Poverty Mapping in Rural Syria for Enhanced Targeting

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1. INTRODUCTION

Poverty mapping is becoming an increasingly important tool for identifying and targeting the poor. Major international organizations involved in global efforts for poverty reduction, and various CGIAR centers have been developing different approaches to poverty mapping in recent years[1]. Some countries use poverty mapping, developed by using extensive household surveys, to design policies aimed at reducing income disparities. Yet poverty mapping is a costly exercise and many low-income countries lack the resources to carry out large surveys.

Poverty maps help in capturing the heterogeneity due to the presence of different economic conditions and agro-ecologies within a country, identifying the geographic factors that influence poverty, targeting interventions, and improving communication about poverty. They can integrate biophysical data with socio-economic indicators to present a more systematic and analytical picture of human welfare (Henninger and Snel, 2002). Policy-making in various countries has been influenced by the use of poverty maps in the areas of food security, health, education, and infrastructure planning, early warning and mitigation of natural disasters, economic vulnerability, livelihood security, environment, and conflicts.

1.1 Mapping approaches to link rural poverty and natural resources

Sub-national poverty mapping approaches are diverse, ranging from participatory poverty profiles to sophisticated econometric approaches, and are under continuous development. Each approach has different data requirements, implementation costs, advantages and

[1] Examples of different approaches and applications are: poverty maps for Mexico by CIMMYT, for Ecuador by CIAT, for Malawi by IFPRI, for Kenya by ILRI, for Bangladesh by IRRI, etc. See: www.povertymap.net/

disadvantages. Various studies have been linking well-being, geographic and environmental variables, and visual spatial analysis at the sub-national level. A number of rural poverty studies have indicated correlation between rural poverty and access to physical resources (owned land, water, animals, machinery) and agro-ecological variables (climate, soil, water for irrigation) (Szonyi et al., 2005 for a full review). For instance, geographic location and climate have large effects on income levels and growth through their effect on agricultural productivity (Gallup and Sachs 1999); physical variables of water availability linked with socio-economic variables can produce regional water poverty indexes that can be used in poverty maps (Sullivan, 2002). As soil degradation is a determinant of poverty, GIS-based environmental datasets can be integrated with socio-economic information to analyze the interactions between poverty and environmental degradation (Osgood and Lipper, 2003).

Agro-ecological factors are thus likely to have a strong impact on income distribution and poverty in rural areas, hence agro-ecological variables can be incorporated in the mapping of the distribution of agricultural income. Since such variables can be mapped by using GIS and spatial databases, and household surveys are available only in few and small geographic areas, household income data can be extrapolated by using agro-ecological information.

1.2 The situation of poverty in Syria

Syria is a mid-size country with total land area of about 18.5 million hectares of which 13.7 are for agricultural purposes. Syria ranks relatively low in human development indicators (UNDP, 2005), behind most of its neighboring countries. National-level indicators of human welfare hide a complex picture of poverty and food insecurity at the local level, particularly in rural areas. Poverty in Syria is poorly documented and statistical data is not readily available, yet there is much circumstantial evidence corroborating a link between poverty and the access to quality land and water resources. The country is mainly an agrarian economy with limited industries and services. The total population is about 17 million, with a 3.2%

annual growth rate. The rural population is about 50% of total population (AOAD, 2001). Most people living in rural areas depend directly or indirectly on agriculture. Their livelihoods and food security depend on the natural resource base and on the highly variable weather conditions. Although many find additional income by temporary or permanent off-farm labor in other rural areas or often in urban areas, most rural people have limited access to incomes from industrial production or services. Rural households who depend only on livestock production have been identified to be among the most vulnerable (La Rovere et al., forthcoming); these face serious food insecurity and poverty as they depend on degraded rangelands (steppe) and unreliable precipitation. A recent drought (1998-2000) had a severe impact on many pastoralists living in steppe areas who had to sell off all their livestock. Many of those have now joined the unemployed in the major cities. About 60% of agricultural land is permanent pasture, mostly located in steppe areas that provide about 20% of the total livestock feed. Poverty, however, is not confined to the drought-prone steppe areas. In the more densely settled higher-potential areas of west and northwest Syria, land shortage, as a result of population increase, also leads to migration to cities and higher pressure on marginal lands. For instance, grazing puts pressure on communal areas, while hillsides are cleared for olive trees, usually without proper soil conservation measures. Such land uses deplete the natural resource capital and widen the welfare gap between the better off, with enough capital for land development, and the poor, who are squeezed off the land.

