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Land Use and Food Security in 2050: a Narrow Road

Agrimonde-Terra

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6. The Global Context

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Introduction

As presented in Chapter 1, there are a number of indirect causes of land-use change which operate diffusely. Agrimonde-Terra decided to consider the 'global context' as a driver of change in the land use and food security system. Three forces were identified in the global context: (a) governance, *i.e.* political factors, alliances between actors and policies, (b) economic development and resources, *i.e.* economic growth and inequalities, energy mix, international trade, research and innovation, and (c) human development, *i.e.* demography, education, culture and ethics.

In this chapter, we first present a number of past and on-going trends as well as uncertainties that have been identified at the global level relative to these three forces, and look at their influence on land use and food security. Then, we describe the hypotheses for 2050 relative to the global context, which have been built by the Agrimonde-Terra team and discussed with the Scenario Advisory Committee.

Upon the recommendation of this Committee, the five "alternative pathways of future societal development, described as shared socioeconomic pathways (SSPs)" (O'Neill *et al.*, 2017) prepared by the climate change research community were not adopted for two reasons. First, they were developed for another purpose as their ultimate goal was "to produce integrated scenarios that will indeed include socioeconomic and environmental conditions as affected by both climate change and climate policy" (O'Neill *et al.*, 2014, p. 389). They describe future conditions that are relevant for adaptation and mitigation of climate change whereas the Agrimonde-Terra's hypotheses are about the global context for land use and food security. Second, at the time of the development of the Agrimonde-Terra's hypotheses relative to the global context, the concept of SSPs had started to be developed (O'Neill *et al.*, 2014) but the elements of the SSPs were not yet precise and assumptions were not yet published.

Governance

Fukuyama (2013) defines governance as "a government's ability to make and enforce rules, and to deliver services, regardless of whether that government is democratic or not"

27. The authors thank Denis Lacroix for his comments on this chapter.

(p.348). Governments are therefore the major actors involved in the governance of the land use and food security system. However, a number of other institutions, such as international and regional organizations and initiatives, private companies, NGOs and philanthropic associations, as well as citizens, are also active. Alliances between these actors are formed and rivalries for power exist. They frame access to land, as well as the priorities for policies, public investments, and regulations related to land, to the environment and climate change, to agricultural production and food processing, and to diets.

Political instability and conflicts in the poorest regions of the world

While a number of countries have improved the governance of their land over the past 40 years, a great number of countries remain unstable, subject to frequent *coups d'état*, protracted conflicts and corruption. They are unable and/or not ready to effectively govern on land use and food security issues. During this period, the number of member countries of the United Nations has grown from 149 to 193, some of them as a result of the division of countries.[28] There has also been a rise in the number of inter-ethnic conflicts, terrorism and piracy activities. Armed violence is resulting in the death of many civilians, or their displacement and migration, and their lack of access to land and food. In 2017, the World Bank believed that two billion people lived in countries where development outcomes were affected by fragility, conflict and violence.[29] Natural resources are rarely the sole cause of conflicts, but land is implicated in all phases of conflicts, from the outbreak of violence to the resolution, and conflicts lead to land degradation, deforestation, the decrease in cultivated areas and production, and migration. Non-controlled areas are home to illicit trade and armed rebels. In the future, demographic growth, climate change, economic instability and tensions over resources will contribute to the increase in political instability and concentration of fragility in areas where multiple vulnerabilities intersect; a protracted 'ecosystemic crisis' impacting several generations and causing irreversible damage will develop (Maietta *et al.*, 2017). Such crises are already taking place in the Lake Chad Basin, the Ganges Delta and the Aral Sea. Also, whereas in the past rich countries have contributed to the extraction of resources in fragile areas, in the future they could face significant tensions due to political instability in Africa, the Middle East and Latin America.

Globalization, integration, national sovereignty and local governance

From a political and economic point of view, an increasing number of countries are hesitating between integration and national sovereignty. There is also increased demand for recognition of governance at more local levels, be they cities or territories (Caron *et al.*, 2017).

28. http://www.un.org/en/sections/member-states/growth-united-nations-membership-1945-present/index.html (accessed 21 September 2017).

29. http://ida.worldbank.org/theme/conflict-and-fragility (accessed 21 September 2017).

Global governance is promoted by a number of specialized United Nations (UN) agencies and other international institutions and programmes. The relationships between international institutions and countries are complex. On the one hand, States are members of the UN agencies and other international institutions. States participate in collective work and finance international institutions. However, in the past 20 years, core funding by countries has been decreasing and earmarked contributions have grown. International institutions are now financed with hybrid arrangements that weaken them and lead to a fragmentation of their strategies (Jenks and Topping, 2016). On the other hand, a number of agencies can impose their point of view on countries and even challenge the authority of governments. In some cases, domestic policies are influenced by the recommendations and funding of these international institutions. In other cases, countries do not take into account the recommendations of these reports, or there is a long time span between the publication of the report or the signature of the agreement and the implementation of a policy. While the world was alerted about the limits of resources 45 years ago (Meadows *et al*., 1972), sustainable development became an objective 30 years ago (Brundtland, 1987), the first global report on climate change (IPCC) was written 26 years ago and the first Conference of Parties on Climate Change was held 21 years ago, these have not yet radically modified the policies of most governments, the strategies of many enterprises, and the attitudes of most farmers and citizens towards resources (Box 6.1 for other major events in the global governance of land use and food security). It is now widely recognized that international institutions need reforms and there are uncertainties about their future capacity to govern and provide strategic directions.

Historically, regional governance has been based on geographical proximity. Countries decided to cooperate for their mutual security, *e.g.* the European Union and ASEAN. However, trans-national cooperation is now essentially driven by trade. The development of information and communication technologies increases the importance of shared interests or ideology and regional entities can now link cities or territories. Over the past two decades, the world has become increasingly multipolar and no State currently seems able to find a solution to conflicts or impose its view of the world. In the future, regional governance could become more amorphous, of a pop-up nature. Initiatives could be set up to pursue particular purposes and these will be easily disbanded. However, regional cooperation could emerge from people engaging in social and cultural exchange (Jarrar, 2016).

