Energy Scenarios in a Water Perspective
Changes in water footprints related to energy transitions

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Preface

This report marks the end of my study Water Engineering & Management at the University of Twente. The concept of the water footprint has intrigued me since it was first presented in one of the master courses. Particularly, the new idea of virtual water in goods and services I found fascinating. It made me realize that humans indirectly (and often unknowingly) use an enormous amount of fresh water through the consumption of their daily products and services. And that ultimately using all this water to realize these products will have an impact on our fresh water systems. During my search for a thesis subject, an assignment caught my attention that linked the water footprint to bio-energy. It read: make a global assessment of the impacts of bio-energy on fresh water systems. This seemed a new contemporary domain, with bio-energy receiving so much attention nowadays, and this was exactly what I was looking for!

Beginning of September 2008 I eagerly dived into the subject. The realm of bio-energy and energy scenarios was quite novel for me and it required a fair amount of time to get to grips with it. Making the translation to water consumption also came with its challenges. Fortunately, there was always my daily supervisor, Winnie Gerbens-Leenes, who I could turn to with my questions and ideas. Although this often led to more questions, she proved to be a great sparring partner and I hereby thank her greatly for that. The comments provided by Arjen Hoekstra and Theo van der Meer, during our committee meetings, were also always highly appreciated. Furthermore, I would like to thank my family, my friends and my girlfriend for the support they have given me in the past months. And last but not least, a thank-you to all my colleagues and fellow room mates at the WEM-department for all the discussions and good times!

In the mean time I have been granted a function as researcher at the university to further my research and publish a report for the UNESCO-IHE. I am very happy with this opportunity, as there is still so much to explore in the fascinating field of bio-energy and water. But for now, I wish you a lot of enjoyment in reading this report.

Sander van Lienden
Enschede, June 2009

Summary

Transitions in the energy sector are occurring continuously. They are driven by the need to find more efficient, cleaner and sustainable fuels. The use of bio-energy is currently seen as an alternative that has many of these characteristics. Renewable energy from plants and trees seems very promising and countries all over the world are already heavily promoting its use. It is not strange therefore that bio-energy has a prominent role in future energy scenarios. In general, it is expected that in 2030 biomass will have the largest share of all renewables.

However, the large-scale production of energy from biomass also has its complications. Issues about competition between food and energy crops and the carbon dioxide neutrality of bio-energy are already discussed plentiful. In addition, many studies have been done to examine the extent bio-energy can be used in the light of land availability, agricultural technology, biodiversity and economical development. But there are very few studies that look at the impact of bio-energy on the water system. Plants and trees need water to grow and the production of biomass is indisputably one of the largest water consumers in the world.

This research aims to map the consequences of the transition to a larger share of bio-energy in total energy consumption on the water footprint of energy sectors across the globe, and subsequently assess the water stress caused by existing energy scenarios for 2030. The water footprint is a measure of how much fresh water is used to produce the goods and services, in this case bio-energy.

This research uses water footprint analysis to investigate the change in water demand related to a transition to bio-energy. Information about these transitions is based on specific energy scenarios. A clear distinction is made between three different bio-energy carriers. The analysis includes the consumption of first generation bio-ethanol, bio-diesel and bio-electricity and heat in nearly all countries of the world. Each of these bio-energy types uses different biomass feedstocks (i.e. energy crops) and this research examines the probable feedstock choice per type in each country. Using blue and green virtual water content data of each crop per country, a translation is then made from bio-energy consumption to water consumption.

It is found that existing energy scenarios all project an absolute increase in bio-energy consumption in the future. In the global bio-energy mix, it is expected that about 91 percent is bio-electricity and heat, 6 percent is bio-ethanol and 3 percent is bio-diesel. Overall, this means that more biomass will be grown for energy purposes and, since biomass needs water to grow, the transition to bio-energy will lead to a larger water footprint of the global energy sector.

Together with the blue and green water demands from other sectors, the bio-energy water footprint is compared to the blue and green water availability. For each country, a balance is made of fresh water resources and uses, enabling the determination of the water volume available for bio-energy. The comparison allows a measure of water stress to be established corresponding to the (projected) bio-energy consumption.

The competition for available runoff between blue water users will likely cause blue water stress in many countries, especially in Europe, Developing Asia and the Middle East. In about half of the countries that are likely to suffer blue water stress in 2030, bio-energy consumption contributes to, or is fully responsible for, the water stress. It is expected that the green bio-energy water footprint, will cause green water stress in even more countries all over the world. The primary reason is the enormous projected increase in consumption of bio-electricity from rain fed plantation wood. This is expected to take up much of the productive green water supply in many countries. On a global level, the green bio-energy water footprint will comprise almost 40 percent of the total green water supply, whilst the blue bio-energy water footprint is expected to be about 4 percent of total available runoff for humans in 2030.

Hence, energy scenarios should not only be analyzed in the context of land availability, food production, biodiversity and the carbon dioxide balance, they also need to be looked at in a water perspective. This study shows the repercussion of extensive bio-energy consumption on the fresh water resources. It advocates that countries should consider the water factor thoroughly when investigating the extent to which bio-energy can satisfy their future energy demand.

1 Introduction

This research commences with some background information on the topic. From this context the necessity of the research is made clear, which is then translated into a research objective. To guide the research and reach the objective, several research questions and a research model are drawn up.

1.1 Research context

Energy use by humans has seen many changes throughout time. Wood was the first primary source of energy for mankind; since ca. 7000 BC it was already used for heating and light (Landau, 2005). Later (ca. 600 BC) it was discovered that wind- and waterpower could be converted to do mechanical work, such as pumping up water or milling grain. From 1600 onwards, wood was gradually being replaced by more efficient fossil fuels, which could be used to create movement using the steam engine. Once the dynamo was invented early 1800s, this movement could be converted to electricity, a form of energy that knows copious technical applications. Approximately a quarter century ago, it was discovered that nuclear energy could also be used to produce electricity. However, it was soon realized that the use of these forms of energy also had downsides. Events like the oil crisis in 1973, the Chernobyl nuclear disaster in 1986 and ongoing global warming have opened our eyes to the risks of depending on fossil and nuclear fuels (Sørensen, 1991). This has given the development of alternative, renewable fuels an enormous impulse. Energy from wind, water, sunlight and biomass is said to be clean and renewable, but production on a large scale also has its complications. This is why our supply of energy today comes from many different sources and it is evident that transitions in the energy sector will continue in the future.

To gain insight in what the future may look like, scenarios are being developed. There are numerous cases for which scenarios exist, such as the climate, population growth and energy usage. All scenarios are based on assumptions about driving forces and the relations between them. Disagreement on the number of forces and their exact effects results in the construction of several scenarios for the same case. A good example of this can be found in the energy scenarios, for instance about the contribution of renewable energy sources. Generally, it is expected that in 2030 biomass will have the largest share of all renewables (IEA, 2006)(WEC, 2007)(Shell, 2008)(IPCC, 2008b).

