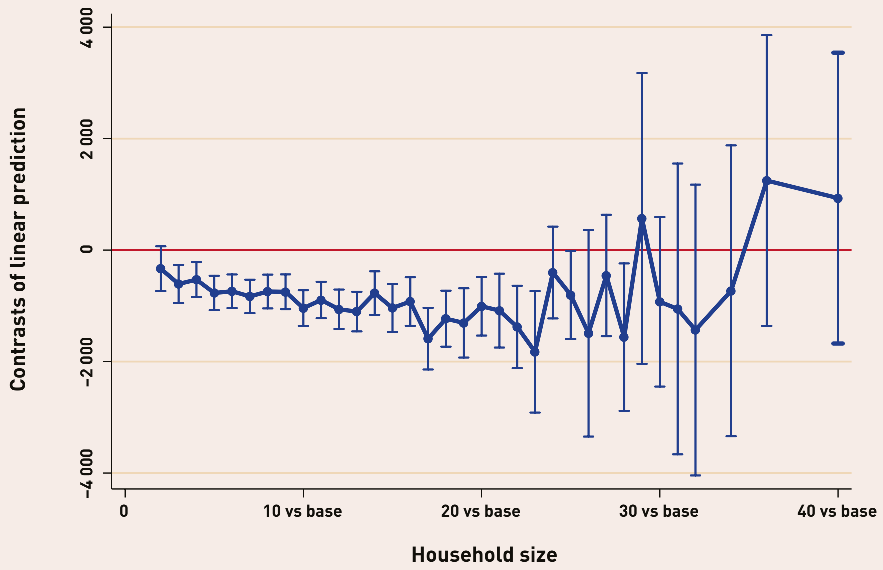
Assets play a major role for this sub-sample of the population, even if with a minor impact (but still significant and positive) for those in the lowest quantiles.

Finally, **expenditure on health, housing and non-food items** reduces the growth in food expenditure, which most likely correlates with an already positive and stable food security situation.

Better access to markets is crucial for those households in the lowest quantiles. This is closely correlated with what has been reported so far here for resilience capacity growth, with the current literature on access to markets (Dercon *et al.*, 2004), and with the most recent policies implemented in the most food insecure areas of Senegal. Being closer to markets as well as being in contact with numerous associations both increase food security.

Household size plays the same peculiar role played in (1) – a very large household increases food expenditure, yet the initial effects of household size are negative. This can be visualized through Figure 18.

Figure 18. **Contrasts of adjusted predictions of household size with 95 percent Confidential Intervals (CIs) in Senegal 2005/2011**



Source:
Author's own calculation from Sénégal 2011

Where the initial negative effect of an increase in the household size is successfully compensated by an increase in food security for larger families.

In conclusion, similar to the results for the RCI, a positive difference among food expenditure in 2011 and 2005 is positively affected by the ownership of assets, and easier access to markets or public transportation, safe water, electricity, safe toilets and lighting (more generally, infrastructure), as well as the possibility of being part of numerous groups. Otherwise, expenditure on non-food items and healthcare can partially explain a decrease in food expenditure.


© Flickr CC Anne Delaporte

6 MAIN CONCLUSIONS 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 government of Senegal.

This analysis has utilized the RIMA-II methodology in order to measure the resilience capacity of households in Senegal in 2011, and to understand how resilience capacity and food security changed over time from 2005 and 2011 in a continuation of the preceding RIMA-I analysis carried out for 2005. The datasets used are from the ESPS-I and ESPS-II surveys, respectively collected in 2005 and 2011 by the ANSD of Senegal. Numerous dimensions of Senegalese households' resilience capacity have been explored in order to provide a comparison at the regional, urban status, and HH gender levels, and in order to provide an adequate foundation for policy implications.