The concept of 'sovereignty' is used in law, political philosophy and geopolitics. It relies on the idea that entities are impenetrable to one another and are, for that reason, delineated by precise boundaries that define their identity (Latour, 2016). On the one hand, sovereignty is used at the national level to defend the Nation State, national values and protectionism, as well as by groups who share the same ethnic, religious, linguistic or other cultural categories to claim some form of independence. On the other hand, sovereignty is challenged by global issues such as climate change (Latour, 2016).

Also, over the past 30 years, cities and territories have become geographical scales in which new types of governance are developing. Elinor Ostrom (2011) considered that territories

Box 6.1. Some major events in the global governance of land use and food security.

1945	FAO: creation of the Food and Agriculture Organization
1961	World Food Programme is created because of concern about potential world food shortage.
1963	FAO and WHO: creation of the Codex Alimentarius Commission for harmonized international food standards to protect the health of consumers and ensure fair trade practices
1964-67	GATT: Kennedy round → Wheat Trade Convention (WTC) and Food Aid Convention (FAC)
1972	Club of Rome: publication of 'Limits to growth'
1973-79	GATT's Tokyo round: increased trade liberalization but modest agreement on agriculture
1973	First recognized world food crisis → creation of Committee on Food Security (CFS)
1979	FAO: World Conference on Agrarian Reform and Rural Development
	Brundtland Report on environment and development
1990	IPCC First Assessment Report
1992	Rio Earth Summit
	Convention on Biological Diversity
1994	United Nations Framework Convention on Climate Change (UNFCCC)
	United Nations Convention to Combat Desertification (UNCCD)
1986-94	GATT's Uruguay round: agreement on agriculture, limiting domestic support and export subsidies, prohibiting non-tariff import restrictions, and establishing special and differential treatment for developing countries
1995	WTO: creation of World Trade Organization
	First Conference of Parties (COP 1) on Climate Change
1996	FAO: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life"
2000	Adoption of the eight Millennium Development Goals (MDGs)
2001-05	Millennium Ecosystem Assessment (MEA)
	WTO's Doha round: negotiations on agriculture
2005-08	International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD)
2008	United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation (REDD)
2012	FAO – CFS: Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries, and Forests in the context of National Food Security
2013	WTO's Bali package: agreement to negotiate a permanent solution to public stockholding for food security purposes, call for more transparency in tariff quota administration, expansion of the list of General Services and declaration to reduce all forms of export subsidies
2015	WTO's Nairobi package: elimination of agricultural export subsidies by developed countries, except for a handful of agricultural products; developing countries have longer periods to do so.
2016	World Forum on Access to Land and Natural Resources
	Adoption of 17 Sustainable Development Goals (SDGs)

are a prime area for applying new governance processes situated somewhere between collective action and public action, and at the interface between the State and markets.

As far as land is concerned, there is no global governance or international convention related to the issue because "land is seen as too politically sensitive or too technically complicated to lend itself to meaningful resolution" (UN Interagency Framework Team for Preventive Action, 2012). Nevertheless, 'Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security' (FAO, 2012) were developed through a broad partnership of international, regional and national organizations. They outline principles and practices that governments can refer to when making laws and administering land, fisheries and forest rights. Further, a World Forum on Access to Land was held in 2016 at the initiative of associations. Land governance is mostly conducted at national level. However, there is also the promotion of land governance at the territorial level as well as '*terroir*' or origin-linked products. As far as food security is concerned, a large number of institutions are active on the issue but "none has the authority and legitimacy to take responsibility for all aspects or to coordinate the various institutions and manage potential conflicts" (Fouilleux *et al*., 2017).

Changes in the role of governments

Traditionally, governments have three main responsibilities: "To provide goods and services (*e.g.*, education and health care); regulate the interactions within society and the economy; and redistribute income (*e.g.*, through the tax and transfer system). Among many other responsibilities, governments are also responsible for managing risks, ensuring fairness in society, fighting corruption and protecting the environment. To finance these activities, governments raise money in the form of revenues (*e.g.*, taxation) and/or through borrowing" (OECD, 2017). Over recent decades, a number of countries have made efforts to transform the management of their public sector, for example, by promoting the adoption of private sector practices, reducing the costs of the public sector, transferring traditional public sector responsibilities to the private sector or to decentralized services, developing a culture of performance, evaluation and impact, encouraging holistic strategies and coordinated actions etc. Evidence of declining public trust has also been seen for some time in declining voter turnouts, the growing appeal of populist and extremist ideologies in some regions and, above all, in negative perceptions of the government as an institution prone to corruption (Bertucci, 2006). For the future, major uncertainties are related to the capacity of governments to regain trust, to decrease debts and adjust budgets to new expenses, and to adapt to the digital age.

Policies: From Millennium Development Goals to Sustainable Development Goals and land use policies

The evolution from the eight Millennium Development Goals (MDGs) through to the 17 Sustainable Development Goals (SDGs) represents an important change in the global governance of development issues (Box 6.1). The eight MDGs emanated from UN Summits and Conferences of the 1990s and were endorsed in the United Nations Millennium Declaration of 8 September, 2000. They formed a blueprint for action agreed by all of the world's countries and leading development institutions to eradicate poverty, illiteracy, hunger, discrimination against women, unsafe drinking water and degraded environment. They reflected widespread public concern about the issues and marked a historic and effective method of global mobilization (Sachs, 2012). During the MDG era, the number of hungry people in the world declined but "much of humanity's progress has come at a considerable cost to the environment. High-input, resource-intensive farming has contributed to deforestation, water scarcity, soil depletion and high levels of greenhouse gas emissions" (FAO, 2017a, p. 14).