1.3 Objectives of the study

Within the context of the social and ecological conditions described in the previous section, the objective of the present study was to develop a poverty map of Syria. The aim of this map, based on the spatial representation of income distribution from agricultural activities, is to identify where the poor are located and define the hot-spots where poverty is determined by the endowment in, and quality of, natural resources, and by population pressure.

2. MATERIALS AND METHODS

Natural resource poverty is one of the fundamental poverty issues in Syria. At the national planning level it concerns the availability of quality land, water, soil, and topographic resources in parts of the country, while at the household level it concerns the individual household's access to resources. The two levels are linked, since in areas with poor resource basis, such as arid or rocky parts of the country, there are not many households with access to quality land. On the other hand, in areas with a good natural resource base, many households will not benefit of it either because of limiting property rights or because many people depend on them. Additionally, in Syria natural resource poverty is strongly linked with the need of parts of the rural population to use marginal lands, i.e. lands that are too dry for high agricultural productivity or that have severe topographic (e.g. steep slopes) or soil limitations (e.g. shallow soils). The total land unfit for agriculture is an indicator of agricultural resource poverty. By defining an *agricultural resource index* (ARI) we quantified this kind of agricultural resource poverty (see Annex 1). This index-based method considers all relevant biophysical factors and allows consistent comparisons between different locations. The method assesses the contribution of individual environmental factors towards agricultural resource poverty, is scale-independent, and can be applied using currently available datasets.

While most CGIAR centers use 'bottom-up' approaches that extrapolated survey data at larger spatial levels to develop poverty maps, this study uses a 'top-down' method to disaggregate income from census sources to the pixel level based on agro-ecological data.

2.1 Assessing agricultural resource endowment

Agricultural resource poverty is a component of environmental poverty. Three components of resource potential are assessed separately through thematic indices, by using a common scale:

(1) *Climate Resource Index* (CRI), for the climatic potential to produce biomass

(2) *Soil Resource Index* (SRI), for the proportion of the pixel without problematic soil types

(3) *Topographic Resource Index* (TRI), for the proportion of pixel without topographic limits

These thematic indices are combined as raster themes in GIS, with the same spatial scope and resolution, into the ARI index (details in Szonyi *et al.* 2005). This is calculated as the lowest of the indices CRI, SRI, and TRI. The ARI pattern in Syria is due to two main sources of resource potential: the rainfall gradient from north to south and west to east, and the presence of irrigated areas associated with the Orontes and Euphrates rivers and the presence of groundwater aquifers. Areas with low ARI are associated with low rainfall (especially steppe areas), the absence of sources of irrigation water, and the presence of mountain ranges.

2.2 Income distribution based on agricultural resource endowment

In order to match resource poverty indices with sub-national statistics, poverty index values were aggregated to the lowest level of administrative units for which statistical information was available (CBS, various years). These are the intersections of provinces with Agricultural Stability Zones based on rainfall (MAAR, various years). These spatial units are named 'Agricultural Sub-zones'. NAPC (2003) provided sub-regional production data for crops, fruits, vegetables, and animal products at the level of agricultural sub-zones. Prices for different agricultural products was obtained from different sources; for year 2000 they were collected from the Agricultural Production Database of Syria (NAPC, 2003), FAOSTAT (2000) and local market surveys. The NAPC price database provided prices for agricultural commodities by province. FAOSTAT provided farm gate price based on national averages. Farm gate prices are national average prices of individual commodities for all grades, kinds, and varieties received by farmers, available at the provincial level. Prices for products not included in the NAPC and FAO databases were collected from local surveys and a regional wholesale market in Aleppo based on year 2000 data. The sum of all agricultural products was multiplied by their wholesale value; this was consistent with the share of agriculture in the national account, equivalent to about 25% of the GDP in year 2000 (NAPC, 2003).

