Economics
The Open-Access, Open-Assessment E-Journal

Discussion Paper
No. 2017-39 | June 27, 2017 | http://www.economics-ejournal.org/economics/discussionpapers/2017-39

Please cite the corresponding Journal Article at
http://www.economics-ejournal.org/economics/journalarticles/2017-32

Key policy actions for sustainable land and water use to serve people

Joachim von Braun, Ashok Gulati, and Homi Kharas

Abstract

To achieve food security for all, new resource policies for sustainable land and water use are needed. Land, water and energy need to be considered jointly in policies, not in isolation. G20 countries' policy makers, corporate and civil society actors, and those of other countries should act in coordinated fashion in the following four policy areas on which specific proposals are made in this policy paper: 1) focusing land, and water resource policies on human wellbeing, 2) investing in and sharing water, agricultural and energy innovations, 3) making wider use of digital opportunities for sustainable agriculture, and 4) re-designing global governance of agriculture and food.

(Published in Special Issue The Sustainable Development Goals—Assessing interlinkages, trade-offs and synergies for policy design)

(Submitted as Global Solutions Paper)

JEL F53 Q10 Q18 Q28
Keywords G-20; international resource policy; sustainable agriculture; food security

Authors

Joachim von Braun, ✉ Center for Development Research (ZEF), Bonn University, Germany, jvonbraun@uni-bonn.de
Ashok Gulati, Indian Council for Research on International Economic Relations (ICRIER), New Dehli, India
Homi Kharas, The Brookings Institution, Washington, DC, USA

Citation Joachim von Braun, Ashok Gulati, and Homi Kharas (2017). Key policy actions for sustainable land and water use to serve people. Economics Discussion Papers, No 2017-39, Kiel Institute for the World Economy. http://www.economics-ejournal.org/economics/discussionpapers/2017-39

Received June 25, 2017 **Accepted as Economics Discussion Paper** June 26, 2017
Published June 27, 2017

The Challenges of Water, Land and Energy Linkages with Hunger and Environment[1]

Achieving the Sustainable Development Goals (SDGs) requires much stronger attention to sustainable agricultural practices. Land and water use are currently not sustainable in many regions of the world, including in G20 countries. While there is progress in reduction of hunger in the world, close to 800 million people still face hunger and about a quarter of children are affected by stunting due to malnutrition (IFPRI 2016), mostly in Sub-Saharan Africa and South Asia. A productive and sustainable agriculture sector will be key to addressing these challenges and achieving food security and improved nutrition for all. An integrated, cross-sectoral strategy requires G20 and global action since land, water and energy are no longer just local or national issues:

- **Water quality and overuse** are growing problems around the world. Two-thirds of the world population could be under stress conditions caused by water scarcity by 2025 (von Grebmer et al. 2016). About 780 million people lack access to safe water (WMO 1997), 2.5 billion people lack access to proper sanitation (WHO and UNICEF 2012). Declining groundwater tables, changing water flows, and water pollution above and below ground affect communities all over the globe. Water use in the agriculture sector accounts for 69% of global water withdrawal (Prüss-Üstün et al. 2008), and is the largest consumer

[1] This paper is based on a policy brief prepared in the T20 process. The T20 Task Force on "Ending hunger and sustainable agriculture" is co-chaired by Joachim von Braun (ZEF, Bonn University, Germany), Ashok Gulati (ICRIER, New Delhi, India), and Homi Kharas (Brookings, Washington DC, USA). These authors are solely responsible for the content and their views do not necessarily represent the views or recommendations of their related institutions.
Members of the task force are: Li Xiaoyun (China Agricultural University College of Humanities and Development, China International Development Research Network (CIDRN), China), Jikun Huang (Center for Chinese Agricultural Policy of Chinese Academy of Sciences, China), Sachin Chaturvedi (Research and Information System for Developing Countries (RIS), India), MartÃn Pineiro (Argentina Council for Foreign relations (CARI), Argentina), Catherine Bertini (Chicago Council on Global Affairs, USA), Rebecca Nelson (Cornell University, USA), Shenggen Fan and Rajul Pandya-Lorch (International Food Policy Research Institute (IFPRI), USA), Jean Lebel, Dominique Charron (International Development Research Centre (IDRC), Canada), Achim Dobermann (Rothamstead Research, UK), Nick Vink (University of Stellenbosch, South Africa), Regina Birner (University of Hohenheim, Germany), Michael Brüntrup, Ines Dombrowsky (German Development Institute (DIE), Germany), Ruth Delzeit (Kiel Institute for the World Economy (IfW), Germany), Heike Baumüller, Nicolas Gerber, Alisher Mirzabaev, Mekbib Haile (Center for Development Research (ZEF), University of Bonn, Germany), Ken Giller (Wageningen University, The Netherlands), Jörg Hacker (German National Academy of Sciences Leopoldina, Germany), Hermann Lotze-Campen (Potsdam Institute for Climate Impact Research (PIK), Germany), Michael Obersteiner (International Institute for Applied Systems Analysis (IIASA), Austria), Matin Qaim (University of Göttingen, Germany)