Many studies investigate the potential of bio-energy in the light of land availability, agricultural technology, biodiversity and economical development (Fischer & Schrattenholzer, 2000)(Berndes et al., 2002)(Smeets et al., 2006)(Dornburg et al., 2008). Issues about competition between food and energy crops and the carbon dioxide neutrality of bio-energy are already discussed plentiful. But there are very few studies that look at the impact of bio-energy on the water system, whilst the production of biomass is indisputably one of the largest water consumers in the world (Berndes, 2002)(Varis, 2007)(de Fraiture et al., 2007). Research about the water usage of energy crops in several regions already exists (Gerbens-Leenes et al., 2008), as does research about regional water systems and the stresses that are exerted on them (IPCC, 2008a)(UNESCO, 2006). The link between water availability and (future) bio-energy production however, has not been analyzed in great detail yet, especially not using the comprehensive water footprint concept. Recent studies have shown that the water footprint of energy from biomass is nearly hundred times larger than that of fossil fuels (Gerbens-Leenes et al., 2008). Nonetheless, very little attention is paid to this aspect of the transitions (bound to) taking place in the energy sector. This research will consider the water issue in more detail and will address the effects it has on the plausibility of some leading energy scenarios.

1.2 Research objective

The objective of this research is to map the consequences of the transition to a larger share of bio-energy in total energy consumption on the water footprint of energy sectors across the globe, and subsequently assess the water stress caused by existing energy scenarios for 2030.

1.3 Research questions

To guide this research in achieving its goals, two research questions have been developed. These will be answered on the basis of six sub-questions, in which key points for this research will be systematically dealt with. The questions will be answered for nearly all regions and countries in the world (see paragraph 3.2.1).

1. What is the effect of the transition to bio-energy on the water footprint of the energy sector?

1.1 What does the current energy sector look like?
1.2 What are the possible transition paths (i.e. scenarios) to the future?
1.3 What is the impact of these transitions on the water footprint of the energy sector?

2. Does the change in the water footprint of energy lead to increased water stress?

2.1 How much water is available for bio-energy?
2.2 Does the water footprint of the energy scenario exceed the volume of water available?
2.3 To what extent can biomass be used to satisfy future energy demand?

Concepts and terms mentioned above are clarified in the glossary in Appendix A. A short description is given along with an explanation of how some concepts are operationalized in this research.

1.4 Research model

This research focuses on the relation between bio-energy and fresh water. Specifically, the water footprint of scenarios in which bio-energy plays a substantial role will be determined. Most energy scenarios suggest that the contribution of this energy carrier becomes substantial in the future, resulting in a growing water demand for the energy sector. The relations are visualized in Figure 1 using the confrontation model of Verschuren en Doorewaard (2003).

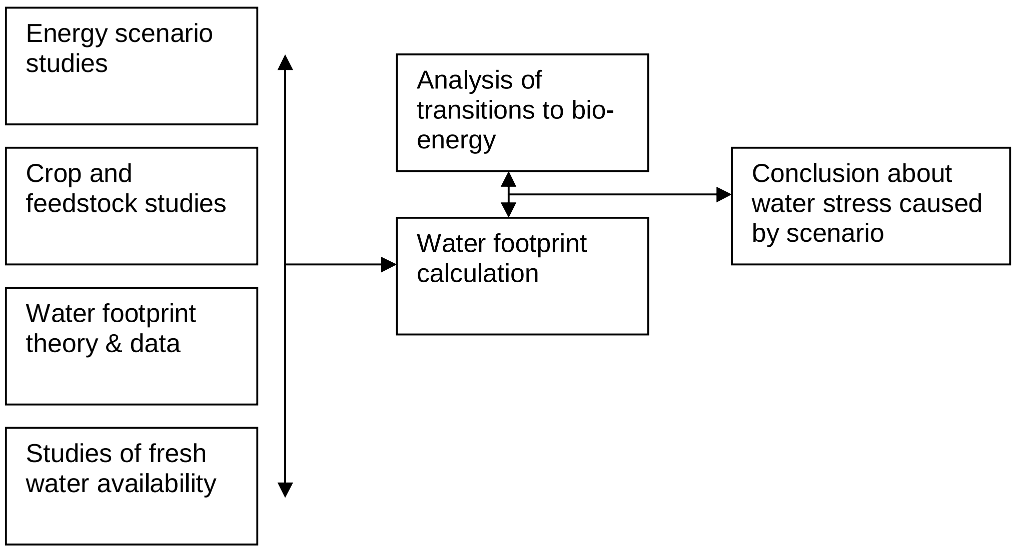


Figure 1: The analysis of the water footprint of an energy scenario, based on existing studies of energy, feedstocks, and water use and availability, leads to a conclusion about the water stress caused by the scenario.

2 System description

In this chapter the key elements within this research will be addressed. The energy system and the water system both play an important role, and in this systems analysis their formation and behavior under different conditions is discussed. The link between the systems is made clear using the water footprint of energy concept.

2.1 The Energy system

2.1.1 Today's energy sector

The current energy consumption of the total human population amounts to roughly 500 EJ per year (= ca. 12000 Mtoe), and it is expected that this will continue to grow in the future (IEA, 2006) (Sims et al., 2007)(Shell, 2008). This energy is produced from several sources and is used for many different purposes. More than 80 percent of our energy nowadays comes from fossil fuels (coal, oil and natural gas), about 7 percent from nuclear sources (uranium) and approximately 13 percent is produced from renewable sources such as biomass, wind and hydropower (IEA, 2006). The dependency on fossil and nuclear fuels has some downsides. First of all, the supply is not infinite and fossil sources in particular are being exhausted quickly. It is expected that reserves of oil will be depleted in approximately 40 years, reserves of natural gas in 70 years and reserves of coal in 210 years (Earthtrends, 2005). Besides this, most of the stocks are situated in unstable regions, which may lead to irregularities in supply to depending nations. Secondly, a large amount of carbon dioxide (ca. 23 gigatons) is released into the atmosphere when fossil fuels are burned, and the general perception is that this contributes to global warming and all its consequences. Acid rain is another commonly stated environmental problem that is attributed to the use of fossil fuels. Nuclear waste remains dangerous to all living beings for a long time, and moreover a nuclear disaster is catastrophic. Political considerations about energy security, safety, and the quality of the environment can eventually lead to a movement away from fossil and nuclear fuels (IPCC, 2008b). The current contribution of renewable sources is fulfilled by about 80 percent biomass and 16 percent hydropower (Varis, 2007). It is expected that these shares in the global energy mix will rise sharply (IEA, 2006).

Biomass is defined as all material which is of organic origin, excluding what has been converted to geological formations like fossils (FAO, 2008a). It requires resources such as land, water, nutrients and sunlight to grow and once it has reached the desired size it can be harvested as feedstock for bio-energy (Figure 2). Examples of biomass used for energy production (i.e. feedstock) are wood, straw, (food)crops, manure and organic waste.