Agricultural income is a function of prices and agricultural production, which itself depends on resource endowment. Aggregate census data of agricultural sub-zones was spatially disaggregated by the ARI index. Within each sub-zone the distribution of the income coefficient followed the same pattern as the distribution of the ARI. In the allocation of income to individual pixels from rainfed or irrigated agriculture, the ARI values were weighted in accordance with the proportions of either rainfed or irrigated land in each pixel.

The income distribution of rainfed and irrigated agriculture, disaggregated according to resource endowment, is calculated per pixel within each Sub-zone (Equations 1-3). Differences in rainfed production are determined by diverse water availability, soil quality and topography, accounted for by the ARI (rainfed Equation 3). The presence of irrigated agriculture shows that there is no significant soil or topographic limitation. The ARI accounts for production differences determined by climate limitations (irrigated Equation 3).

Equations 4, 5 show the disaggregated livestock income. MAAR provides the value of total livestock production by provinces, very large spatial units that may contain much diversity in terms of grazing value. For obtaining reasonable allocation coefficients of the total value per pixel, a livestock distribution coefficient is introduced (Equation 5), based on estimates of livestock proportionality by land use/land cover type as obtained from the land use/land cover map of Syria (De Pauw *et al*., 2004). Income from sheep, goat and cattle includes sale of live animals, meat, wool, milk and other dairy product. Income from chicken includes sales of meat and eggs. In calculating livestock income, the primary income of live animal and milk sale was taken into account with the added value of the fattening and dairy industry.

2.3 Per-capita income distribution from agriculture

Since the income from agricultural activities was introduced above on a pixel basis, the representation of per-capita income distribution also requires that population density is disaggregated from the lowest administrative level (*nahia*) to the pixel level. Population data for *nahia* obtained from the latest census survey (CBS, 1994) was updated with annual growth rates for rural areas in the different administrative regions (CBS, several years). The adjustment of population density to the pixel level has been done by using estimated population density coefficients (Equation 6) obtained from a mapping procedure based on identified ‘agricultural regions’ (Szonyi et. al, 2005). The characterization of agricultural regions based on settlement patterns provided the population density figures. The population density in the *nahia* was corrected by an adjustment factor based on the agricultural regions.

3. RESULTS

Map 1 in Annex 2 shows the resource based distribution of total income from agriculture and livestock in rural areas of Syria. This suggests the influence of resource endowment, as better income areas are located in irrigated or higher-rainfall areas. However, within these areas pockets with poor soils or unfavorable topography appear as lower-income spots. One exception seems to be the coastal mountains, where income appears better than would have been expected from resource endowment only. It is likely that large-scale investments by the government and the private sector in land improvement, principally through terracing, have significantly improved the earning capacity of the agricultural resource base.

The overall pattern of total per-capita income from agriculture (Map 2 in Annex 1) is quite compatible with the pattern of total income from agriculture (cfr. with Map 1): where total income is high, so is per-capita income, and vice-versa. In fact, areas with higher per-capita incomes (SYL 100,000-500,000/pixel) extend quite deep inside the steppe, into areas in which the total income is fairly low (SYL 20,000-100,000/person/pixel). This indicates that in some areas the total income is shared among fewer people, increasing accordingly the per-capita incomes. There are various exceptions though, which seem to point to poverty hotspots: e.g. the southern Euphrates plains despite high total incomes (SYL 5,000,000/pixel) have fairly low per-capita incomes (SYL 10,000-20,000/person/pixel). It appears that in such areas the higher population densities may compensate for the higher total incomes.

3.1 Comparison of the results with case studies in Syria

The results of this study were compared with those of two studies referring to areas situated in northern Syria. The first is the Khanasser valley, a marginal area with 200-250 mm annual rainfall situated between the cropped and steppe rainfed systems (see circle in Map 1, Annex 2). The total area is 630 km^2 with a population of 27,000 and density of 93 persons / km^2.

La Rovere *et al.* (2005) quantified the total income of the area at 0.5 billion SYL/year, including off-farm earnings. The total income quantified by the present study for the same area is 0.33 billion SYL/year, not including income from off-farm-labor. When we add the percentage share of off-farm income (42% of total income, La Rovere *et al.*), the total income of the area becomes 0.47 billion SP/year. This matches with the total income found by La Rovere *et al.*, hence providing a form of validation for our results at the sub-regional level.