- At the national level, the main results in terms of the RSM for 2011 demonstrate that the main pillars in explaining resilience capacity are **ABS** and **AST**, while SSN and AC have a more marginal role. In terms of ABS, the infrastructural wealth index and having a sound roof, walls and floor are the most important variables. Meanwhile, for AST, agricultural inputs such as land and TLU are the factors that influence more significantly the RCI at the national level. The dynamic analysis shows that the infrastructural wealth index plays a major role in explaining resilience capacity and food security increases over time, as do distances to markets and to public transportation, social networks, and the value of assets owned by the household.
- At the regional level, Dakar, Thiés and Saint-Luis record the highest levels of RCI, while Zinguinchor, Kolda and Kedougou are the regions scoring the worst. In line with the official national poverty indexes, proximity to basic services, better housing conditions, different levels of education and literacy levels, and agricultural inputs such as land and TLU are the main factors explaining regional differences.

- In terms of HH gender, FHH are on average better off than MHH in terms of resilience capacity. This result could be biased by the localization of households; indeed, the majority of FHH are located in urban areas, where RCI is generally higher than in rural areas. Generally, FHH are advantaged in terms of ABS and SSN. The fact that FHH are the main receivers of cash transfers should be considered by policy makers, especially for the key roles that remittances have in income distribution and consumption behaviour at the household level. Moreover, there is a significant gap in terms of education and literacy level between FHH and MHH, given that female HHs generally receive less education than male HHs.

Finally, the dynamic model comparing resilience capacity and food expenditure in 2005 and 2011 shows that the main drivers of food expenditure growth are literacy level, safe walls, safe water, an adequate roof, and access to electricity, as well as the network index. Similarly, assets owned by the household and easier access to public transportation and market are also key components in increases in resilience capacity and food expenditure.

These findings have been taken into consideration, especially with reference to the numerous policies recently implemented or with the potential to be implemented by the Government of Senegal, both at the national and regional levels.

Given the results of the resilience capacity analysis, further public policies should focus on: developing better infrastructure for basic services; increasing the availability of infrastructure, especially in rural areas; increasing the level of education, especially for women; and increasing the focus on agricultural development, both in terms of infrastructure and assets.

An important development model adopted has been the PSE, which aims for long-term economic and social growth through social inclusion and the reinforcement of agriculture, agribusiness, environment, mines and tourism. With reference to the agricultural sector, the main objective is its modernization, considering also the livestock, fishery and aquaculture sectors in order to reinforce national food security, bring about trade balance by reducing food item imports, develop a competitive food value chain, and finally to invigorate the rural economy.

The promotion of commercial agriculture, for example through the restructuring of the peanut production chain (aiming to increase the production of edible groundnut by 20 to 30 percent), and the modernization of household level agriculture is another important element of the PSE through more than 150 micro-projects. The Programme de Développement des Marchés Agricoles du Sénégal has similar development objectives.

Given the vital importance of the livestock sector in terms of the RCI, policies like the PNIA aims to increase the productivity and the competitiveness of the animal production chain; to reinforce meat and dairy product transformation; and conserve infrastructures, as well as make an improvement in livestock health. Special efforts have been made especially in the poultry sector and in strengthening pastoral infrastructure.

Moreover, even if this analysis demonstrates the higher level of the RCI for FHH compared to MHH, many indicators suggest that women should be targeted with focused development policies, especially with regard to education and access to safe water, electricity, toilets and waste disposal systems. The PRN aimed to increase – among pregnant women or mothers of children under five years old – awareness of hygiene, health and nutritional practices, especially in the regions of Kolda, Kédougou and Tambacounda, the first two of which rated among the lowest regions in terms of the RCI in the present analysis.

In conclusion, this report highlights the main sectors that should be targeted for future and actual policies in order to strategically and positively affect Senegalese household resilience capacity.

REFERENCES

ANSD. 2002. TRPH-III. Troisième Recensement de la population et de l'habitat. Ministère de l'économie et des finances.

ANSD. 2005. ESPS - Enquête de suivi de la pauvreté au Sénégal. Ministère de l'économie et des finances.

ANSD. 2011. ESPS-II. 2011. Deuxième enquête de suivi de la pauvreté au Sénégal. Ministère de l'économie et des finances.

ANSD. 2015. ESAM-II. Enquête sénégalaise auprès des ménages 2e édition. Ministère de l'économie et des finances.

Barrett, C.B. 2010. Measuring Food Insecurity. *Science*, 327(5967): 825–8.