Beginning in 2016, 17 SDGs and 169 targets to wipe out poverty, fight inequality and tackle climate change over the next 15 years were adopted. The SDGs mark some changes in global governance because they were developed after wide consultation with people from all sectors of society. The notion of developed and developing countries has changed – Brazil, India, and China are increasingly influential in global politics – and connections between places have rapidly developed. The SDGs do not focus on the end goal alone, but also on the means used to achieve it. There is recognition that natural resources (including land use), food and livelihoods cannot be looked upon separately. Interconnections between the goals are recognized and taken into account. There is an attempt to break the 'silos approach' as well as the lack of coordination between sectors and policies, which means that governments will need to have a more holistic and coherent approach to problems and will need to monitor and evaluate policies (OECD, 2017). All countries – whether they are upper, middle or low income – are concerned by the SDGs and have to make tangible improvements to the lives of their citizens. There are uncertainties about delivering the SDGs by 2030, globally and in particular countries. It will depend on many factors, such as the ability to connect local innovation capacity with global parameters (Leach *et al.*, 2012), to break the silos in government actions, to make stakeholders accountable and to find the necessary financial resources.

In relation to these goals, there has been an evolution in the 'measure' of governance. Starting in the early 1990s, expert thinking in the international development community focused on the concept of 'good governance' with the expectation of a strong positive correlation with improved economic performance. Large investments were made to improve public administration and transparency and broaden democratic participation. However, there was a progressive realization that policy bottlenecks and political conflicts that impede good governance are complex and could not be easily resolved.

Three aspects of governance are now increasingly considered: good governance (the processes of decision-making and their institutional foundations), effective governance (the capacity of countries to pursue sustainable development) and equitable governance (distributive outcomes) (Bierman *et al.*, 2014). Also, official development assistance (ODA) which used to encourage convergence between less and more developed economies is increasingly focused on protecting global public goods and on delivering SDGs (Severino and Ray, 2009). It is confronted with the interventions of a variety of new actors, especially large private foundations and the private sector, as well as local interventions.

Growing role of large corporations in global governance

There is a great variety of enterprises in the world, both formal and informal. There are an estimated 125 million formal micro-small-medium enterprises (Kushnir *et al.*, 2010) and 100,000 multinational enterprises (MNEs) and among the latter, 1,500 are State-owned MNEs which own more than 86,000 foreign affiliates (UNCTAD, 2017). Large corporations – industrial, financial and service companies – are major political, economic, environmental and cultural forces in the world. Until the end of Cold War, most multinational corporations focused their strategies on influencing home and host governments and policies (Gilpin, 1975). Since then, many countries have introduced policies to attract potential investors. Information technologies and management capacities have allowed firms to maximize efficiencies, to set up global supply chain across countries, to improve productivity and also to gain bargaining power vis-à-vis governments (Detomasi, 2007). As these companies benefit from the lack of fiscal coordination between countries and "play by the rules they are given" (Reich, 2008), they often pay as little tax as possible and can endanger Nation States' sources of revenue. They are accountable only to their own self-selected boards and "rationalize their actions as necessary to address market failures" (Birn, 2014), and promote new technologies, innovation, and management techniques. The influence of MNEs and of their affiliates on global governance is also found in the public-private partnerships they form. Furthermore, over the past decade, private companies and their philanthropic branches, foundations and trusts are increasingly implicated in the humanitarian sector as funders and direct implementers (Maietta *et al.*, 2017).

Agro-industrial, trading and food processing companies, alongside large supermarkets and digital companies, as well as investments funds, are major actors in the global land use and food security system. In past decades, they have provided modern inputs, technology, machinery and skills to modernize production techniques, which have contributed to higher yields, resistance to pests and diseases, easier work for farmers and increased food availability. However, over time, they have also contributed to the specialization and standardization of production, and the use of inputs which may have negative impacts on soils, water and health. They have led to a homogenization of cultivated varieties, reduction in the use of local varieties and their exchange, increased erosion of biological diversity, heavy debts for farmers and market dependence. Private companies are the main

large-scale buyers of land, followed by stock exchange-listed companies and investment funds (Nolte *et al.*, 2016). These companies promote "both productionist and productivist visions of food security. They are organized globally and offer global technical solutions for a problem presented as a global one, using food security as a justification for their business by citing the need to increase productivity levels to feed nine billion people" (Fouilleux *et al.*, 2017, p.11). They have contributed to improved access to food and nutrition transition (Chapter 8).

Global activism by civil society groups

A great variety of NGOs, civil-society groups, churches and faith-based organizations, producers' and consumers' associations are involved in global governance, including land use and food security issues. They gain access to political arenas. As far as land is concerned, there are NGOs which are influential at international level (*e.g.*, La Via Campesina, the Farmer Network, COPA-COGECA in the European Union, Agricultural Producers' Organizations of West Africa – ROPPA) and some of them strongly oppose productivism and agribusinesses. Other groups concentrate on the rights of indigenous populations on their land. As far as food security is concerned, the approach of these groups is "to re-politicize the debate by asking questions about how food is produced and by whom" (Fouilleux *et al.*, 2017, p. 13). A number of associations and NGOs actively campaign to influence political and economic actors and their strategies. NGOs, for example, have played a key role in shaping new private regulatory schemes that have emerged (Busch, 2007).

Development of alliances between a wide variety of actors

A number of alliances of public and private actors are formed. For example, there are alliances of public and private actors that "interact with traditional public forms of land use regulation, leading to 'hybrid' interventions" (Lambin *et al.*, 2014, p. 129). Their interventions can take the form of instruments such as "eco-certification, geographical indications, commodity round tables, moratoria, and payments for environmental services" (Lambin *et al.*, 2014). There are many other examples, too. For instance, environmental performance standards and standards for socially responsible production are established by NGOs and industry associations (Gulbrandsen, 2012). Non-State actors "such as mining companies, conservation NGOs, consultants, scientists and foreign aid donors" influence the State in order to control and secure forests for wealth generation or biodiversity conservation (Corson, 2011). The 'New Alliance for Food Security and Nutrition' has been formed by G8 countries led by the USA, several African governments and transnational corporations and aims to facilitate foreign investment in Africa without any obligations to protect local farmers. Another example is social networking, which enables citizens to coalesce and leads to open, participatory and peer-driven power (Heimans and Timms, 2014).