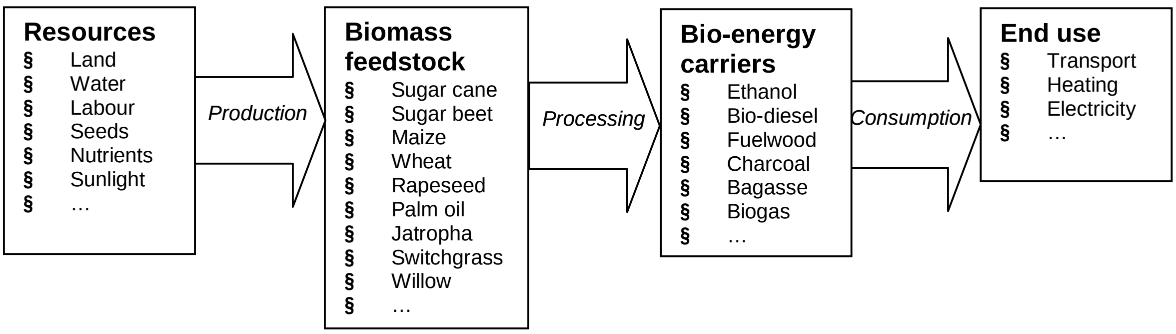


Figure 2: Bio-energy – from resources to end use

More than 85 percent of all biomass is burnt directly in solid form for cooking, heating and light. Biomass feedstock can include agricultural residues, animal manure, wood wastes from forestry and industry, municipal green wastes, sewage sludge, and dedicated energy crops such as short-rotation coppice (eucalyptus, poplar and willow) (IEA, 2007). However, biomass can also be converted to another energy carrier in several ways, namely: thermo-chemical, biological, physical, or chemical processing. The first method includes gasification (production of syngas), and pyrolysis (production of charcoal or bio-oil). Biological processing comprises the production of biogas and bio-ethanol by respectively anaerobic and aerobic fermentation of biomass. Physical processing encompasses the extraction of oils by pressing. Last of all, biomass can be converted to bio-diesel by chemical transesterification (FAO, 2008e).

Broadly speaking, there are three classes of crop that correspond to two forms of liquid bio-fuel. Bio-ethanol is usually produced from fermentation of so called sugar crops. These are crops that contain a high level of glucose, which by fermentation is metabolized to ethanol and carbon dioxide. This is the easiest, most efficient process but ethanol can also be produced from the starchy component of cereal crops. In this case, the starch has to be malted first to release the enzymes that can convert it to sugar. Both processes are first generation conversions, in which the fuel yields are limited by the relative small sugar or starch portions of the plant (FAO, 2008e). Most of the plant consists of cellulosic materials, such as hemicellolose and lignin. These materials can also be converted to ethanol by second generation conversion processes, but this still faces significant technological challenges and is expensive. Second generation processes are therefore not expected to become commercial viable before 2030 (IEA, 2006) and are thus not within the scope of this study.

Another type of bio-fuel is bio-diesel, which is obtained from first generation conversion of oil crops. Typically, the extracted vegetable oil reacts with an alcohol in an esterification reaction to produce alkyl esters of long chain fatty acids and glycerol as a byproduct. In warmer countries however, the vegetable oil is less viscous and can be used directly as fuel. The above conversion processes are shown in Figure 3. Again, this study considers only the first generation routes, i.e.:

1) direct combustion of lignocellulosic biomass (here wood) for electricity and heat,
2) fermentation of sugar and starch-rich crops for ethanol,
3) esterification of oil from oil-rich crops for bio-diesel.

These routes are shaded in the figure below.

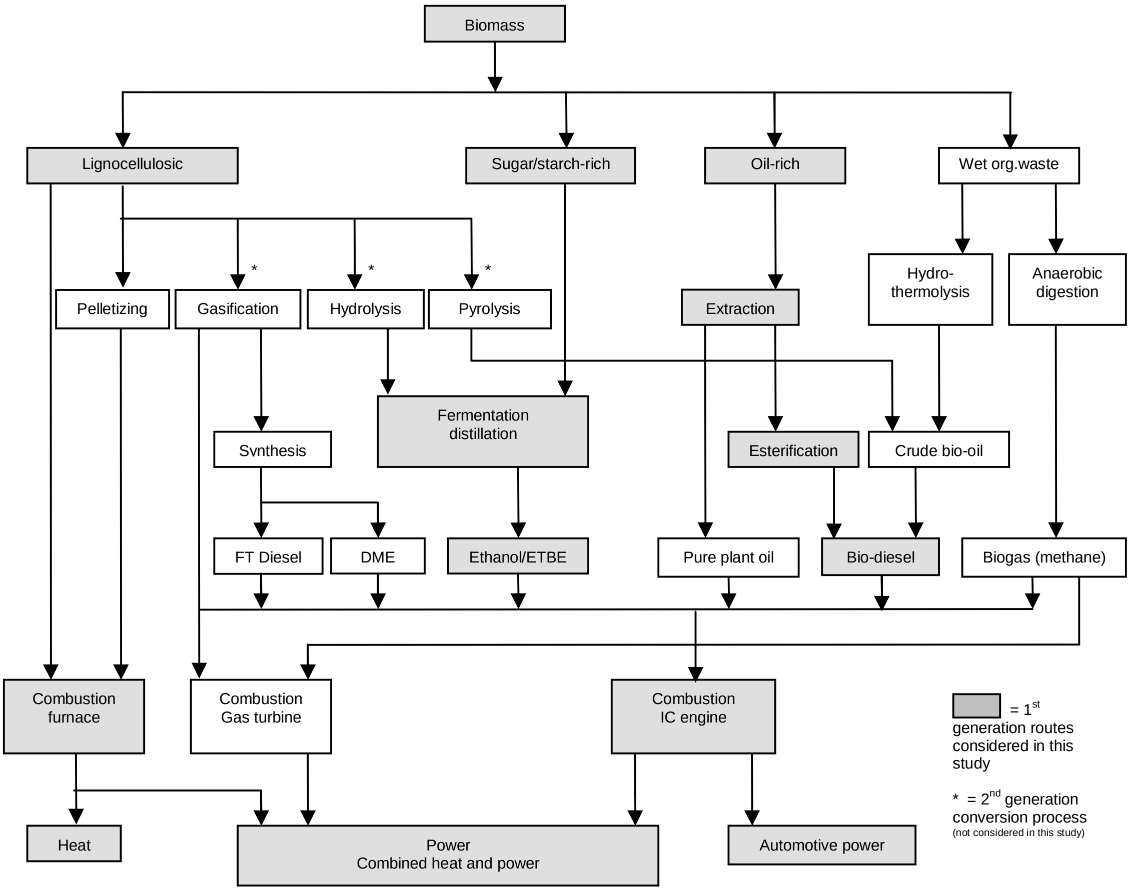


Figure 3: Conversion routes for bio-energy (based on: EUBIA, 2007 and Sielhorst et al., 2008)

Liquid bio-fuels (and biogas) contribute to only 2 percent of total transport fuels worldwide (FAO, 2008b). Around 85 percent of liquid bio-fuels is in the form of ethanol. The two largest producers are

Brazil (from sugar cane) and the United States of America (from maize) and the remainder is primarily made in China, India and the EU (FAO, 2008e). Bio-diesel production is mainly situated in the EU (60 percent) and uses rapeseed as dominant feedstock. Other significant bio-diesel producers include the United States of America (from soybean), China, India, Indonesia and Malaysia (mostly from palm, coconut and castor oils) (Gerbens-Leenes et al., 2008a)(FAO, 2008e).

2.1.2 Scenarios for the future

What the future will look like in terms of how much energy is consumed and from what sources is hard to say. There are too many uncertainties and many factors are interdependent. Nevertheless, decisions that affect our future energy supply will have to be made now. A tool that can help make those decisions and deal with the dynamics is scenario planning.

Scenario planning originates from the observation that, given the impossibility of knowing precisely how the future will unfold, a good decision or strategy to adopt is one that plays out well across several possible futures (Wilkinson, 2008). These possible futures are modeled by scenarios, which are basically specially constructed stories that diverge markedly from each other.