Caliendo, M. et Kopeinig, S. 2005. *Some practical guidance for the implementation of propensity score matching*. IZA Discussion Papers No. 1588. Available at: http://ftp.iza.org/dp1588.pdf

Dehejia, R. H. et Wahba, S. 1999. Causal Effects in Nonexperimental Studies: Re-evaluating the Evaluation of Training Programs. *Journal of the American Statistical Association*, 94(448): 1053–1062.

Dehejia, R. H. et Wahba, S. 2002. Propensity Score Matching Methods for Nonexperimental Causal Studies. *The Review of Economics and Statistics*, 84(1): 151–161.

Dercon, S., Bold, T. et Calvo, C. 2004. *Insurance for the poor?* QEH Working Paper Series No. 125. Available at: www3.qeh.ox.ac.uk/pdf/qehwp/qehwps125.pdf

El Aynaoui, J.P.K. 1996. *Une Investigation du Lien Pauvreté - Marché du Travail dans le Contexte du Maroc*. Revue Région et Développement, 3. Available at: region-developpement.univ-tln.fr/en/pdf/R3/R3_El_Aynaoui.pdf

FAO. 2015. *Country fact sheet on food and agriculture policy trends: Senegal*. Available at: www.fao.org/3/a-i4841e.pdf

FAO. 2015b. *Resilience Analysis in Senegal 2005*. Available at: www.fao.org/3/a-i4456e.pdf

FAO. 2016. *RIMA-II: Resilience Index Measurement and Analysis - II*. Available at: www.fao.org/3/a-i5665e.pdf

FAOSTAT. 2016. *Country profile: Senegal*. Available at: http://faostat.fao.org/site/666/default.aspx

GTT-MR. 2014. *Resilience Measurement Principles. Toward an agenda for measurement design*. Technical Series No. 1. Available at: http://www.fao.org/fsnforum/resources/fsn-resources/resilience-measurement-principles

Heckman, J.J., Ichimura, H. et Todd, P.E. 1997. Matching as an Econometric Evaluation Estimator. *Review of Economic Studies*, 65, 261-294. Available at: http://www.jstor.org/stable/pdf/2971733.pdf

Imbens, G.W. 2000. The Role of the Propensity Score in Estimating Dose-Response Functions. *Biometrika*, 87(3): 706–710.

IMF. 2013. *Inclusive Growth and Inequality in Senegal*. IMF Working Paper 13/215. Available at: www.imf.org/external/pubs/ft/wp/2013/wp13215.pdf

Kane, S. 2013. Women and Development in Urban Senegal: Microcredit and Social Capital. *African Sociological Review*, 17(1): 45–64. Available at: www.ajol.info/index.php/asr/article/view/99584

Lo, Y.T., Chang, Y. H., Lee, M.S. et Wahlqwist, M.L. 2012. Dietary diversity and food expenditure as indicators of food security in older Taiwanese. Appetite, 58(1): 180–187.

Masters, E. 2009. *Indicators of Food Security*.

Mooney, C. Z., et Duval, R. D. 1993. *Bootstrapping: A Nonparametric Approach to Statistical Inference*. Sage, Newbury Park, Californie (États-Unis).

Randazzo, T. et Piracha, M. 2014. *Remittances and Household Expenditure Behavior in Senegal*. IZA Discussion Papers No. 8106. Available at: http://ftp.iza.org/dp8106.pdf

Rose, D., et Charlton, K. E. 2002. «Quantitative indicators from a food expenditure survey can be used to target the food insecure in South Africa», *The Journal of nutrition*, 132(11): 3235–3242.

SE-CNSA. 2015. Stratégie nationale de sécurité alimentaire et de résilience (SNSAR) 2015-2035. Secrétariat exécutif Conseil national de sécurité alimentaire, Sénégal.