Economic development and resources

Global economic growth and structural transformation of economies

The global per capita GDP has increased almost five-fold in the 20th century and tripled over the past 30 years with the average global GDP/capita (in constant 2010 US $) climbing from $3,800 (1961) to $9,516 (2010) and 10,283 (2015).[30] Global employment grew at an average annual rate of 1.7% between 1991 and 2007, but since then employment growth has slowed to 1.2% per annum. For the future, there are questions about the evolution of the economy, and unemployment could continue to rise as the labour force expands (ILO, 2015).

The sectoral and spatial distribution of economic activities has also changed. According to UNIDO (2013), in developing countries, the percentage of GDP originating in agriculture was 37% in 1950, 21% in 1980 and 16% in 2005. The percentage of GPD originating in manufacturing rose from 12% in 1950 to around 17% in 1980 and 15% in 2005 (UNIDO, 2013). In advanced countries, the percentage of GDP originating in agriculture fell from 16% in 1950 to 4% in 1980 and 2% in 2005. The percentage originating in manufacturing fell from 23% in 1980 to 16% in 2005. For services, the percentage climbed from 60% in 1980 to 71% in 2005. However, manufacturing and agriculture still play a major role in employment. According to ILO modelled estimates starting in 1991, at this date 43.4% of the world's population was employed in agriculture, 23.7% in industry and 42.1% in services; in 2015, the estimates were 27.2% for employment in agriculture, 24.1% in industry, and 42.1% in services. The decrease in the percentage of the population employed in agriculture has been particularly high in South East Asia and the Pacific, in Eastern Asia and Latin America. In 2015, the percentage of the population employed in agriculture was about 57.6% in sub-Saharan Africa, 29% in Northern Africa, 33.3% in South East Asia and the Pacific, 18.5% in Eastern Asia, 14.2% in Latin America and the Caribbean, 4.5% in European Union 28, and 1.7% in Northern America. In the future, agricultural employment, like the other economic sectors, could change due to the development of automation technologies.

Productivity gaps between agriculture and other sectors can contribute to an explanation of the differences between countries in agriculture's contribution to GDPs and employment shares. These gaps are mainly related to the levels of technology currently applied in the agricultural sector: "At the global level, agricultural work remains largely manual and mechanization is limited. As a result, agricultural productivity has been decoupled from other types of activities, resulting in lower agricultural incomes, which are also impacted by changes in relative prices between agricultural and non-agricultural goods. The consequence is that the value added of other sectors rises much faster than in the

30. https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?page=6.

agricultural sector, which, nevertheless, continues to employ a significant proportion of the working population. Given the importance of agriculture in rural areas, these processes explain the income gap between towns and the countryside and account for the broad extent of rural poverty" (Losch, 2016, p. 7).

Also, since the 1970s, policies have been liberalized, there has been a greater concentration of assets and a growing role for financial markets. This includes deregulation for banks and equity funds and rapid financial innovation (Crotty, 2009) which have contributed to economic growth but also to growing debts for all economic actors and a major financial crisis in 2007-08. In the mid-2015, the total global debt-to-GDP ratio is significantly higher than it was before the 2008 crisis. Whereas advanced economies got indebted before the 2008 crisis, in emerging and developing countries aggregate debt levels have increased sharply since that period and represent a major risk for the future (WEF, 2018). The debt level of enterprises and governments has also increased (WEF, 2018). These processes have major impacts on agriculture and the rural economy in developing countries, especially off-farm diversification and on-farm specialization (Losch *et al.,* 2012). Also, new financial models for agriculture are being developed (Kloeppinger-Todd and Sharma, 2010). Banks and investment funds are increasingly engaging in commodity and farmland investments, and conventional agrifood firms are acting like financial institutions (Clapp *et al.,* 2016). Land is increasingly considered a financial asset, and that could impact the land market dynamics (Fairbairn, 2014; Ducastel and Anseeuw, 2017). Food chains are increasingly managed to facilitate mass production and standardization, and the development of trade (McCullough *et al.,* 2008; Rastoin and Ghersi, 2010). Nevertheless, a variety of agrifood systems remain (Fournier and Touzard, 2017) (Chapter 8).

Income and wealth disparity

Per capita income has diverged across countries for decades, but since the 1990s and in particular since the 2000s, there is evidence of convergence at the global level (UN-DESA, 2015). The convergence between rich and poor countries has been driven by Asian countries, first China and India, and now the whole Asian region. However, in East Asia, widening income inequality gaps between inhabitants of rural and urban areas have been linked to higher incomes associated with good education and rapid industrialization. Over the past decade, income growth has been seen in Latin American and the Caribbean. Africa and Oceania have hardly contributed to global convergence. Nevertheless, the top richest 1% in the world has more wealth than the rest of the world combined (Piketty, 2013) and sub-Saharan Africa and South Asia account for more than 80% of the world's poor. Almost three-fifths of the world's extreme poor are concentrated in five densely populated countries: Bangladesh, China, the Democratic Republic of Congo, India and Nigeria.[31] In all regions of the world inequality in income distribution within countries

31. https://globalmillennials.org/poverty

compels some citizens to live in poverty. In OECD member states, since the 2007-2008 recession, inequality levels are at their highest since data collection started (OECD, 2015). The same trend is observed across many countries across the world.

Production: energy and water use, and digital transformation

Wood and later coal, oil and natural gas have played an enormous role in the development of society. Nuclear energy, renewable sources of energy (hydroelectric, solar, wind and biomass) and non-conventional hydrocarbons started to play a role much later. Global energy consumption has grown rapidly over the past 40 years in response to economic development and demographic growth, especially in emerging economies such as China and India. The future availability of fossil fuels (especially oil and natural gas) and their impacts on greenhouse gas (GHG) emissions are leading to major questions about the means to reduce their production and use (Stern, 2006). Fossil fuels are used in many agricultural and food processing activities, such as mechanization, irrigation, drying and cooking, and the production of fertilizers and herbicides. Smith *et al.* (2007) have estimated that agriculture accounted for 10-12% of total global anthropogenic GHG emissions, and that agricultural CH_4 and N_2O emissions increased by nearly 17% from 1990 to 2005.