The second case is a study on child nutrition in 3 villages (Ghosh *et al*., 2004) of northwest Syria, one of which situated in the same Khanasser area where barley and livestock are main livelihood sources. The other 2 villages are located in irrigated and olive growing areas. In Syria 13% of children aged below 5 is underweight (MDG-Syria, 2003). This is likely higher in the rural than in the urban population. Though Ghosh *et al*. do not quantify income we found a correlation between the natural resource endowments and child nutritional status.

4. DISCUSSION

Our income maps and their supporting databases provide information on the resources for agricultural production, on the actual capacity of production, on prices, and on population on a fine spatial scale for use by researchers, international organizations, and decision-makers.

One main reason for the choice of the top-down approach for this study is that it can be a fairly reliable tool for downscaling poverty-related statistics to sub-national levels for other countries, and it provides a fine resolution regional mapping. The resolution of GIS data has been improving dramatically and continues improving, increasing the value of such top-down approaches, and converting these into tools for conducting more accurate poverty mapping.

Poverty maps can improve poverty alleviation, food security and development efforts by making the spatial allocation of national or international funds for agricultural research and development more effective. They can highlight areas or communities marginalized by resource constraints and help in setting priorities for developing technologies and transferring them where they are most needed and likely to have an impact. In essence, by identifying *who* and *where* the poor are, they help to better target research. In some cases they can also reveal *why* communities or people are poor, based on their natural resource endowments. Poverty maps, however, are often unable to demonstrate quantitatively a high degree of inequality within individual communities. There is thus a case for establishing at the local level relationships between resource-based variables and geo-referenced income data.

Despite these potential benefits, the use of the results of poverty maps that use aggregated data requires caution since they tend to exaggerate differences between poor and less poor areas (Minot and Baulch, 2002). Socio-economic analysis based on GIS data can also pose problems since GIS data is often not readily available at the farm level, and since information might be lost in the process of integrating different databases (Osgood and Lipper, 2003).

4.1 Opportunities for improvement

Opportunities exist for improving the present approach (see more in Szonyi et al., 2005) by:

- Strengthening the link of the top-down approach with micro-level analysis by accounting for local income distribution inequalities based on the existence of different livelihood groups, productive assets, and net production value by livelihood activity. The availability of additional case study sites could strengthen this link and improve poverty measurement.

- Estimating the value of the rural non-farm economy in different areas by linking the results to household surveys as our study does not estimate off-farm incomes and remittances[2].

- Monitoring poverty dynamics with repeated poverty mapping (with updated geophysical and socio-economic databases), and by including the feedbacks of human induced impacts (e.g. land degradation, exploitation of resources) on agricultural productivity.

- Linking with macroeconomic decision support systems used for policy simulations (CGE, input-output models, national Social Accounting Matrixes) to enclose a spatial dimension and provide regional coefficients of production. This can also help in extending the poverty analysis to urban areas, as it is possible to estimate incomes from industry and services.

- Integrating other and more comprehensive determinants of poverty, e.g. accessibility to markets, access to clean water, nutritional indicators, other off-farm income generation opportunities, as well as other dimensions of poverty such as health, education, vulnerability that support the assessment of national Millennium Development Goals (MDG-Syria, 2003).

5. CONCLUSIONS

This study shows that the better income areas of Syria are located in the irrigated or higher-rainfall areas. Within these areas, however, there are lower-income pockets mainly due to the presence of poor soils or harsh topography. Better off areas, however, are present for example in the coastal mountains, while poverty hotspots exist in the southern Euphrates plains.

By revealing such results, and by critically suggesting practical ways of improvement, this study represents an important advancement on the methodology to link micro and macro economic analysis for successfully mapping poverty. Poverty mapping can indeed become more effective and cost-efficient if it combines the classical bottom-up approach, based on

[2] These can be sizeable as off-farm earnings may account for half of total income (La Rovere *et al*., 2005).

household surveys, with the top-down methodology that we have outlined. The present study also represents the first poverty mapping approach done at the national level for Syria.