UNDP. 2013. *Senegal: HDI values and rank changes in the 2013 Human Development Report*. Available at hdr.undp.org/sites/default/files/Country-Profiles/SEN.pdf

UNDP. 2016. *Gender Inequality Index (GII)*. Disponible à l'adresse: hdr.undp.org/en/content/gender-inequality-index-gii

WB. 2015. *Improving Gender Equality and Rural Livelihoods in Senegal through Sustainable and Participatory Energy Management: Senegal's PROGEDE II Project*. Available at: documents.worldbank.org/curated/en/850931467998193048/pdf/97844-BRI-PUBLIC-Box391491B-LW40-OKR.pdf

WB. 2016. *Sénégal*. Disponible à l'adresse: data.worldbank.org/country/senegal

Welch, B. L. 1947. The Generalization of 'Student's' Problem when Several Different Population Variances are Involved. *Biometrika*, 87(1/2): 28–35.

WFP. 2008. *Food consumption analysis: Calculation and use of the food consumption score in food security analysis*. Available at: documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf

(All links were checked on 10 August 2016)

ANNEX

Table A1. **Pillars by region in Senegal (2011)**

Regions	ABS	AST	SSN	AC
	Mean	Mean	Mean	Mean
Dakar	0.467	-1.113	0.666	0.547
Ziguinchor	0.212	-0.29	-0.023	0.556
Diourbel	0.0767	0.0219	-0.228	-0.259
Saint-Louis	0.0473	-0.291	0.035	-0.0606
Tambacounda	-0.366	0.384	-0.141	-0.229
Kaolack	0.0457	0.196	0.194	-0.0124
Thies	0.312	-0.365	-0.00241	0.0826
Louga	0.125	-0.29	1.295	-0.0475
Fatick	0.047	0.312	-0.227	-0.0263
Kolda	-0.319	0.425	-0.547	-0.0555
Matam	-0.115	0.102	-0.123	-0.432
Kaffrine	-0.235	0.588	-0.238	-0.0811
Kedougou	-0.591	0.332	-0.28	-0.238
Sedhiou	0.00782	0.315	-0.564	0.0172
Total	-1.4E-10	-8.44E-10	6.01E-09	-1.40E-09
Observations	4 953	4 953	4 953	4 953

Table A2. **Observable variables by HH gender in Senegal (2011)**

Variables	Mean	Male	Female
House value ($)	0.746	0.695	0.895
Infrastructure wealth index	0.584	0.55	0.687
Distance to water source (min.) (inverted)	-1.083	-1.098	-1.04
Distance to public transport (min.) (inverted)	-1.349	-1.398	-1.204
Distance to market (min.) (inverted)	-1.575	-1.635	-1.395
Distance to healthcare (min.) (inverted)	-10.34	-11.27	-7.558
Distance to elementary school (min.) (inverted)	-1.153	-1.166	-1.114
TLU	1.882	2.308	0.622
Cultivated land (hectares)	1.771	2.204	0.49
Asset value per capita	89.71	79.88	118.8
International transfers per capita monthly ($)	4.996	2.28	13.04
National transfers per capita monthly ($)	16.87	10.58	35.5
Network index	0.646	0.671	0.573
Employment ratio	0.325	0.344	0.27
Participation index	0.193	0.226	0.0946
Literacy level	0.501	0.574	0.286
Education	0.321	0.329	0.298
Observation	4 953	3 703	1 250

Table A3. **Observable variables by urban status in Senegal (2011)**

Variables	Total	Urban	Rural
House value	0.746	0.937	0.523
Infrastructure wealth index	0.584	0.755	0.385
Distance to water source (min.) (inverted)	-1.083	-1.049	-1.123
Distance to public transport (min.) (inverted)	-1.349	-1.143	-1.589
Distance to market (min.) (inverted)	-1.575	-1.279	-1.919
Distance to healthcare (min.) (inverted)	-10.34	-6.389	-14.93
Distance to elementary school (min.) (inverted)	-1.153	-1.083	-1.235
TLU	1.882	0.322	3.698
Cultivated land (hectares)	1.771	0.348	3.429
Asset value per capita	89.71	125.3	48.34
International transfers per capita	4.996	7.915	1.6
National transfers per capita	16.87	25.61	6.686
Network index	0.646	0.598	0.702
Employment ratio	0.325	0.299	0.356
Participation index	0.193	0.0875	0.316
Literacy level	0.501	0.564	0.428
Education	0.321	0.462	0.158