Biomass energy includes garbage, wood, landfill gases and biofuels. First-generation biofuels are produced from traditional food and feed crops. World biofuel production grew five-fold between 2001 and 2011 but is still a minor source of energy. However, its efficiency, impact on land and forest use, food prices and GHG emissions remain very controversial. The steepest rise in biofuel production occurred in 2007-2008, concomitantly with a sharp rise in food commodity prices (HLPE, 2013), quickly followed by food riots in the cities of many developing countries. Research is currently being conducted on the development of second-generation biofuels produced from various sources of biomass which do not directly compete with food and feed crops and whose production is more efficient (Guyomard *et al.*, 2011).

Water is used in industry and mining, in agriculture (including for livestock), in households, but also for energy production and ecosystems' livelihood. The first three uses of water have grown much faster than population growth over the last forty years. In 1960, 2,000 km^3 of water were used every year; since 2000, the annual consumption of water is about 4,000 km^3 (see Aquastat[32]), which is more than capacities of renewal. Around 20% of total water used globally is from ground water resources (renewable or not), and this share is rising rapidly, particularly in dry areas. At global level, the withdrawal ratios are 69% agricultural, 12% municipal and 19% industrial. However, a large percentage of water withdrawn by agriculture is consumed by vapor-transpiration whereas the industry or domestic uses restitute most of the water they use. Agricultural use is the highest in Asia (81% in 2010) and the lowest in Europe (25%). Over the years, uses of water by agriculture

32. http://www.fao.org/NR/WATER/AQUASTAT/water_use/indexfra.stm

and industry have become a major source of pollution of groundwater, watercourses and soils. Water resources have become a real political and economic issue for governments of emerging and developing countries, and a major source of potential conflicts.

Over the past two decades, automation and digitalization have had an impact on production in all economic sectors as well as on patterns of consumption (less ownership and more pay-per-use) and partnerships. Agriculture and the food industry are quickly entering the era of platform economics. Some digital platforms are a meeting place for farmers and consumers (short supply chains), for distributors and farmers (for inputs, spare parts or small farming equipment), for the sharing of equipment, for promoting local production and combating waste, for crowdfunding etc. In the future, data and intelligence could be at the centre of business models; data qualification, ownership and security will become crucial, including for land use and food processing.

Changes in trade

International trade in goods and services has gone from about 124 billion US$ in 1960, to 4 trillion US$ in 1995, to 24 trillion US$ in 2014, and has slightly declined since, which may be a sign a diminishing interdependence and integration between countries (UNCTAD, 2015b). At the same time there has been the development of (a) a multilateral trading system promoting liberalization, elimination of tariffs and quotas, but also facilitating the development of non-tariff trade barriers such as the Sanitary and Phytosanitary (SPS) agreement, Technical Barriers to Trade (TBT) agreement and the Agreement on Trade-Related Intellectual Property (TRIPs) (Box 6.1); and (b) preferential and regional trade agreements and international trade corridors; these were traditionally in Europe and North America, but have shifted to the Asia-Pacific region. Also, there has been the development of Fair Trade, which seeks to re-engineer value chains between small producers in developing countries and buyers, in order that a greater proportion of the overall rents accrue to those who provide the inputs (Nicholls and Huybrechts, 2017). Trade is a key element in land-use changes and food security strategies, a driver of changes in ecosystems (Pace and Gephart, 2017) as well as a vector for the introduction of alien species (Hulme, 2009). Perceptions of future food and resource limitation are causing changes in trade (Pace and Gephart, 2017), especially as structural production surpluses have nearly disappeared and there are no more big players with large stocks (Daviron and Douillet, 2013).

Global agricultural trade has grown much slower than trade in other products. Farm products accounted for more than 30% of all merchandise traded globally until 1960, but since the early 2000s, its share has averaged less than 9% (Anderson, 2010). The value of global agricultural exports nearly tripled between 2000 and 2012, while agricultural exports increased by about 60% in volume terms over the same period (FAO, 2015a). The geography of agricultural trade is changing quickly (Daviron and Douillet, 2013). In Asia, imports as a share of apparent consumption increased regularly between 1960 and 2004 (from 4% to 14%) (Anderson, 2010) and Asia has become the fastest growing net importer

since then, driven especially by China, South East Asia and India. The Latin American share of agricultural production was stable (around 25%) between 1960 and 2004 (Anderson, 2010) but over the past decade, Latin America has become the largest net exporter of food, with significant production growth outstripping sustained consumption growth (FAO, 2015a). North America was the second largest net exporter but has lost its domination. Eastern Europe and Central Asia are shifting from being net importers to becoming net exporters (FAO, 2015a). Sub-Saharan Africa's net imports have been growing as food production is unable to keep pace with growing population and demand.

Research and innovation: growing role of the private sector

Over the past 40 years, scientific breakthroughs and technological and organizational innovations have fuelled substantial gains to the economy, and they are continuing to do so to the point that experts say that we are on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate to one another. Agriculture and food systems have been transformed by technological advances in material and life sciences which have led to major improvements, for example, genetic engineering, vaccines for livestock, Integrated Pest Management (IPM), minimum tillage systems, geographical information systems, and robotic systems.

In the agri-food sector, research and development in the public and the private sectors contributed to major gains in agricultural productivity in industrial countries after World War II, and to the spread of the Green Revolution beginning in the 1960s, allowing food output to more than keep pace with demand. Over the years, the geographical distribution of Agricultural Research and Development (Ag R&D) has changed. The governments of middle-income nations are now investing more in agriculture research than those in high-income ones, and the gap between spending by high-income and low-income countries is widening. Rich countries accounted for 56% of global public sector spending on Ag R&D in 1960, but only 47% in 2011 (Pardey *et al.*, 2016). Globally, private sector spending on agricultural research and development is catching up with public sector spending. "In 2011, an average of 52.5% of the research on crop breeding, informatics, fertilizers, pesticides and food technologies in rich countries was being done by private firms (in 1980, the figure was 42%). For middle-income countries, the private proportion of domestic spending was 37% in 2011 (up from 19% in 1980). Middle-income countries' share of private AgR&D spending in 2011 was 35.5%, up from close to 16% in 1980" (Pardey *et al.*, 2016, p. 302). The growing role of the private sector means that intellectual property rights in agriculture, such as plant patents, plant breeders' rights, utility patents, trade secrets, trademarks and geographical indicators, are going to play a major role and influence who will benefit from the research. It also means that the pursuit of public research leading to common goods and the capacity of governments to fund public research are going to be major challenges in the future (Piesse and Thirtle, 2010).