The possible transition paths in the energy sector of a country or region can be portrayed by energy scenarios. Differences in assumptions about driving forces behind these transitions lead to numerous dissimilar scenarios. The literature states roughly five general categories of driving forces: 1) Political driving forces, 2) Economic driving forces, 3) Societal driving forces, 4) Technological driving forces, and 5) Environmental driving forces (Nakićenović et al. 1998)(Wilkinson, 2008)(Mason, 2009). Exploring the nature of the uncertain elements within these forces provides a framework for the scenarios.

There are several independent organizations that have put forward sets of energy scenarios, but individual researchers have also contributed to the large number of scenarios published in the last decade (FAO, 1999). Eighteen energy scenarios from six leading organizations are summarized below; they form the frame of reference in which the energy transitions to 2030 are explored in this study.

i. International Energy Agency – World Energy Outlook

The International Energy Agency has developed two scenarios in which the expected procession of technological, economical and sociological change is different (IEA, 2006). The first scenario is called the Reference Scenario which assumes that policy plans of 2006 will be carried out and that the energy supply and end-use technology will slowly become more efficient. The world population grows steadily with a rate of 1 percent per year and their GDP with 3.3 percent per year. Per capita income grows fastest in developing countries. The price of fossil fuels will be significantly higher in 2030. The Reference Scenario is used as a business-as-usual baseline.

The second scenario is the Alternative Policy Scenario which considers the development of the energy sector if governments implement policy plans concerning energy security and carbon dioxide emissions. These plans specifically aim at improving the efficiency of the energy supply and the reduction of dependency on fossil fuels. They lead to about 10 percent less energy use and a significant role for bio-fuels in road-transport, and hence help mitigate the harmful effects on the environment.

ii. Shell – Energy Scenarios 2050

Shell has developed two scenarios that describe alternative ways the future may develop (Shell, 2008). In the first scenario – called Scramble – policymakers pay little attention to more efficient energy use until supplies are tight. Likewise, greenhouse gas emissions are not seriously addressed until there are major climate shocks. In Scramble growth in coal and bio-fuels becomes particularly significant. In the second scenario – Blueprints – growing local actions begin to address the challenges of economic development, energy security and environmental pollution. A price is applied to a critical mass of emissions giving a huge stimulus to the development of clean energy technologies, such as carbon dioxide capture and storage, and energy efficiency measures. Initially oil production is raised to maintain lower prices and defer the development of more costly substitutes, but benefits also begin to emerge from accelerated growth in distributed power generation from wind and solar energy.

iii. IIASA / World Energy Council – Global Energy Perspectives

The World Energy Council (WEC, 2007) has developed 3 cases, each containing one or more scenarios that share similar driving force characteristics:

- A: high-growth future of vigorous economic development and rapid technological improvements (3 scenarios):
  - A1: High growth; Ample oil and gas, leads to dominance of these sources to the end of the 21st century.
  - A2: High growth; Return to coal, due to scarce oil and gas resources.
  - A3: High growth; Fossil phase-out, due to rapid technological change in nuclear and renewable energy technologies.
- B: Middle course; Intermediate economic growth and more modest technological improvements (1 scenario):
  - B: Middle Course (reference baseline)
- C: Ecologically driven; Incorporates challenging environmental and energy taxes to simultaneously protect the environment and transfer wealth from industrialized to developing countries to enhance economic equity. (2 scenarios):
  - C1: new renewables and a phase-out of nuclear energy (proves a transient technology).
  - C2: with renewables and new nuclear (new generation of nuclear reactors is developed that is inherently safe and small scale).

iv. IPCC – SRES scenarios

The Intergovernmental Panel on Climate Change has created four storylines, which combine two sets of divergent tendencies: one set varying between strong economic values and strong environmental values, the other set between increasing globalization and increasing regionalization (IPCC, 2000). The storylines are summarized below:

- A1 storyline and scenario family: a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies.
- A2 storyline and scenario family: a very heterogeneous world with continuously increasing global population and regionally oriented economic growth that is more fragmented and slower than in other storylines.
- B1 storyline and scenario family: a convergent world with the same global population as in the A1 storyline but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies.
- B2 storyline and scenario family: a world in which the emphasis is on local solutions to economic, social, and environmental sustainability, with continuously increasing population (lower than A2) and intermediate economic development.

Although each storyline has its own scenario family, they are best reflected in the, so called, marker Emission Scenarios (A1 AIM, A2 ASF, B1 IMAGE, B2 MESSAGE respectively) (IPCC, 2000).

v. Greenpeace – Global Energy Outlook

Two different scenarios are used here to characterize the wide range of possible paths for the future energy supply system: a Reference Scenario, reflecting a continuation of current trends and policies, and the Energy [R]evolution Scenario, which is designed to achieve a set of dedicated environmental policy targets. Reduction of carbon dioxide emissions and the phase-out of nuclear power are the main focus points in the latter. To achieve this, investments are made in electricity and heat generation from renewable sources and the production of bio-fuels for transport (Greenpeace, 2008).

vi. European Renewable Energy Council (EREC) – Renewable Energy Scenarios to 2040

The EREC has developed two scenarios that specifically address the development of renewable energy:

- The Advanced International Policies Scenario (AIP), which assumes: ambitious growth rates for renewable energy sources (RES), increased promotion of renewables by regions already active in RES and other regions following their example, higher prices for conventional energy supply, growing support for electrification of the less and least developed regions by renewables, additional measures on the international level for climate protection, and strengthened international cooperation on environmental protection and international equity.

- The dynamic current policies scenario (DCP), which is based on less international cooperation than in the AIP scenario, but expects ambitious policy measures on national level at least in the industrialized part of the world. It is assumed that the commitment to renewables development in the very proactive countries continues to strengthen and will be adopted also by others at least in the industrialized part of the world as national policies. In the least developed countries renewables will be a competitive alternative to conventional sources in the near future, even without special promotion.

Furthermore, there are researchers who have made projections for bio-energy only. Some prominent studies in this field are from Fischer & Schrattenholzer (2000), Hoogwijk et al. (2002), Johansson et al. (1992),Yamamoto, Fujino & Yamaji (2001), Smeets et al.(2006), Dornburg et al. (2008), and Wolf et al. (2002). The findings of these researchers will be presented and compared in chapter 4.

Foreseeing future energy demand and supply is notoriously difficult and inexact, but what is evident from examining all these scenarios is that biomass could be a major contributor to future energy supplies especially as a modern fuel, while still playing an important role as a traditional fuel (FAO, 1999). In developing countries 95 percent of all energy is produced like this, although these countries are slowly switching from traditional biomass for heating and cooking to more modern fuels (IEA, 2006). In OECD countries on the contrary, biomass is (partly) replacing gas and coal for power and heat production (co-firing in CHP plants). Another major new use related to technological advances comprises liquid bio-fuels, mainly for road-transport. It is expected that virtually all the bio-fuels consumed in a region will continue to be produced indigenously as a result of protective farm and trade policies (IEA, 2006). The volume of bio-fuels traded internationally will nonetheless grow significantly.