of groundwater resources (FAO 2014a). Pressures on water resources from agriculture are set to increase with the expansion of irrigation and changes in food consumption. So far, 21% of total cultivated land is under irrigation (GWP 2012), and 42% of irrigation is located in just two G20 countries, China and India (FAO 2014b).

- **Climate change** will expand the geographic extent of water-stressed areas and increase production variability and price volatility. Under climate change, larger expansion of investments in water management and water saving irrigation, using precision farming and soil moisture conservation, is needed, as part of a climate smart food system. Financing this calls for G20 attention, and multilateral development banks and private sector finance.

- **Land degradation** is occurring in almost all world regions, and already affects about 30% of the global land area where about three billion people live. Nutrient depletion is a cause especially in Africa, while too intensive use of inputs and soil contaminations are causes in some other regions. The annual global cost of land degradation is about 300 billion US dollars. Sub-Saharan Africa accounts for a quarter of these total global costs, the largest share. Only about 46% of the cost of land degradation represents private costs by immediate land users, with the remaining share is social costs due to lost ecosystems services locally and at a global level (FAO 2014b).

- The food sector accounts for 30% of global **energy** consumption, and agriculture and land use change are responsible for about 24% of greenhouse gas emissions (Nkonya et al. 2016). On the other hand, over 1.2 billion people, mostly rural and agricultural households, still lack access to electricity and 2.7 billion people rely on traditional fuels, namely, firewood, crop resides and animal dung for cooking (FAO 2011), with highly detrimental health impacts due to indoor air pollution.

- Continued degradation of land and waste of water may lead to a rise in rural **poverty** that can potentially trigger human conflict, rural instability and large-scale population migrations crossing borders and regions. Sustainable land and water use therefore form central parts of the package of instruments required to buttress global security and advance the goals of the SDG Agenda 2030. This is part of the broader agenda of human **rights** to health and good nutrition, safe drinking water and other basic services, to land rights, and the right to participate and have voice in development, and related decision making without discrimination of any kind.

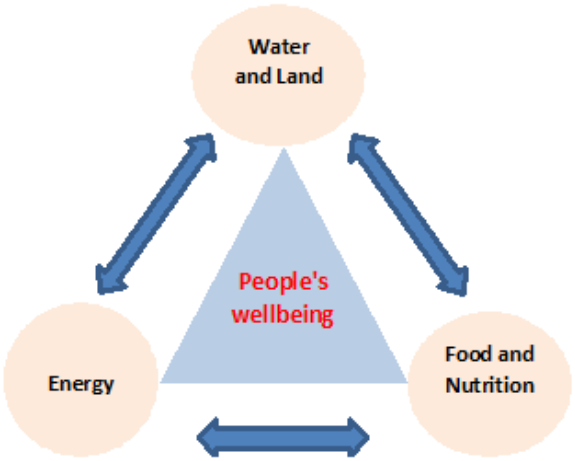

Figure 1: The Nexus Linkages

Proposal 1: Focusing land and water resource policies on human wellbeing

Broaden policy focus to health and nutrition linkages: **Water in agriculture has deep implications for food safety, peoples' health and hygiene**, and if not managed well triggers large health costs. Waste water irrigation has the potential to boost food production in many rural and peri-urban areas, but also carries risks such as increased exposure to pathogens and related health issues for farm workers and food consumers, or increased exposure to water-borne diseases for neighboring communities. In emerging economies, as much as 80% of illnesses and large proportions of child undernutrition are linked to poor water and sanitation conditions and about 1.5 million children die every year from diseases caused by unsafe water and inadequate sanitation[2]. Water borne diseases like malaria and dengue need more attention in irrigation systems design. In many locations including in G20 countries, this requires a **fundamental re-design of water use systems in agriculture**, by separating the agriculture water systems as much as possible from people's living environments.