Furthermore, for many decades, society in richer countries has had total confidence in the capacity of science and technology (S&T) to overcome many problems. This situation

is changing because S&T now involves diverse sets of actors which leads to a complex distribution of power and struggles over which directions should be taken (EFS, 2013). Youth interest in science is declining and budget constraints are triggering tensions about the governance of science and technology. The perceptions of S&T's impacts on society and the environment are increasingly diverse.

Human development

Demography: concentration of population growth in Asia and Africa

The world's population almost quadrupled in the twentieth century, rising from 1.6 to 6 billion people. More precisely, it has gone from 3 billion in 1960 to 6.96 billion in 2010, and in 2016, the world population reached about 7.4 billion.[33] The global population growth rate is declining: this growth rate was 2.1% in the 1960s and 1.2% in the 2010s. In 2016, Asia represented about 59.7% of the world's population (55.2% in 1950), Africa accounted for 16.4% (9.1% in 1950), OECD countries for 15.3% (29% in 1950) and Latin America and the Caribbean for 8.6% (6.7% in 1950). The growth of the population is therefore concentrated in Africa and Asia.

The average annual rate of change of the urban population has tended to decrease at world's level: 2.99% for the period 1960-1965, down to 2.20% for the period 2005-2010, and 2.05% for the period 2010-2015. It is decreasing in all regions of the world, including Africa where it remains however very high (3.55% for the period 2010-2015) and Asia (2.5% for the period 2010-2015). The average annual rate of growth of the rural population in less developed regions has fallen drastically (from 0.72% in 1960-1965 to 0.21% in 2010-2015), but in sub-Saharan Africa it has remained very high (2% for the period 1960-1965 and 1.86% for the period 2010-2015).

As a share of the world's population, international migration is increasing slightly faster than the world's population. International migration represents 3% of all people today, compared with 2.6% in 1960, according to United Nations statistics. South-South migration flows (*i.e.* across developing countries) are growing compared to South-North movements (from developing to developed countries) (UN-DESA, 2017). The vast majority of refugees are hosted in Asian and African countries (UN-DESA, 2017). Out-migration from rural regions is also a major trend that leads to a decrease in rural labour. Once they get out of rural areas or move across borders, many migrants send money (remittances) back to families in their countries of origin; the overall annual flow of such remittances has nearly tripled since 2000 (Connor *et al.*, 2013). Remittances help to make vulnerable communities more resilient to shocks (Lambin and Meyfroidt, 2011); they give receiving

33. https://esa.un.org/unpd/wpp/Download/Standard/Population/

groups the capacity to opt for more risky or costly agricultural choices. Migrations from rural areas can lead to labour shortages and therefore to shifts to less labour-intensive practices (Mendola, 2008; Radel *et al.*, 2010) or to adoption of monoculture practices (Schmook and Radel, 2008).

Unprecedented changes are occurring worldwide as fertility and mortality rates decline in most countries and the population ages (236 million people over 60 in 1960; 769 million in 2010, and 969 million in 2015). According to the United Nations Population Fund, the proportion of people aged 60-plus is already higher in less developed regions than in developed regions; it is rising at a fast pace in the developed regions which have little time to adjust to the adverse impacts of ageing. The youth (ages 10 to 24) constitutes more than 1.8 billion of the world's population and is at its highest ever level; 226 million youth aged 15-24 live in Africa and represent 19% of the global youth. For Africa, youth represents both an opportunity and a challenge: they need to be educated and employed, fed in a healthy fashion and cared for, but they are also full of energy, creativity and talents.

The levels of development have improved all over the world. UNDP (2016) reports that "every developing region's Human Development Index (HDI) value has increased considerably between 1990 and 2015, although progress has been slowing since 2010. This reflects important advances not only in income, but also in health and education. Between 1990 and 2010, the aggregate HDI value of the least developed countries increased by 46%." (UNDP, 2016, p. 26). The global extreme poverty rate (1.90 $ a day) has fallen from 60% in 1990 to 3.5% in 2013 in East Asia and the Pacific, and from 44% to 15% in South Asia during the same period (UNDP, 2016).

Persistence of global divide in education and gender inequity

Since the 1970s, there has been a strong focus on primary school enrolment in developing countries and secondary school enrolment has also progressed. Nevertheless, a great divide remains between the poorest and richest countries: in 2010, about 33% of the population over the age of 15 had no schooling in South Asia and sub-Saharan Africa and 23.8% in the Middle East and North Africa (Barro and Lee, 2010). However, significant progress has been made by developing countries in terms of reducing gender inequality in education among the overall population over the age of 15; for example, the ratio of female to male average years of schooling increased from around 62.5% in 1950 to 81.2% in 1990 and 85.9% by 2010 (Barro and Lee, 2010). This situation has an impact on land use and food security as education is a necessary, though not sufficient, driving force for alleviating hunger and poverty. Better education levels can facilitate social and technological change.

More generally, women's participation in the labour force is significantly less compared to men; women have substantially lower salaries for the same type of work and a higher percentage of women are employed in vulnerable or irregular jobs. In no country do women have the same opportunities as men to participate in economic and social decision-making processes. In agriculture, the population is ageing and increasingly feminized as men migrate

for longer periods and for further destinations. Data must be considered with caution but FAO estimated that in 2010, 43% of the workforce in agriculture was feminine. There are however large differences between countries, and the share of women' employment in agriculture varies from crop to crop, from activity to activity and from age group to age group (de Schutter, 2013). Women are often farm workers and sometimes independent food producers, and they face then different kinds of issues (de Schutter, 2013).