In this paragraph insight was given in the structure of the current energy sector and it was explained how transitions to the future in this sector can be portrayed by scenarios. A prominent trend is the increased use of biomass in all energy scenarios (in absolute terms), and this is an important motive for this study. In the introduction it was already briefly mentioned that this may have a significant impact on the water system in some regions of the world. Before the link between energy and water is addressed in more detail, some insight is given in the workings of the water system.

2.2 The Water system

2.2.1 The water cycle

The water system can be seen as a closed cycle (Figure 4). When precipitation falls over land, part of the water flows off as surface runoff to lakes and rivers, part of it seeps into the earth to recharge groundwaters, and part is directly absorbed by vegetation. Subsequently, wind and radiation from the sun result in evapotranspiration. This consists of direct evaporation from the earth’s surface and transpiration from plants. This water vapor rises and then condenses in higher, cooler air layers to form clouds from which eventually precipitation will fall again. These processes are all linked in the water balance, which shows that precipitation equals the sum of runoff, evapotranspiration and change in storage (Viessman & Lewis, 2003). The water balance can be used to manage water supplies and predict where there may be shortages. Especially in agricultural practice it can be useful to manage irrigation and drainage issues.

Human activity disrupts the natural water cycle and can upset the balance. Water is used for many purposes and in many regions competition between these uses is not uncommon. The construction of dams in rivers, for example, is done to generate electricity and create a steady supply of (drinking) water but it constrains the natural flow and affects the environment both upstream and downstream. Furthermore, reservoirs collect a lot of radiation and local evaporation rates may thus increase significantly (Gleick, 1993). Groundwater from aquifers is used for drinking and to irrigate crops but excess pumping can lead to depletion of the storage. Last but not least, the water that is discarded after use is often polluted badly and can have a major impact on the ecosystem. It is thus of utmost importance to regulate human water usage in order to maintain a healthy water system.

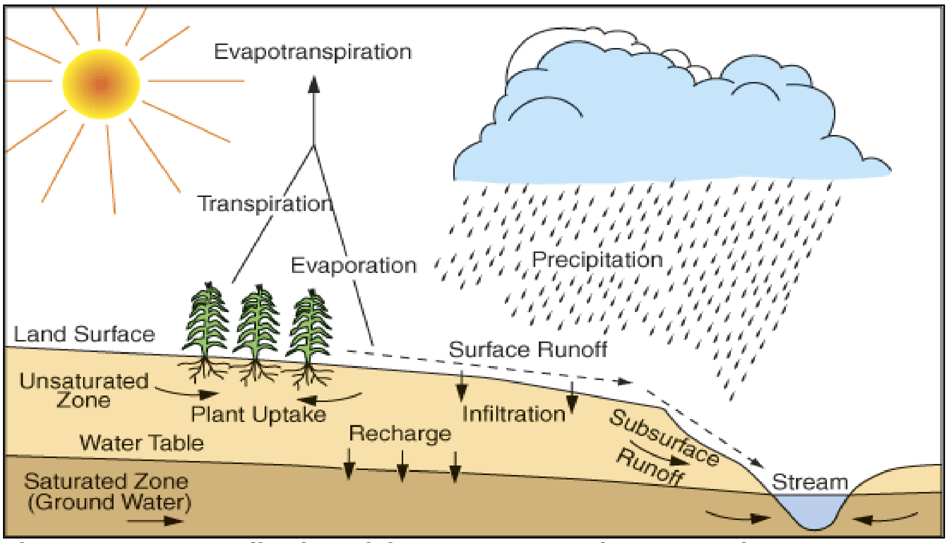


Figure 4: conceptualization of the water system (RIVM, 2008)

2.2.2 Fresh water availability and water stress

The total volume of water on earth is approximately 1.4 billion km^3, about 35 million km^3 (2.5%) of this is fresh water. However, about two thirds of this is in form of ice and permanent snow cover, the rest is contained in the ground (30.8%) and in lakes, rivers and swamps (0.3%). The principal sources of water for human use are lakes, rivers, soil moisture and relatively shallow groundwater basins. The usable portion of these sources is only about 200 000 km^3 of water (Gleick, 1993). Nonetheless, a large part of this volume is located in remote areas, or escapes as floodwater (Postel et al., 1996), and part is non-renewable (fossil) groundwater. Efforts to characterize the volume of renewable fresh water actually available to a given nation have been ongoing for several decades. The primary input for many of these estimates is the information database, AQUASTAT, which has historically been developed and maintained by FAO (UNESCO, 2006). It is based on data related to the quantity of water resources, and uses a water balance approach for each country. The database includes tables of long-term average precipitation, renewable fresh water resources and sector withdrawals, and has become a common reference tool used to estimate each country's fresh water availability. Figure 5 gives an indication of the renewable fresh water resources per country.

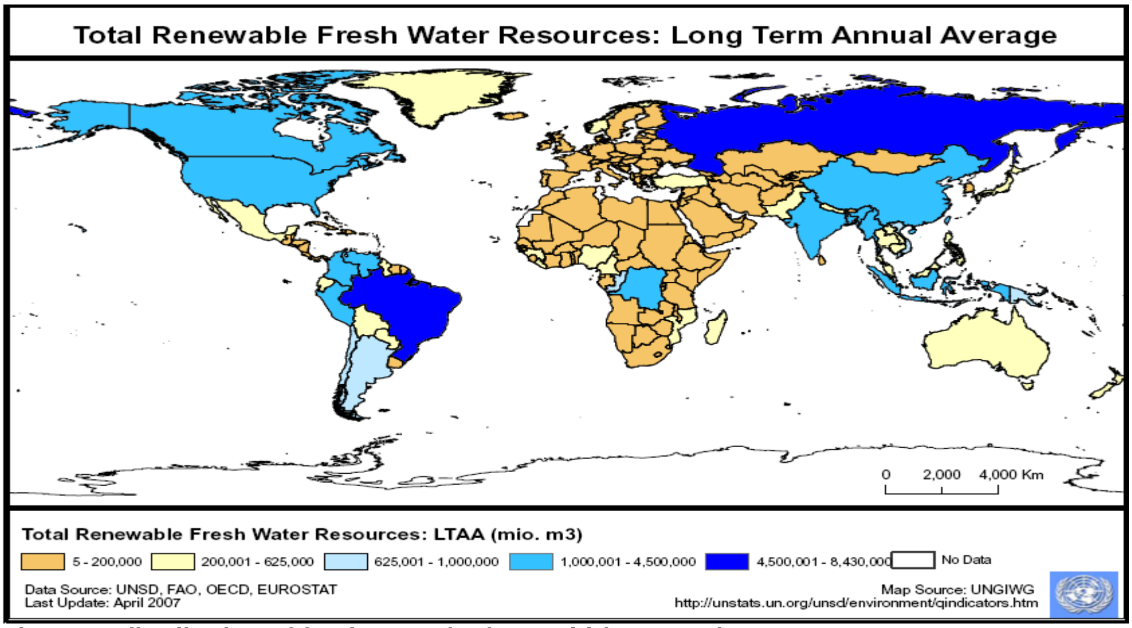


Figure 5: distribution of fresh water in the world (UN, 2007)

The use of these fresh water resources can be traced back to different sectors, such as industrial, domestic and agricultural. Globally, about 2 percent of the available fresh water is withdrawn for industrial and domestic purposes (FAO, 2008c). It is expected that the extraction of water for these sectors will increase in the future (UNEP, 2008a), resulting in less water available for other sectors. Besides human use, part of the water should be reserved for ecosystems. This is often termed the Environmental Flow Requirement (EFR). Worldwide, ecosystems need about 20 to 50 percent of the average, yearly amount of water from rivers to stay in good shape (Smakhtin, Revenga & Döll, 2004).