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Annex 1: Equations and nomenclature

$$INC_{w,z,j} = APC_{w,z,j} * (\sum_i q_{i,w,z} * p_{i,w,z}) / n_z \quad \textbf{(1)}$$

$$APC_{w,z,j} = \frac{ARI_{w,z,j} * M_{w,j}}{\sum_j (ARI_{w,z,j}) / n} \quad \text{and} \quad \sum_j (APC_{w,z,j}) / n = 1 \quad \textbf{(2)}$$

$$ARI_{'r',j} = MIN(CRI_j, TRI_j, SRI_j) \qquad ARI_{'ir'} = CRI_j \quad \textbf{(3)}$$

$$INC\_l_j = lc_j * (\sum_i q\_l_{i,z} * p_{i,z}) \quad \textbf{(4)}$$

$$lc_j = \frac{LV_j}{\sum_j LV_j / n} \quad , \; LV_j = CRI_j * (\sum_k B_k * A_k) \quad \textbf{(5)}$$

$$Pop_{n,ar} = \frac{Pop_n * p_{ar} * DSSEa_{ar}}{\sum_i^n p_{ar} * DSSE_{ar}} \quad \textbf{(6)}$$

z : subzones, z(j) : pixel number (~1km^2), i : different crops, fruits, vegetables or livestock in (eq.4)

w: water availability (‘r’ rainfed, ‘ir’ irrigated), k: different land use/land cover types,

suffix _*l* : livestock

INC_j income from agriculture (SYL) in pixel j

APC_j : Agricultural Production Coefficient in pixel j

ARI_j : Agricultural Resource Potential Index in pixel j

$M_{w,j}$: % of irrigated and rainfed areas in pixel j

q_i: agricultural production in Agricultural Sub-zone

p_i : price for agricultural product ‘i’ in Agricultural Sub-zone

n_z : pixel area (number of pixels in the subzone)