Importance of culture in land use and food consumption

The importance of culture in land use has been widely recognized thanks to the Millennium Ecosystem Assessment (MEA, 2005b) which posits that "people are integral parts of ecosystems and that a dynamic interaction exists between them and other parts of ecosystems, with the changing human condition driving, both directly and indirectly, changes in ecosystems and thereby causing changes in human well-being". A number of the Millennium Ecosystem sub-global assessments found that human cultures, knowledge systems, religions and social interactions have been strongly influenced by ecosystems; how societies and individuals organize landscapes, production and consumption are also influenced by behavioural factors related to culture, ethics and values. The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) (McIntyre *et al.*, 2009) has played a major role in the assessment of the importance of local and traditional knowledge in agriculture. Local, traditional and indigenous communities are increasingly recognized as a reservoir of knowledge about agricultural practices and diets.

Future global contexts in 2050

THE GENERAL PURPOSE OF THE NARRATIVES ABOUT THE POLITICAL, economic and social contexts is to provide broad descriptions of future conditions that will indirectly but strongly impact the land use and food security system. Five hypotheses have been built and their main characteristics are presented in Table 6.1. Each column in Table 6.1 describes one hypothesis for the global context in 2050, which is a combination of assumptions of change in the three identified forces: governance, economic development and resources, and human development. Below are very brief narratives for each hypothesis. They appear in greater detail in the section 'How did we get there?' of the narratives of the Agrimonde-Terra scenarios (Chapter 13).

As far as demography is concerned, Agrimonde-Terra adopted the same assumption for all hypotheses for the global context in 2050. Based on the median projection provided by the United Nations (2015 revision), it is assumed that the world population will reach 9.7 billion people in 2050. The situation between 2010 and 2050 will vary in each region: stability in the European Union, Former Soviet Union and China; strong increases in West Africa, and in East, Central and South Africa (+192% and +155%, respectively), in North Africa and the Near and Middle East (+72% and +70%, respectively), and to a lesser extent in India (+45%) (Chapter 14).

When a foresight exercise on land use and food security is carried out at a regional, national or territorial scale, assumptions about governance, economic development and resources, and human development should also be built at the scale that is considered.

Hypothesis 1: Sustainable and cooperative world

There is a major rupture in this hypothesis: a change in the attitudes of institutions and individuals which leads to cooperation towards sustainability. States cooperate amongst themselves and with businesses, civil society organizations and international institutions and they all make strong commitments towards the mitigation of climate change, regulation of the nutritional quality of food products, health and a shift to a green and collaborative economy. Over the years, energy, climate, agriculture, logistics and food policies are integrated and converge. Land reforms are adopted and there is secure access to land for all. Policies also support the reduction of energy consumption and GHG emissions; they place limits on transport, improve carbon sequestration, encourage efficient use of inputs which are harmless for the health, advocate for consumer restraint and are people-centred. In developing countries, with technology transfer, technical assistance and financial resources, efficient energy production systems are established which generate little pollution and operate on small scales. Agri-food companies are committed to improving the nutritional quality of their food products, diversifying production and limiting their ecological footprint. Efforts are made to reduce losses and waste. Economic growth is moderate (in 2050, per capita GDP is $20,000 in 2050). Trade is liberalized but regulated through social and environmental norms. In developed and developing countries, research is highly participative, and innovation is technological, social and organizational. The fight against poverty is multifaceted and world inequalities are reduced.

Hypothesis 2: Regionalization and energy transition

The major break that leads to this hypothesis is that States join and form large, supranational blocs to face together recurrent crises caused by climate, social and economic change, and to implement a 'food sovereignty and subsidiarity' principle based on regional food supplies and supported by businesses and civil society organizations. Countries regroup by regions and globalization is abandoned.

Policies are steered towards regional issues. Each region uses its own energy resources. In regions with little fossil fuel, large quantities of renewable energy, especially biomass energy, are produced and efforts are made to reduce energy consumption. Economic growth is moderate (per capita GDP is $20,000) with a strong intra-regional trade. Trade between regions is limited. Investment in research varies according to the region. Regions with more limited financial resources concentrate on social innovation and on modernizing organizations, allowing them to remain competitive in a digital world. Within each region, countries network to improve education and research.

Table 6.1. Characteristics of the five hypotheses for future global contexts in 2050.

Hypotheses for 2050	Sustainable and cooperative world	Regionalization and energy transition	Economic and political fragmentation	Conventional development led by market forces.	Dominance of non-State actors
Governance	Cooperation among States, businesses, civil society organizations and international institutions.	States join to form large, supranational regional blocs to face recurrent crises while preserving their own cultural specificities. Competition among regions remains.	Many countries have unstable governments, unable to cope with crises. Local communities share and manage resources.	Alliances between multinational companies, investment funds and international institutions. Weak States.	Domination of hybrid and agile coalitions made up of NGOs, MNEs, foundations, associations and local authorities. Governments try to coordinate their actions.
	Coherent and integrated policies and regulations.	Policies based on regional interests	Few policies	Few policies or influenced by the interests of companies.	Policies for climate change mitigation and to fight poverty
Economic development and resources	Moderate economic growth. Shift to a circular and green economy. Geographical proximity between producers and consumers. Differentiation of products, quality. Average GDP/cap: $20,000.	Moderate economic growth. Principle of 'food sovereignty and subsidiarity' at the regional bloc level. Average GPD/cap: $20,000.	Low economic growth. Production and processing mostly carried out by small units and exchanged locally. Severe national debts. Average GDP/cap: $18,000.	Steady economic growth. Subsidized consumption for the poorest in urban areas to avoid social tensions. Agro-industrial food system. Average GDP/cap: $24,000.	Economic growth at global level but economic situation of groups and individuals depend on their capacity for networking. Spread of ICT.

Table 6.1. Continued.