When the amount of water demanded by all users exceeds the water supply in a country, it will suffer from water scarcity and experience water stress. If the available water resources are no longer adequate to satisfy all human or ecosystem requirements, this results in increased competition between water users and other demands (UNEP, 2008). To allow good management of the fresh water resources, a distinction is often made in the 'type' of water available for each purpose (Falkenmark, 1997)(Hoekstra,2008) (Berndes, 2008). The runoff in rivers, lakes and groundwater aquifers is classified as the blue water supply and the fraction of rainfall that infiltrates through the land surface and forms soil moisture is the green water resource. The green water availability is quantified by the total evapotranspiration over land. The same distinction (i.e. blue, green) is also made in water usage. This has also been done for water demands in bio-energy production (Gerbens-Leenes et al., 2008). In the next paragraph, this will be explained in more detail and insight will be given in how the production of bio-energy can contribute to water stress.

2.3 Linking the systems: Water Footprint of Energy

Plants and trees need water to grow. Hence, the generation of energy from biomass requires water. This is where the energy system and the water system overlap. The demand of water corresponding to the consumption of bio-energy can be expressed using the water footprint concept (Hoekstra & Hung, 2002). In general, the water footprint of energy is the total volume of fresh water that is used to produce the energy carriers consumed by energy services. The method sums the water use by energy carriers throughout their life cycle, referred to as the virtual water content of the carrier. Virtual water in the life cycle can be classified as (Gerbens-Leenes et al., 2008):

- Supply chain ("upstream"): water used to produce raw materials and product ingredients.
- Operational ("midstream"): water needed to manufacture products.

The water flows that are included in a footprint are:

- Use of green water: evaporation of rainwater
- Use of blue water: evaporation of water withdrawn from aquifers, lakes, rivers, reservoirs (for irrigation purposes)
- Production of grey water: polluted water (the water it takes to dilute a polluted effluent to enable it to conform to water quality standards)

Table 1 shows the average virtual water content of some common energy carriers.

Table 1: avg. virtual water content of primary energy carriers (Gerbens-Leenes et al., 2008)

Primary energy carriers	Average virtual water content (m^3/GJ)
Fossil fuels	1.3
Nuclear energy	0.1
Biomass energy (excl. waste)	71.5*
Hydropower	22.3
Other renewables (solar, wind)	0.3

* average of production in the Netherlands, US, Brazil, Zimbabwe

The virtual water content of bio-energy (m3/GJ) is based on: 1) the blue, green and grey crop water use (m3/ha), 2) the biological yield (ton/ha), and 3) the energy content of the crop (GJ/ton).

Crop water use depends on the water demand of the crop, precipitation, irrigation and pollution. The latter is addressed in the grey component, which looks at leaching of fertilizers and pesticides into ground- and surface waters. The amount of leaching depends on many factors, such as timing and quantity of chemicals applied, soil type and condition, irrigation management, etc. (Chapagain et al., 2006) The volume of water that is needed to dilute these leached pollutants to a set quality standard forms the grey water use. In some regions the norms are stricter than in other regions (e.g. drinking vs. recreational norms)(EPA, 1986)(STOWA, 2007), which leads to a larger grey component for the energy crops. The blue crop water use is the volume of irrigation water that evapotranspirates from the crop field during the growth period. The amount of irrigation depends on the crop water requirement and precipitation. The green crop water use assesses the volume of effective precipitation (entering the soil) that evapotranspirates from the field during crop cultivation. All in all, the water use of plants and trees can be very different corresponding to the species, location, climatic conditions and agricultural practice.

The relation between the virtual water content of bio-energy and crop yield is rather complex. At first glance, you would expect the virtual water content of bio-energy to decrease if more crops could be harvested per unit area, but to realize this higher yield you would need more water, for example by applying more irrigation. Thus, the virtual water content of bio-energy depends on the interaction of both parameters. The only way to increase yields without using more water, is by increasing the harvest index (HI), which basically means using a larger part of the crop. This is the idea behind second generation technologies, which was discussed briefly in paragraph 2.1.1 and falls outside the scope of this research.

Last of all, the link between the virtual water content of bio-energy and the energy content of crops. All plants and trees have a different composition of elements such as carbohydrates, fats, lignins, minerals, organic acids and proteins. Each of these building blocks has its own energy value, which leads to a characteristic energy content for each type of biomass. These differences are revealed in studies that have calculated the virtual water content of bio-energy from several crops in different countries (Gerbens-Leenes et al. 2008)(Van Meekeren, 2008). Table 2 shows the energy content of the crops used in this study corresponding to the type of bio-energy they are used for.

Table 2: bio-energy provided by dedicated energy crops

Crop	Energy content		
	Bio-ethanol (MJ/kg[i])	Bio-diesel (MJ/kg[i])	Power/heat (MJ/kg[j])
Wheat	10.2 [a]		-
Maize (corn)	10.0 [a]		-
Sorghum	10.0 [a]		-
Sugarbeet	2.6 [a]		-
Sugarcane	2.3 [a]		-
Soyabean	-	6.4 [a]	-
Rapeseed	-	11.7 [a]	-
Palmkernel	-	7.2 [b]	-
Jatropha	-	12.8 [a]	-
Eucalyptus	-	-	4.1 [b]
Pine	-	-	4.1 [b]
Poplar	-	-	4.1 [b]

a) Gerbens-Leenes et al., 2008 i) per kilogram fresh crop
b) Van Meekeren, 2008 j) per kilogram dry roundwood (30% moisture)

Conclusively, the water footprint of bio-energy consumption depends on: 1) how much bio-energy is consumed, 2) what types of bio-energy are used (bio-ethanol, bio-diesel, and/or bio-electricity and heat), 3) the biomass feedstocks that are used to produce them, 4) where they are produced and 5) under what circumstances. Each country has its own climate conditions, hydrological system, soil types and agricultural practices, which all have a direct effect on the growth of vegetation and thus influence crop choice and water usage (FAO, 2008d). The approach chosen to analyze this is explained in the next chapter.

3 Methodology

In the previous chapter insight was given on the interaction between the energy system and the water system. It was shown that energy transitions can be depicted by scenarios and that existing scenarios all show an absolute increase in bio-energy supply and demand. A distinction was made in the different bio-energy types that can be used, the crop feedstocks that correspond to them, and the inherent virtual water content. In this chapter, an explanation is given about how to proceed with all this information and answer the research questions stated in paragraph 1.3.

3.1 Strategy

In this research several data sources will be coupled together to enable a verdict about the water footprint of energy scenarios for 2030. In particular, the transition to bio-energy will be analyzed and quantified per country, making a clear distinction between three different types of bio-energy. Research will be done on crop feedstock choice for each bio-energy type per country, and this will be linked to virtual water content data, allowing the translation from bio-energy consumption to water consumption (i.e. the water footprint). Subsequently, the water footprint is compared to data collected about water availability. For each country, a balance is made of fresh water resources and uses, enabling the determination of the water volume available for bio-energy. The comparison allows a measure of water stress to be established corresponding to the (expected) bio-energy consumption.