CRI_j, TRI_j, SRI_j: Climatic, Topographic and Soil Resource Index in pixel j

lc_j: livestock distribution coefficient in pixel j

LV_j: Livestock Value in pixel j

B_k: correction factor for ‘useful’ biomass in land use/land cover type k

A_k: proportional area of land use/land cover type k in pixel j

$Pop_{n,ar}$: estimated population in each agricultural region within a *nahia*

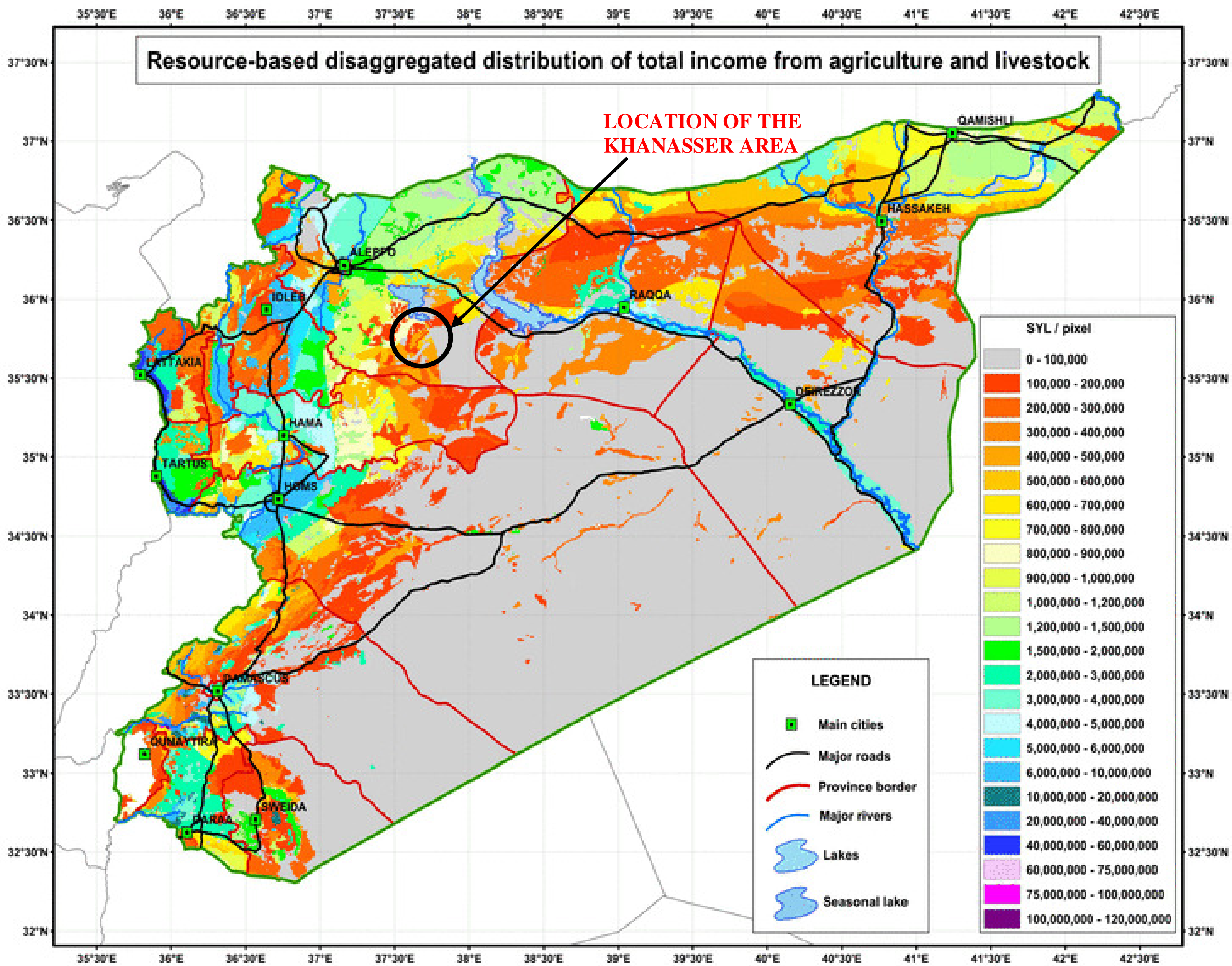
Pop_n: population in the *nahia*

p_{ar}: proportion of the agricultural region inside the *nahia*

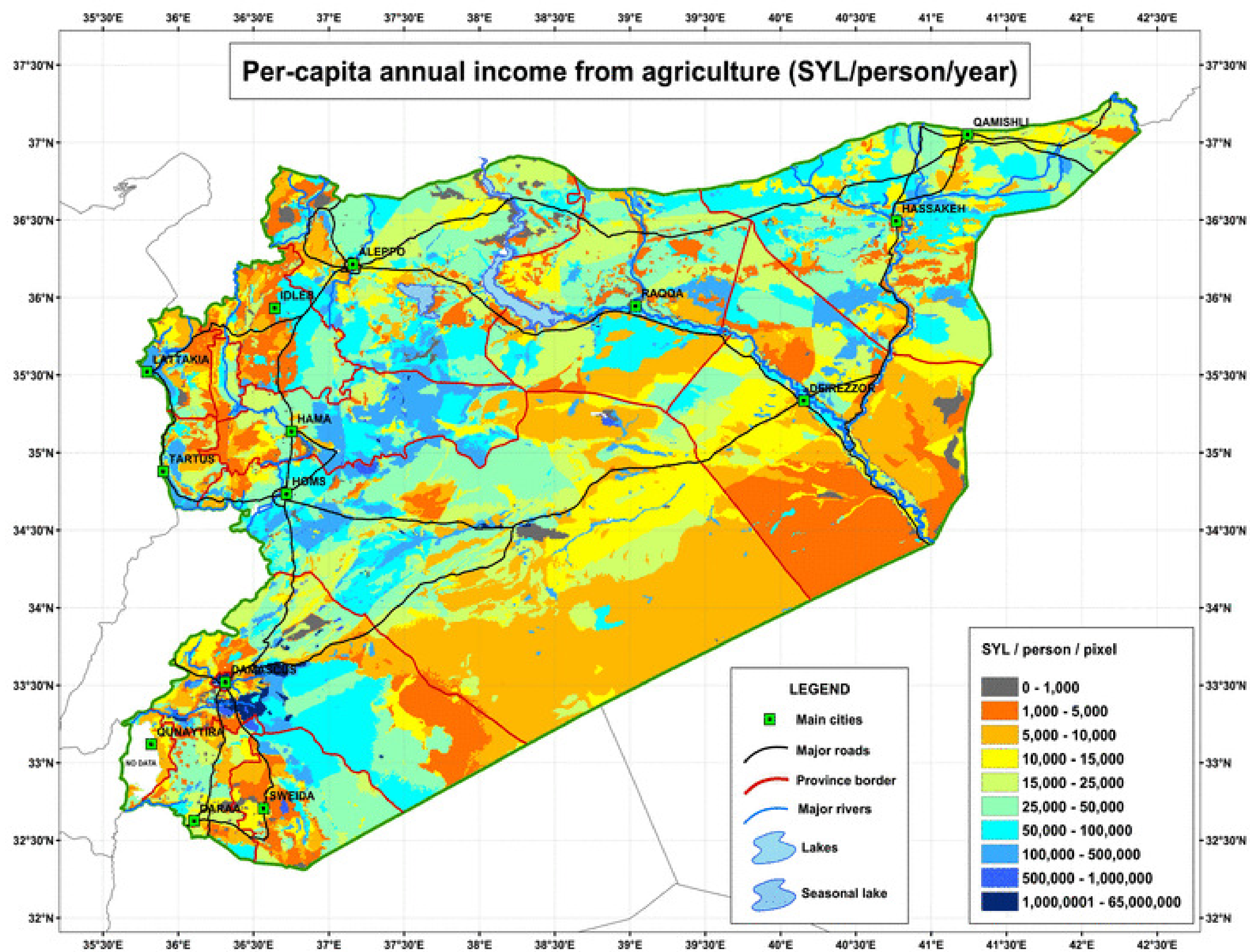
$DSSEa_{ar}$: adjusted standard settlement density for the agricultural region

n: number of agricultural regions inside a *nahia*

Annex 2: Poverty maps of Syria by ICARDA. Map 1: total income from agriculture and livestock; Map 2: Per capita annual income from agriculture



Resource-based disaggregated distribution of total income from agriculture and livestock
LOCATION OF THE KHANASSER AREA
QAMISHLI
HASSAKEH
ALEPPO
IDLEB
RAQQA
LATTAKIA
HAMA
DEIREZZOR
TARTUS
HOMS
DAMASCUS