Harnessing investment in small farm sector as bearers and mitigators of food security risks: **Land degradation and mismanaged water heavily impact over 400 million smallholder farmers**. Smallholder farms are key to national and

[2] Energy Access Database, International Energy Agency, http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/

regional food security because they represent a large number of people who are themselves vulnerable to food insecurity, but also because these small farms produce a large share of the food exchanged on the markets. The small-scale farm sector in Sub-Saharan Africa and in Asia has large investment opportunities and will help improve the resilience of the global food system, contribute to increased economic growth, and employment (UNICEF 2006). A focus on **youth employment and women** is central to improve food security and sustainable agricultural systems. Investing in youth would reduce unemployment and rural outmigration, and could support the adoption of innovation and uptake of digital technology in sustainable land and water use. Empowering women farmers much more with programs for enhancing their access to finance and markets remains critical.

Proposal 2: Investing in and sharing water, agricultural and energy innovation

Increasing economic water use efficiency in agriculture: G20 countries will be the main drivers of growing and changing food demand, which will significantly increase water use, unless innovative investment opportunities are found. In particular the rapid expansion in the consumption of animal products, which account for a third of all water used in agriculture (HLPE 2013), will require investments in innovations. **Addressing water shortages requires increasing water use efficiency**, as measures increasing water supply are often costly, unsustainable (e.g. pumping more groundwater), or may have substantial ecological and social consequences (e.g. construction of large dams).

Policy reforms need to look beyond physical efficiency to bear in mind **economic efficiency**, i.e. the extra cost that is needed to achieve higher levels of water efficiency. New policies and legal frameworks will be needed to stimulate efficient water use, including the **establishment of locally adapted water markets** (Mekonnen and Hoekstra 2010), which will require addressing the thorny issue of property rights for water. Water is subsidized, when costs of water supply are not recovered and energy for pumping is covered by governments. While protecting poor irrigating farmers' access to sufficient water, **general water subsidies should be phased out**, especially energy subsidies for irrigation which make up much of the indirect water subsidies.

New technologies and farming practices play a crucial role for sustainable water and land use. For instance, moving from canal systems, to ground water to drips and sprinklers can increase efficiency from about 35% to 85% in India,

and experiments in rice drip irrigation show a saving of 60%.[3] Water re-use and proper recycling of wastewater need to be an integral part of increased water use efficiency. Agronomic and plant breeding innovations to increase water use efficiency are to be considered too.

Step up investments in energy innovations: **Renewable energy innovations are promising for water use** and for the development of the food and agriculture sector as a whole. Especially solar energy creates new opportunities for higher value agricultural production and processing businesses in rural communities. For example, shifting from thermal to **solar energy** for pumping groundwater for irrigation could provide substantial environmental, economic and health synergies, once ground water systems are governed by sound policy and legal frameworks at local levels.

These innovations are critical to address the tradeoffs between water for agriculture, industry or energy, and the dilemmas between energy resources extraction (hydro, oil, gas), energy generation (hydro, thermo), and energy access (use by different groups in society). **G20 can assist each other and other countries by supporting and sharing sound energy technologies and planning capacities**.

Need to reverse land degradation: Reversing land degradation trends makes economic sense and reduces poverty. The costs of in-action are much higher than the costs of action for reversing land degradation: Globally, on average, one US dollar invested into restoration of degraded land returns five US dollars (FAO 2014a). In spite of these high returns from investing in healthy soils and land, degradation is persisting in many areas across the world. Policies are needed to minimize the indirect costs of land degradation, which for instance include siltation of waterways and lakes, erosion, deterioration of water cycles, and loss of biodiversity. Related knowledge sharing, effective extension and vocational training will go long ways. This is **a G20 policy matter, since land degradation reduces productivity, increases costs and prices, and to a considerable extend these are global burdens**.

Land degradation and water runoff are related in many areas and need to be addressed. Investments are needed for both **rehabilitation and restoration of degraded lands** through such policy measures as strengthening community participation in natural resource management, enhancing government effectiveness and the rule of law around land tenure issues. Land titling is increasingly important, to ensure that productivity gains in agriculture can be realized by farmers, whilst ensuring that the process is fair. **G20 may consider strengthening the existing international understandings** (Jain 2015) **beyond mere voluntary guidelines**.