Table A4. **Regression on income, food expenditure and FCS in Senegal 2011**

Variables	(1) Year Income	(2) Food Expenditure	(3) FCS
HH age	41.68*** (9.592)	2.242*** (0.500)	0.103 (0.0688)
Household size squared	-5.559*** (0.354)	-0.220*** (0.0185)	-0.00407 (0.00254)
Household size	336.8*** (11.82)	13.45*** (0.617)	0.244*** (0.0848)
FHH	23.45 (76.63)	17.55*** (3.997)	1.467*** (0.549)
Urban location	-594.9*** (74.42)	-12.07*** (3.881)	-1.659*** (0.534)
House value	142.5* (82.46)	10.22** (4.301)	2.106*** (0.591)
Infrastructure wealth index	501.8*** (143.7)	58.61*** (7.496)	4.157*** (1.031)
Distance to water source	-7.802*** (2.727)	-0.187 (0.142)	-0.00465 (0.0196)
Distance to public transportation	0.940 (1.297)	-0.0585 (0.0677)	0.0228** (0.00930)
Distance to police station	-0.513 (0.767)	-0.102** (0.0400)	0.00326 (0.00550)
Distance to asphalted road	1.183 (1.036)	0.00450 (0.0541)	0.0218*** (0.00743)
Distance to market	0.317 (1.079)	-0.00870 (0.0563)	0.00343 (0.00774)
Distance to healthcare	-0.964 (1.679)	0.0436 (0.0876)	-0.00928 (0.0120)
Distance to elementary school	-1.186 (3.478)	-0.832*** (0.181)	-0.0135 (0.0249)
TLU	1.334 (5.450)	0.774*** (0.284)	0.0457 (0.0391)
Cultivated land	-25.84** (10.60)	-1.844*** (0.553)	-0.0185 (0.0760)
Asset value per capita	0.972*** (0.263)	0.154*** (0.0137)	0.00943*** (0.00189)
International transfer per capita	0.708 (0.637)	0.118*** (0.0332)	0.00421 (0.00457)
National transfer per capita	3.020*** (0.352)	0.0515*** (0.0184)	0.000159 (0.00252)
Network index	118.3*** (32.08)	6.028*** (1.673)	1.387*** (0.230)
Employment ratio	3.108*** (114.9)	-7.895 (5.992)	-1.530* (0.824)
Participation index	861.8*** (112.5)	14.64** (5.869)	2.023** (0.807)

Table A4. **Regression on income, food expenditure and FCS in Senegal 2011** (cont.)

Variables	(1) Year Income	(2) Food Expenditure	(3) FCS
Literacy level	36.06 (61.17)	2.978 (3.190)	0.607 (0.439)
Education	-60.79 (68.94)	5.491 (3.595)	0.847* (0.494)
Constant	-2.565** (1.034)	43.48 (53.91)	43.61*** (7.412)
Observations	4 930	4 930	4 930
R-squared	0.443	0.358	0.196

Standard errors in parentheses
*** p < 0,01; ** p < 0,05; * p < 0,1

Table A5. **Observed variables - Descriptive statistics at the national and regional levels in Senegal (2011)**