3.2 Approach

In this paragraph the approach to answering the research questions will be explained in more detail. Each step is discussed chronologically, along with the assumptions and system boundaries that apply there. A visual outline of the approach is found in Figure 6.

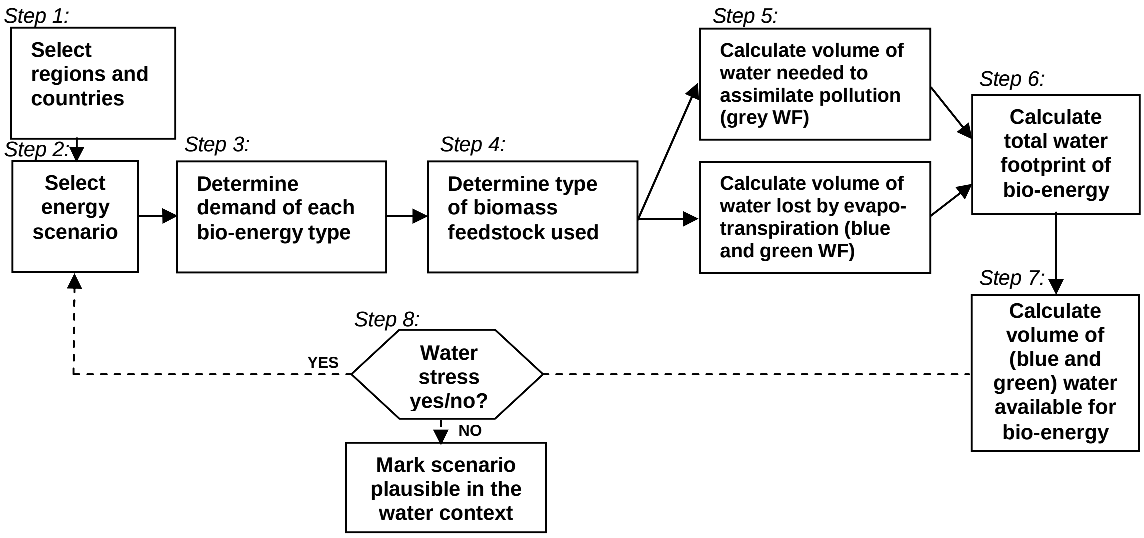


Figure 6: schematization of the research methodology

3.2.1 Research area

Step one comprises the selection of the research area. In the system analysis energy scenarios were already presented on a global scale, but it is more meaningful to divide the world up in smaller segments. The choice is made here to cover almost all countries in the world, 190 to be specific. For this study the same division is applied as in the energy scenarios of the IEA. Countries are first categorized according to their economic development and market structure: OECD, Transition Economies, and Developing Countries. Within these categories countries are grouped by region: North America, Europe, Pacific, Former USSR and Balkans, Developing Asia, Middle East, Africa, and Latin America. The subdivision is found in Appendix B. Next, the geographic scale is made more explicit and the research will zoom in to a national scale to enable statements about country-specific situations and create a first awareness of potential problems in the future.

3.2.2 Energy scenario selection

The second step is the selection of a representative scenario. A choice is made from the scenarios introduced in paragraph 2.1.2. Some important selection criteria used in this study are: that the scenario contains all the necessary data, that it is geographically explicit enough, and that is workable (i.e. is everything well documented and does it come with clarifying background information?).

The scenario data supplied by the International Energy Agency appears to be the most detailed and comprehensive. It contains detail on different energy and fuel types and provides information about energy use in a large number of regions and some specific countries. It also seems very pragmatic as developments in the global energy sector between 2006 (scenario release date) and 2009 indicate that governments are indeed implementing extra policy plans concerning energy security, efficiency and carbon dioxide emissions (e.g. the European Union Greenhouse Gas Emission Trading Scheme). For these reasons, the scenario chosen for this study is the Alternative Policy Scenario of the International Energy Agency (IEA).

Although the Alternative Policy Scenario has world coverage, it does not provide energy data for each country separately. Where specific country data is missing, the database is complemented by data from scenario's that share a similar basis. For example, for countries in Europe the Baseline Scenario from the European Commission is selected (EC DG Transport and Energy, 2008). Key assumptions about policy implementation, technological development and energy efficiency in the region are similar to the ones underlying the Alternative Policy Scenario and trends in energy consumption in all sectors are also alike.

For countries that are not specifically addressed by a scenario, the bio-energy use is extrapolated from base-year 2005. In such case, the total regional bio-energy consumption in 2030, as projected by a scenario, is ascribed to the country according to the share it had in total bio-energy consumption in 2005. Consumption data for this year was obtained from Van Meekeren (2008), Eurostat (2009), USDA FAS GAIN reports, and various official bio-energy websites. A detailed overview of how this study processed the scenario data is found in Appendix D.

3.2.3 Bio-energy types and feedstocks

In the selected scenarios, bio-energy demand is given for different purposes, such as transport, electricity and heat, and industrial, residential and agricultural services. Bio-energy demand in transport refers to the use of liquid bio-fuels by motorized road vehicles. This research assumes solely bio-ethanol and bio-diesel for this purpose. The numbers for the Alternative Policy Scenario tabulated in the World Energy Outlook (IEA, 2006) represent total bio-fuel consumption; the distinction between bio-ethanol and bio-diesel is made in this research based on percentage shares and sector development reports published by the International Energy Agengy (2006), the USDA FAS (2006) and business journals. For the bio-fuel figures in the supplementary European Baseline Scenario (EC DG Transport and Energy, 2008), this research assumes that public transport and trucks are fueled by diesel and private cars and motorcycles by gasoline. Subsequently, these totals are multiplied by the percentages stated for the bio-fuel share in diesel and gasoline per country to obtain the amount of each bio-fuel consumed there (in energy terms).

Bio-energy demand for electricity and heat generation refers to biomass use in electricity plants, heat plants and combined heat and power (CHP) plants. Both public plants and small plants that produce fuel for their own use (autoproducers) are included (IEA, 2006). Bio-energy demand in the industrial, residential and agricultural sectors comprises the consumption of electricity and heat, which are produced by biomass. Transformation losses are also included in this study. The (bio-) energy balance is depicted below:

Total primary energy demand = power & heat generation + total final consumption + transformation losses*

**Total final consumption = Industry + transport + residential, agricultural and services demand*

This study makes some assumptions about the feedstock used for each bio-energy type. Considering the vast amount of potential biomass resources, it would be impractical to take every source into account in each region. Moreover, attempting to consider the varying quality of biomass would lead to an unwieldy problem. Hence, for this research only the dominant, first-generation feedstock for each bio-energy type will be considered. For liquid bio-fuels these are the sugar, starch and oil crops shown in Figure 7. Data on crop choice per country is mainly based on research by Dufey (2006) and USDA FAS (2006). It is complemented and verified using production data from Food Balance Sheets provided by the FAO (2009a) and information from various (local) bio-energy websites. Based on these sources each crop is given a percentage that represents the probability that the crop is used in a country.