[3] e.g. by up 30% in Rio Grande Basin in USA (Booker et al. 2005)

Proposal 3: Making use of digital opportunities for sustainable agriculture

Service provision through mobile ICT networks and platforms: Information and communication technology (ICT) in agriculture is still an underrated game changer for sustainable resource use. ICTs can play a central role in offering services to farmers and other actors at scale in the value chains, and for gathering and analyzing policy relevant data. The rapid expansion of mobile networks and devices around the world offers unprecedented opportunities to offer services to farmers and other players in the agriculture value chains. ICTs can facilitate access to and management of water in farming operations, e.g. through water bills using mobile payments, remotely operating pumps, automated analysis of soil moisture sensors. Examples of applications in land management include land title registry using blockchains to protect against fraud, **precision agriculture** technologies, and optimized drip irrigation even in field crops, and in-field variable rate application of fertilizer, which allows for site-specific management of fields. **To tap these ICT opportunities G20 may consider establishing food and agriculture related ICT platforms** at national levels, and make them available for transnational sharing. This is **a promising field for public-private partnerships within and across G20**, and with other pioneering countries, such as Kenya. Particular attention should be paid to Women farmers' access to ICT supported services.

Risk mitigation through early warning and insurance: Data gathered through ICT supported monitoring networks combined with the organizational capacities to analyze this information can **improve preparedness and risk mitigation**. Thereby, ICTs can help to strengthen extension services, develop hydro-meteorological capacities and early warning systems in emerging economies, which could yield high benefits. In particular dryland farmers could greatly benefit, as climate risks are increasing. Data collected through weather stations (which have unfortunately been declining in numbers) and satellites can also be used to provide index based crop and livestock insurance. Examples already exist where remotely collected data on rainfall patterns trigger automatic insurance pay-outs to farmers. **G20 nations should implement regulatory frameworks that facilitate expanded experiments and their scaling of such innovations that can support resilience of farmers**.

Improved metrics and open data for political decision-making: G20 members should also share and deploy these technologies to ensure that adequate **metrics of land degradation and water use** are available and used to identify priorities where

the issues are most severe. ICT-based monitoring and data analytics by satellite technology for real-time measurements of agricultural production in relation to water and weather estimations are promising. Remotely sensed satellite data, mobile phone networks or sensors connected through the Internet of Things can be helpful to trace, for instance, rainfall patterns, soil moisture or nutrient levels with increased time and scale resolutions. Further G20 support for **open data/open access solutions**, including support for the Global Open Data for Agriculture & Nutrition (GODAN)[4] on soil, water and land resources is warranted, as well as data integration from traditional and non-traditional (industry, NGOs, crowd sources), and harmonized rules, incentives and supporting policies at international levels, facilitating knowledge sharing.

Proposal 4: Re-designing global governance of agriculture and food

Towards a sustainable bioeconomy: Challenges related to water and land use cannot be addressed in isolation. Rather, a resource policy with joint attention to water, land, and energy should be created, to deal with complex tradeoffs and synergies. Expansion of bio-energy production must not contribute to food insecurity and to deforestation. At the same time, food waste and losses directly translate into waste of water, land and energy. The **linkages between water, energy and food production call for a broader framework** under which policies should be designed, and this is offered by the bioeconomy concept (German Bioeconomy Council 2015). Bioeconomy is the knowledge based use of biological resources, biological systems, and technologies for all industries and economic sectors to provide sustainable products. More than 40 nations, including most of G20, have adopted it in recent years. Bioeconomy is a central element of a green growth strategy, and sustainable agriculture is a key part of it. **G20 should collaborate to establish sound and transparent international standards for a sustainable bioeconomy** and its food and agricultural products to accelerate investment, and trade in bio-based products.

Capitalize on trade opportunities for the efficient allocation of water and land use: Trade is one way in which challenges related to water and land use transcend national boundaries, because water and land are embodied in traded goods, thus water and land are virtually traded between nations. These **interconnections offer opportunities to allocate water use and agricultural production more efficiently** at the global level, while the implications for local food security

[4] http://www.godan.info

are borne in mind. Shifting production from countries with low comparative advantages and low water productivity to those with high productivity can enhance more sustainable resource use. Global food trade is estimated to have resulted in 34% reduction in the global water use in producing the traded amounts (German Bioeconomy Council 2015, FAO 2016, Yang et al. 2006). The same applies to shifting production to countries with abundant or less degraded land. **International trade and investment agreements by G20 need to explicitly factor in the potential positive and negative trade related impacts on sustainable land and water use** in the analyses that are typically used to advise on expected outcomes of trade agreements.