Pillars and variables	Total	Dakar	Ziguinchor	Diourbel	Saint-Louis	Tambacounda	Kaolack	Thies	Louga	Fatick	Kolda	Matam	Kaffrine	Kedougou	Sedhiou
ABS															
House value	0.746	1.012	0.947	0.792	0.852	0.572	0.754	0.945	0.8	0.733	0.495	0.698	0.473	0.273	0.874
Infrastructure wealth index	0.584	0.887	0.558	0.581	0.641	0.494	0.591	0.726	0.709	0.549	0.455	0.504	0.471	0.331	0.464
Distance to water source (min.) (inverted)	-1.083	-1.028	-1.033	-1.083	-1.172	-1.082	-1.028	-1.032	-1.218	-1.1	-1.014	-1.141	-1.061	-1.216	-1.07
Distance to public transport (min.) (inverted)	-1.349	-1.058	-1.317	-1.315	-1.373	-1.411	-1.276	-1.234	-1.293	-1.414	-1.632	-1.536	-1.395	-1.678	-1.271
Distance to market (min.) (inverted)	-1.575	-1.22	-1.379	-1.574	-1.632	-1.878	-1.66	-1.272	-1.45	-1.529	-1.779	-1.551	-1.723	-2	-1.559
Distance to healthcare (min.) (inverted)	-10.34	-4.829	-6.193	-9.707	-10.92	-16.2	-11.81	-5.965	-8.528	-8.597	-13.67	-11.84	-13.12	-15.68	-9.092
Distance to elementary school (min.) (inverted)	-1.153	-1.096	-1.086	-1.164	-1.237	-1.176	-1.146	-1.058	-1.134	-1.109	-1.221	-1.225	-1.199	-1.117	-1.155
AST															
TLU	1.882	0.054	0.577	1.335	2.125	3.488	1.327	0.848	2.572	2.03	2.703	3.727	1.91	3.053	1.54
Cultivated land (hectares)	1.771	0.049	1.185	2.006	0.703	2.168	2.475	1.191	1.01	2.523	2.569	0.986	3.446	2.129	2.46
Asset value per capita	89.71	197.7	77.2	85.86	86.91	67.85	76.81	108.9	129.4	71.29	65.29	51.86	69.49	64.7	47.85
SSN															
International transfers per capita	4.996	6.324	3.156	2.253	6.391	4.575	6.428	1.711	26.92	0.725	1.509	7.149	0.588	2.638	1.483
National transfers per capita	16.87	38.35	19.95	13.63	15.57	11.95	22.03	23.47	22.95	16.8	2.577	8.204	16.76	11.35	2.906
Network index	0.646	0.5	0.84	0.66	0.643	0.449	0.906	0.882	0.326	0.777	0.377	0.565	0.821	0.778	0.707
AC															
Employ ratio	0.325	0.384	0.255	0.35	0.301	0.306	0.32	0.351	0.262	0.275	0.327	0.289	0.396	0.367	0.328
Participation index	0.193	0.065	0.138	0.201	0.209	0.22	0.239	0.217	0.119	0.267	0.148	0.204	0.219	0.348	0.208
Literacy level	0.501	0.628	0.626	0.438	0.46	0.419	0.517	0.54	0.466	0.477	0.513	0.315	0.571	0.421	0.528
Education	0.321	0.555	0.56	0.207	0.313	0.24	0.315	0.358	0.28	0.337	0.261	0.178	0.235	0.287	0.317

Table A6. **Quantile regression on delta RCI in Senegal 2005/2011**

Variables	(1) Quantile 0.25	(2) Quantile 0.50	(3) Quantile 0.75
Infrastructure wealth Index	4.796*** (1.025)	5.037*** (0.798)	4.045*** (0.970)
House value	5.130* (2.629)	6.778*** (1.751)	5.524*** (2.069)
Distance to water source (min.) (inverted)	0.580 (0.684)	-0.583 (0.519)	-0.104 (0.783)
Distance to public transport (min.) (inverted)	0.602 (0.520)	0.852** (0.389)	1.040** (0.472)
Distance to market (min.) (inverted)	0.810* (0.437)	0.161 (0.384)	0.318 (0.452)
Distance to healthcare (min.) (inverted)	0.0887 (0.522)	0.435 (0.381)	0.547 (0.444)
Distance to elementary school (min.) (inverted)	0.365 (0.617)	0.443 (0.518)	1.008* (0.564)
Employment ratio	-3.306 (2.563)	-1.662 (1.929)	-2.429 (2.109)
Sick persons per HH	1.187 (1.244)	-0.825 (0.956)	0.560 (1.213)
Literacy Level	11.70 (7.932)	9.243 (5.819)	6.247 (5.918)
Cultivated land (hectares)	-0.231 (0.273)	0.0281 (0.181)	-0.486*** (0.176)
TLU	0.0722 (0.124)	0.0101 (0.0946)	0.0500 (0.107)
Agricultural assets	0.977 (1.475)	-0.0538 (1.513)	0.303 (1.683)
Vehicle assets	1.542 (1.248)	1.275 (0.988)	0.783 (1.156)
Household assets	5.488** (2.411)	4.608*** (1.712)	7.104*** (1.871)
Network Index	1.808*** (0.660)	1.457*** (0.435)	1.892*** (0.428)
Health expenditure	-0.0164** (0.008)	-0.00805 (0.005)	-0.0152*** (0.006)
School expenditure	0.009 (0.014)	0.004 (0.010)	-0.001 (0.010)
Food expenditure	-0.009*** (0.002)	-0.008*** (0.001)	-0.008*** (0.001)
House expenditure	0.002 (0.006)	0.002 (0.004)	0.004 (0.006)
Urban status	3.306** (1.579)	3.479*** (1.215)	4.931*** (1.435)
Household size squared	0.035** (0.014)	0.061*** (0.010)	0.063*** (0.014)