Hypotheses for 2050	Sustainable and cooperative world	Regionalization and energy transition	Economic and political fragmentation	Conventional development led by market forces.	Dominance of non-State actors
Economic development and resources	Decreased reliance on fossil fuels and increased use of 1st and 2nd generation biofuels. Carbon as a cornerstone of energy markets. Energy consumption: 696 EJ	Transition to renewable energy (300 EJ), especially biomass. Regional carbon trading schemes.	Use of fossil fuel when locally available and use of renewable energy in other cases. Weak access to energy in some regions.	Heavy reliance on low-cost fossil fuel and rare metals leading to depletion of reserves. Low concern for environment. Energy consumption: 879 EJ	Development of renewable energy. Decentralized production and smart networks.
	Free trade but regulations to assure quality of products.	Strong intra-regional trade.	Trade limited to neighbouring countries or countries with whom bilateral agreements have been signed.	Trade is liberalized; low barriers and subsidies, harmonization of standards	Free trade and active international markets.
	Public-private partnerships for R&I. Shared intelligence and participative research. Complexity, integration, interdisciplinarity.	Investments in R&D depend on region's resources.	Joint research projects supported by crowdfunding platforms and run by volunteer activists. Hardly any public research.	Strong influence of R&I's priorities of private sector. Full confidence in technology. Specialization. Development of 'omics"', big data, remote sensing.	Research projects funded jointly by private sector and NGOs. Researchers are mobile, and adaptable. High reliance on information technologies.
Human development	Low migration level. Fight against poverty, high attention to health and education	Migrations within regions. Attention to employment, education and health, but situations vary from one region to the other. Collaboration within regions.	Uncontrolled migrations. High unemployment; social instability. Education at community level if available.	Migrations from resource-poor countries to richer ones. Acceptance of inequalities. Deterioration of public health. High employment rates, except in agriculture.	Circular mobility between urban and rural areas, and between countries. Growth of middle class. Development of e-learning. Attention to health.

Hypothesis 3: Economic and political fragmentation

There are on-going trends towards this hypothesis which assumes political and economic fragmentation, as well as severe geostrategic tensions. Some countries have been in chaos for many years and their situation worsens with monetary and financial crises, States struggle to cope with their debt, there is the rise of nationalism in a few countries, unemployment and social instability are problems and international and regional institutions are unable to roll out coherent policies to help governments overcome their difficulties. International fossil energy markets are hit and access to energy is reduced in some regions. Crises in developed countries trigger more crises in emerging nations. Political instability aggravates economic difficulties and leads to internal conflicts in some countries. Global economic growth is low (per capita GDP stands at $18,000) but there are huge differences within countries and between countries. The informal economy is widely developed. Trade is limited to neighbouring countries. Education develops in an informal yet rather efficient manner through the exchange and sharing of experience; healthcare follows a similar trend. Groups of researchers and other interested stakeholders set up joint research and innovation projects supported by crowdfunding platforms and run by volunteer activists. Local communities of farmers and users of spaces gradually organize themselves to share and manage the use of resources.

Hypothesis 4: Conventional development led by market forces

There are many on-going trends towards this hypothesis: a high reliance on fossil fuels and low level of concern for environmental issues, faith in technological progress to solve all problems, global markets and belief that competitive markets contribute to economic growth.

In this hypothesis, there is an alliance between multinational corporations, investments funds and international institutions to push towards this model. Economic growth is based on low-cost fossil fuel, and trade barriers are low. Above all, people have confidence in technology to overcome limited natural resources, as well as in education and information and communication technologies. Research focuses on industrial efficiency and cost reduction. The convergence of technologies allows considerable progress, but at the price of a number of accidents with serious effects on health and the environment. There are large inequalities at global and national levels. However, this development leads to an increasing number of environmental, health, economic and social catastrophes. Energy prices rise sharply as conventional oil and then gas resources become increasingly rare; reserves of phosphate and rare metals with low extraction costs are depleted. Competition over water is fierce. Public health deteriorates sharply due to pollution and unhealthy diets. Migrations from resource-poor countries to richer ones are very large.

Hypothesis 5: Dominance of non-State actors

The on-going trends towards this hypothesis are the globalization of the economy, the digitalization of relationships and the multiplication of initiatives by non-State actors such as NGOs, civil society organizations, philanthropic associations, faith-based organizations and academic institutions.

In a highly globalized world, where mobility is very common, rather than uniting around a national government, people tend to join groups that share common interests, thereby creating powerful currents of opinion. The consensus within public opinion regarding the main challenges and growth of the middle classes provide the foundation on which the power of the non-State interest groups is based. Urbanization and information technologies facilitate the development of multiple coalitions which are independent of national governments. Governments perceive their role as being organizers and coordinators of the 'hybrid' coalitions of State and non-State actors that evolve according to the challenges concerned. Transnational interest groups have the ability to bypass national governments seeking to regulate their activities. They challenge traditional jurisdictions and regulations. The power of the networks and ad hoc coalitions raises security issues and generates geopolitical uncertainty, although such changes also bring greater global wealth. Energy production is decentralized. The economic situation of groups is dependent on their networking capacities, and there are large inequalities. Researchers are versatile and mobile; there is confidence in their capacity to find solutions to many of the challenges faced by the world.

Conclusion

THE GLOBAL CONTEXT HAS CHANGED DRASTICALLY over the past forty years. A number of political, economic, social and technological trends and stakeholders are manifesting themselves, and opposing each other, creating major disruptions.

In the past forty years, the population has concentrated in Asia and Africa, and this represents a major challenge for future land uses and food security at global level and in these regions.

Global economic growth has been very rapid and contributed to changes in food systems and diets as well as major investments in agricultural research and development. Trade has evolved influenced by the simultaneous development of a multilateral trading system and the development of non-tariff trade barriers and preferential and regional trade agreements, and these evolutions have influenced the distribution of land uses. The pace of technological change has been very rapid, influencing heavily land use intensity in certain countries and less in others, especially in Africa and Asia. The share of agriculture in the economy and employment has evolved at different speed in different regions of the world.

Global governance of land uses and food security has been promoted while there has been increased attention paid to national sovereignty and even recognition of governance of land uses at the levels of territories. Political instability and conflicts represent major risks for land uses and contribute to food insecurity. Large corporations are extremely influential and civil society organizations have become extremely active, and new alliances could shape the land uses and food security.