QUNAYTIRA
SWEIDA
DARAA
LEGEND
Main cities
Major roads
Province border
Major rivers
Lakes
Seasonal lake
SYL / pixel
0 - 100,000
100,000 - 200,000
200,000 - 300,000
300,000 - 400,000
400,000 - 500,000
500,000 - 600,000
600,000 - 700,000
700,000 - 800,000
800,000 - 900,000
900,000 - 1,000,000
1,000,000 - 1,200,000
1,200,000 - 1,500,000
1,500,000 - 2,000,000
2,000,000 - 3,000,000
3,000,000 - 4,000,000
4,000,000 - 5,000,000
5,000,000 - 6,000,000
6,000,000 - 10,000,000
10,000,000 - 20,000,000
20,000,000 - 40,000,000
40,000,000 - 60,000,000
60,000,000 - 75,000,000
75,000,000 - 100,000,000
100,000,000 - 120,000,000


Per-capita annual income from agriculture (SYL/person/year)
QAMISHLI
HASSAKEH
ALEPPO
IDLEB
RAQQA
LATTAKIA
DEIREZZOR
HAMA
TARTUS
HOMS
DAMASCUS
QUNAYTIRA
NO DATA
SWEIDA
DARAA
LEGEND
Main cities
Major roads
Province border
Major rivers
Lakes
Seasonal lake
SYL / person / pixel
0 - 1,000
1,000 - 5,000
5,000 - 10,000
10,000 - 15,000
15,000 - 25,000
25,000 - 50,000
50,000 - 100,000
100,000 - 500,000
500,000 - 1,000,000
1,000,0001 - 65,000,000