Table A6. **Quantile regression on delta RCI in Senegal 2005/2011** (cont.)

Variables	(1) Quantile 0.25	(2) Quantile 0.50	(3) Quantile 0.75
HH size	-0.492 (0.355)	-1.287*** (0.270)	-1.208*** (0.342)
Education	9.082 (7.845)	7.772 (5.866)	4.216 (6.102)
FHH	-1.128 (1.759)	-1.062 (1.340)	-1.649 (1.633)
HH age	-0.330 (0.205)	-0.139 (0.164)	-0.151 (0.170)
Number of rooms	0.489** (0.238)	0.331 (0.218)	0.364 (0.232)
Poor food consumption satisfaction	-1.653 (1.306)	-0.856 (0.967)	-1.684 (1.263)
High food consumption satisfaction	-0.214 (3.869)	-4.479 (3.012)	-6.618* (3.795)
Constant	-14.20 (16.37)	-3.184 (12.02)	18.97 (12.52)
Obsevations	2 661	2 661	2 661

Bootstrapped errors in parentheses
*** p < 0,01; ** p < 0,05; * p < 0,1

Table A7. **Probit on delta of food expenditure in Senegal 2005/2011**

Variables	(1) Delta Food Expenditure
Asset value per capita ($)	335.0** (143.0)
Sick people dummy	22.79 (57.52)
Poor food consumption satisfaction	30.56 (58.05)
High food consumption satisfaction	108.1 (181.1)
Number of room	5.191 (13.22)
Education	676.9* (351.4)
Type house case	-57.77 (109.0)
Type house baraque	81.94 (121.9)
Urban status	114.4 (73.47)
HH size squared	0.599* (0.310)
Number of women per HH	-14.10 (22.83)
FHH	44.63 (63.62)
HH age	-4.677 (9.507)
Healthcare expenditure	-0.604 (0.429)
School expenditure	-0.517 (0.764)
Non-food expenditure	-0.764*** (0.0800)
House expenditure	-0.518** (0.264)
Infrastructure wealth index	320.1*** (48.54)
House value	581.1*** (105.5)
Distance to water source (min.) (inverted)	-8.581 (31.19)
Distance to public transport (min.) (inverted)	48.82** (23.45)
Distance to market (min.) (inverted)	53.91** (23.10)
Distance to healthcare (min.) (inverted)	26.21 (22.94)

Table A7. **Probit on delta of food expenditure in Senegal 2005/2011** (cont.)

Variables	(1) Delta Food Expenditure
Distance to elementary school (min.) (inverted)	45.09 (31.27)
Literacy level	764.1** (348.5)
Cultivated land	2.902 (10.91)
TLU	1.462 (5.702)
Agricultural assets	10.44 (92.22)
Vehicle assets	-55.41 (63.61)
Household assets	344.2*** (106.8)
Network index	116.8*** (26.20)
Constant	-462.3 (727.2)
Observations	2 661
R-squared	0.146