Redesigning global governance arrangements for sustainable agriculture, land and water: Land and water use have international impacts, which reach beyond local and national dimensions, but there is no "world water organization" or "world land use organization". The global public goods aspects, which need international governance arrangements, include trans-boundary water resource management and trade issues, and the sharing of and joint investments in research and innovation, such as by the CGIAR, InterAcademy Partnership, and others. **G20 should consider taking a lead to re-design global food and agriculture governance**; proposals for this have been developed by various forums in recent years (EU 2015). To support this process with research based evidence, an integration and consolidation of the myriad of panels and committees at international level in an **International Panel on Food, Nutrition and Agriculture** (IPFNA) is suggested, partly following the design of the Intergovernmental Panel on Climate Change (IPCC). Existing organizations and mechanisms would form building blocks of such a strengthened food and agriculture governance system. Some re-design in the suggested direction was triggered by the food crisis of 2008, as indicated by the reform of the Committee on Food Security (CFS) with its High Level Panel of Experts (HLPE), but more is needed. Moving forward, **G20 may consider calling for a stakeholder forum that explores the organizational implications of such needed global governance redesign of agriculture and food**.

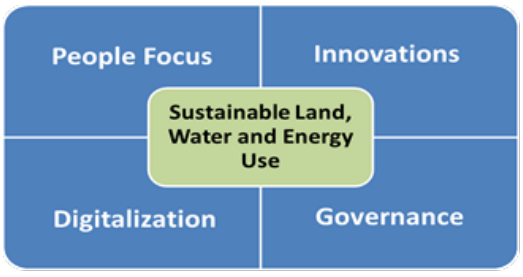

Figure 2: Key Policy Action Areas

Implementation Overview

In sum, implementation actions are proposed for each of the four **areas of G20 attention to pursue ending hunger and sustainable agriculture**.

1. Focusing land and water management and improved energy access on the wellbeing of people. Therefore ministries of agriculture and water-, health- and infrastructure related ministries and development agencies need to co-operate more meaningfully with each other, and establish interdepartmental mechanisms. This requires coordinating leadership by heads of government.

2. Establishing technology sharing mechanisms and broader science policy partnerships to support investment and greater sharing of agricultural, water and energy innovations that accelerate efficiency and reach small farmers and rural poor.

3. Establishing agriculture related ICT platforms in public-private partnerships by G20 nations, with linkages among them and access by non-G20 countries where useful, to facilitate wider use of digital opportunities for improved markets, and capacity strengthening in agriculture and resource use.

4. Strengthening policy coherence in land, water, and trade policies, adopting trans-sectoral bioeconomy policies, strengthening and sharing international research, and re-designing global food and agriculture governance.

Food security and sustainable agriculture have been firmly established as priorities on the global policy agenda, and vigorous follow up to policy commitments by G20 and others is called for. Following the "L'Aquila" Joint Statement on Global Food Security in 2009, G7 leaders in 2015 committed to lifting 500 million people out of hunger and malnutrition by 2030 as their contribution to SDG 2 (zero hunger). Sustainable agriculture was also highlighted as one of the key sectors of importance for achieving the globally agreed Sustainable Development Goals in the G20 Action Plan on the 2030 Agenda for Sustainable Development adopted in 2016. In their Action Plan G20 leaders have stressed the link between sustainable agriculture and healthy land-based ecosystems (SDG 15). In addition, **linkages to SDGs 6 (water and sanitation) and 7 (energy) as drivers and consequences of a sustainable agriculture systems** need to be considered more.