Bootstrapped errors in parentheses
*** p < 0,01; ** p < 0,05; * p < 0,1

Table A8. **Quantile regression on food expenditure delta in Senegal 2005/2011**

Variables	(1) Quantile 0.25	(2) Quantile 0.50	(3) Quantile 0.75
Infrastructure wealth index	273.7*** (53.95)	296.3*** (63.46)	306.9*** (67.72)
House value	374.1*** (121.4)	579.9*** (149.8)	846.0*** (158.9)
Distance to water (min.) (inverted)	-5.695 (31.22)	-31.85 (43.79)	-35.02 (48.30)
Distance to public transportation (min.) (inverted)	84.30*** (27.20)	53.14** (25.59)	23.43 (29.24)
Distance to market (min.) (inverted)	53.71** (23.72)	61.09** (27.84)	92.81*** (30.03)
Distance to healthcare (min.) (inverted)	7.925 (25.40)	26.48 (28.03)	41.51 (27.21)
Distance to elementary (min.) (inverted)	34.05 (35.99)	53.15 (40.96)	43.49 (49.17)
Employment ratio	-308.2** (139.1)	-554.9*** (129.7)	-462.0*** (164.3)
Sick person per household	46.12 (59.37)	-66.29 (61.71)	-103.6 (90.96)
Literacy level	446.8 (606.1)	1.078 (728.2)	1.267 (796.6)
Cultivated land	4.506 (9.484)	16.03 (17.44)	6.330 (15.64)
TLU	7.599 (7.689)	6.584 (5.191)	1.699 (6.567)
Agricultural assets	-19.96 (87.76)	12.17 (125.9)	297.2* (154.0)
Vehicle assets	113.3 (82.40)	21.40 (73.77)	-78.40 (79.72)
Household assets	255.4* (136.4)	323.2** (153.1)	491.9** (194.3)
Social safety nets	92.94*** (29.15)	103.8*** (29.87)	135.5*** (41.54)
Health expenditure	-0.944** (0.469)	-0.836** (0.411)	-1.226*** (0.414)
School expenditure	0.365 (1.148)	-0.185 (0.776)	-0.594 (0.815)
Food expenditure	-0.751*** (0.110)	-0.690*** (0.0983)	-0.561*** (0.102)
House expenditure	-0.0986 (0.416)	0.453 (0.390)	0.594* (0.351)
Urban status	99.83 (85.97)	109.7 (94.46)	91.10 (116.4)
Household size squared	3.024*** (0.701)	3.413*** (0.783)	2.464*** (0.687)

Table A8. **Quantile regression on food expenditure delta in Senegal 2005/2011** (cont.)

Variables	(1) Quantile 0.25	(2) Quantile 0.50	(3) Quantile 0.75
Household size	-84.76*** (17.59)	-77.30*** (21.13)	-49.72** (21.84)
Education	343.5 (602.1)	928.9 (728.7)	1.093 (796.7)
FHH	-45.73 (104.5)	9.425 (97.83)	-109.3 (123.6)
HH age	-13.05 (10.89)	-8.305 (12.22)	-17.29 (14.78)
Number of rooms	17.97 (16.65)	-5.090 (17.26)	8.111 (23.53)
Poor food consumption satisfaction	-76.90 (70.22)	-74.20 (76.46)	31.06 (97.55)
High food consumption satisfaction	44.45 (220.6)	133.8 (183.2)	-192.5 (230.4)
Constant	516.5 (1.218)	-298.7 (1.536)	-361.9 (1.577)
Observations	2 661	2 661	2 661

Bootstrapped errors in parentheses
*** p < 0,01; ** p < 0,05; * p < 0,1

Graphic designer: Tomaso Lezzi

This report is part of a series of country level analyses prepared by the FAO Resilience Analysis and Policies (RAP) team. The series aims at providing programming and policy guidance to policy makers, practitioners, UN agencies, NGO and other stakeholders by identifying the key factors that contribute to the resilience of households in food insecure countries and regions.

The analysis is largely based on the use of the FAO Resilience Index Measurement and Analysis (RIMA) tool. Latent variable models and regression analysis have been adopted. Findings are integrated with geo-spatial variables.

The Food and Agriculture Organization of the United Nations (FAO) would like to thank the European Union for the financial support which made possible the development of this publication.

Contacts:
Luca Russo, FAO Senior Economist - luca.russo@fao.org
Marco d'Errico, FAO Economist - marco.derrico@fao.org

I6584EN/1/04.17