Existing Global Agreements and Policy Frameworks

Sustainable Development Goals, https://sustainabledevelopment.un.org/?menu=1300

G20 Action Plan on the 2030 Agenda for Sustainable Development, 2016 https://www.b20germany.org/fileadmin/user_upload/G20_Action_Plan_on_the_2030_Agenda_for_Sustainable_Development.pdf *Highlights the crucial role of sustainable agriculture in achieving the SDGs*

Broader Food Security and Nutrition Development Approach, Annex to the Leaders' Declaration G7 Summit, 7-8 June 2015, https://www.g7germany.de/Content/EN/_Anlagen/G7/2015-06-08-g7-abschluss-annex-eng_en.pdf?__blob=publicationFile&v=2 *Commits G7 leaders to lifting 500 million people out of hunger and malnutrition by 2030*

"L'Aquila" Joint Statement on Global Food Security, 2009 http://www.g8italia2009.it/static/G8_Allegato/LAquila_Joint_Statement_on_Global_Food_Security[1],0.pdf *Commitment endorsed by G8 leaders and most of the G20 members to work towards sustainable global food security*

Paris Agreement (COP21) http://unfccc.int/paris_agreement/items/9485.php and Marrakech Agreements (COP22) https://www.carbonbrief.org/cop22-key-outcomes-agreed-at-un-climate-talks-in-marrakech

References

Booker, J.F., A.M. Michelsen and F.A. Ward (2005) Economic impact of alternative policy responses to prolonged and severe drought in the Rio Grande Basin. Water Resources Research, 41(2). http://onlinelibrary.wiley.com/doi/10.1029/2004WR003486/abstract

EU (2015) The role of research in global food security. Brussels: European Union.

FAO (2011) "Energy-smart" food for people and climate. Rome: UN Food and Agriculture Organization. http://www.fao.org/docrep/014/i2454e/i2454e00.pdf

FAO (2014a) Water Withdrawal. Rome: UN Food and Agriculture Organization.

FAO (2014b) Area equipped for irrigation. Rome: UN Food and Agriculture Organization.

FAO (2016) How sustainability is adressed in official bioeconomy strategies at internationl, national and regional levels - An Overview. Rome: UN Food and Agriculture Organization. http://www.fao.org/3/a-i5998e.pdf

German Bioeconomy Council (2015) Bioeconomy Policy: Synopsis of National Strategies around the World. Berlin: Office of the Bioeconomy Council.

GWP (2012) Groundwater Resources and Irrigated Agriculture - making a beneficial relation more sustainable. Stockholm: Global Water Partnership. http://www.gwp.org/globalassets/global/toolbox/publications/perspective-papers/04-groundwater-resources-and-irrigated-agriculture-2012.pdf

HLPE (2013) Investing in smallholder agriculture for food security. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security,

IFPRI (2016) 2016 Global Food Policy Report. Washington, DC: International Food Policy Research Institute. http://www.ifpri.org/publication/2016-global-food-policy-report

Jain, A. (2015) Rice farmer grows crop with 60% less water, awarded. The Times of India, 2 September. http://timesofindia.indiatimes.com/city/coimbatore/Rice-farmer-grows-crop-with-60-less-water-awarded/articleshow/48767890.cms

Mekonnen, M.M. and A.Y. Hoekstra (2010) The green, blue and grey water footprint of farm animals and animal products. Delft: UNESCO-IHE Institute for Water Education. http://waterfootprint.org/en/water-footprint/product-water-footprint/water-footprint-crop-and-animal-products/

Nkonya, E., A. Mirzabaev and J. von Braun (2016) Economics of Land Degradation and Improvement - A Global Assessment for Sustainable Development. Springer International Publishing. Dordrecht, Netherlands.

Prüss-Üstün, A. et al. (2008) Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, Geneva.

UNICEF (2006) Progress for children: a report card on water and sanitation. New York: United Nations Children's Fund.

von Braun, J. and R. Birner (2017) Designing Global Governance for Agricultural Development and Food and Nutrition Security. Review of Development Economics. Vol. 21(2) pp. 265-284. http://onlinelibrary.wiley.com/doi/10.1111/rode.12261/full

von Grebmer et al. (2016) 2016 Global Hunger Index: Getting to Zero Hunger. Bonn, Washington, DC, and Dublin: Welthungerhilfe, International Food Policy Research Institute, and Concern Worldwide. http://www.ifpri.org/publication/2016-global-hunger-index-getting-zero-hunger

WHO and UNICEF (2012) Progress on Drinking Water and Sanitation: 2012 Update. United States: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. https://www.unicef.org/media/files/JMPreport2012.pdf

WMO (1997) Comprehensive Assessment of the Freshwater Resources of the World. World Meterological Organisation, Geneva, pp.34.

Yang, H. et al. (2006) Virtual water trade: an assessment of water use efficiency in the international food trade. Hydrology and Earth System Sciences Discussions, European Geosciences Union, Vol.10(3), pp.443-454. http://www.hydrol-earth-syst-sci.net/10/443/2006/