For power and heat production, organic wastes and residues have been the major biomass sources so far, but energy crops are gaining importance and market share. In order to achieve the energy production levels projected by the scenarios, countries will (have to) switch to more organized methods of feedstock production, such as large-scale productive forest plantations (FAO, 2000)(FAO, 2006). Short rotation coppice is a popular choice for such plantations. This research will follow the trend towards dedicated energy crops and assume that solely woody biomass from productive plantations is used. A distinction is made in the type of wood used in a certain region. The FAO ForesSTAT database (FAO, 2009b) contains information on production and trade of forestry products, including coniferous and non-coniferous fuelwood, per country. Van Meekeren (2008) suggests that: 1) coniferous fuelwood is treated as pine round wood, 2) non-coniferous fuelwood in countries with a tropic or sub-tropic climate is treated as eucalyptus roundwood, and 3) non-coniferous fuelwood in countries with a temperate and boreal climate is treated as poplar roundwood. Determination of the climate in a given region was done according to the FAO thermal climate classification scheme (FAO/IIASA, 2000). This research adopts the approach used by Van Meekeren (2008).

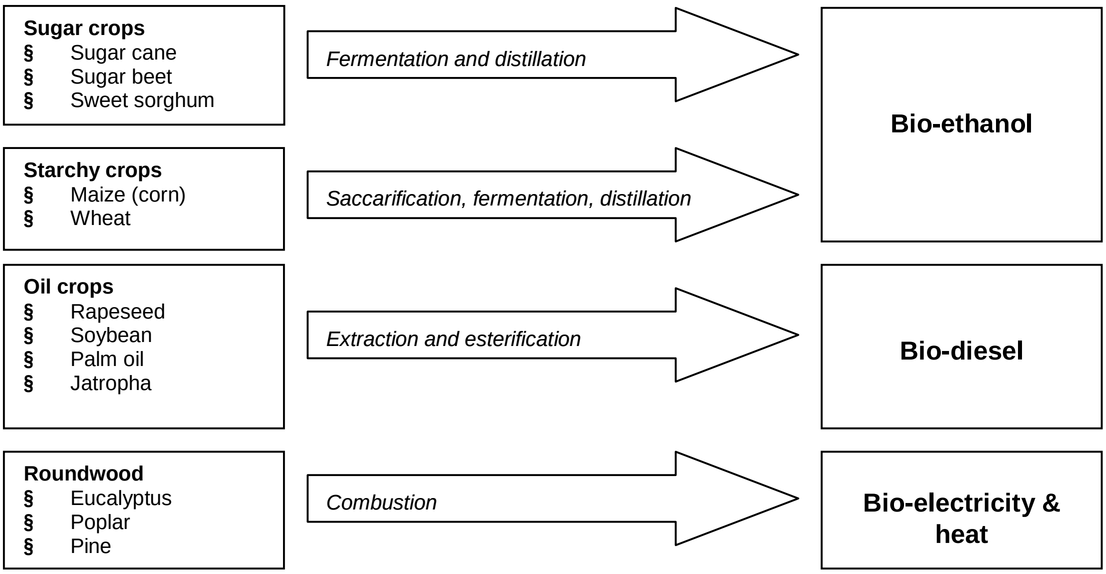


Figure 7: Crops and round wood types, conversion processes, and final energy carriers considered in this study

Data about the feedstock used for each bio-energy type per country is found in Appendix F. In this research it is assumed that in 2030 countries still rely on the same energy crops they used in base-year 2005. Moreover, it is assumed that countries produce feedstock for own consumption, not for trade (as explained in paragraph 2.1.2). This is done to demonstrate potential future (water) problems to countries if they continue on the current path. Further on in this report, some remarks will be made about the effect of switching to more efficient crops and the effect of trade.

3.2.4 Water footprint calculation

The water footprint (WF) related to the consumption of a specific type of bio-energy is based on data of the virtual water content of the crops that are used for that energy. Calculations of (blue and green) crop evapotranspiration were done by Gerbens-Leenes et al. (2008) and Van Meekeren (2008) using the model CROPWAT 4.3 (FAO, 2007), which is based on the FAO Penman-Monteith method and specific crop coefficients. Based on this water usage and the energy content, the virtual water content of each crop was calculated depending on the bio-energy type it is used for (in m3/GJ). The figures provided by these studies are combined in this research. For liquid bio-fuels, virtual water content data from Gerbens-Leenes et al. (2008) is supplemented by data from Van Meekeren (2008). Countries that are not covered by these studies, are assigned regional averages. For bio-electricity and heat, virtual water data is solely provided by Van Meekeren. For countries not covered by his study, regional or global averages are assumed. Furthermore, it has to be noted that only blue and green virtual water data are used for the calculation of the water footprint in this research, because existing data on grey virtual water is incomplete and not sufficient for the geographical coverage of this study. An overview of all the virtual water data is found in Appendix G Subsequently, the virtual water data is coupled with bio-energy consumption and feedstock data (Appendix F) to calculate the water footprint (Appendix H). For each bio-energy type with its corresponding feedstocks (as shown in Figure 7) this is done as follows:

Blue bio-energy WF (km^3/yr) = bio-energy consumed (PJ/yr) x Σ (probability of each feedstock (%) x blue VWC of each feedstock (m^3/GJ))/1000

Green bio-energy WF (km^3/yr) = bio-energy consumed (PJ/yr) x Σ (probability of each feedstock (%) x green VWC of each feedstock (m^3/GJ))/1000

Total bio-energy WF (km^3/yr) = Blue bio-energy WF (km^3/yr) + Green bio-energy WF (km^3/yr)

It has to be pointed out, that determining the water footprint of bio-energy consumption in a scenario means accounting for the dominant part of the water demand related to that scenario. This is evident from the fact that, fossil fuel consumption continues to be about 10 times higher than biomass consumption in all scenarios (in energy terms), whilst virtual water content of the latter is about 70 times larger (see Table 1). This enables a statement to be made about the water stress caused by a particular scenario. The method is explained in the next paragraph.

3.2.5 Water availability and water stress

To calculate the volume of water available for energy crops, a supply and demand balance is created per country using data from AQUASTAT (FAO, 2008c)(see Appendix I). Postel et al. (1996) have illustrated how fresh water is partitioned over different types of flow and have estimated the volume that can be used by humans on a global level (see Figure 8). They show that the renewable fresh water supply (RFWS) is equal to precipitation, and that it subdivides into runoff and evapotranspiration. To quantify these flows per country, this research uses the following data from AQUASTAT: endogenous precipitation (km3/yr), and internal renewable water resources (IRWR) (km3/yr) (i.e. runoff). The difference between the two equals the evapotranspiration flow. This method only looks at water flows generated within the borders of a country; it excludes flows entering the country from neighboring countries to prevent double counting.

Postel et al. distinguish a further division of runoff into remote flow, uncaptured floodwater and the remaining accessible runoff. They have quantified these flows on a global level and conclude that about 19 percent of total runoff is too remote to access (e.g. in mountains or jungle) and that about 50 percent of runoff is floodwater that cannot be captured for use. AQUASTAT does not provide data about these flows on a country basis; hence, for the purpose of this study, the global percentages from Postel et al. are used in all countries. It has to be noted however, that Postel et al. merely evaluate the water (un)available for humans. Smakhtin, Revenga & Döll (2004) argue that environmental water requirement should also be considered in the determination of water availability. They present these flows in their research as percentages of long-term mean annual runoff in 128 major basins and drainage regions of the world. Since the runoff in these basins comprises remote flow, uncaptured floodwater and accessible flow, it is argued here that some part of each of these flows is used to satisfy the environmental flow requirement (see Figure 8).

For the purpose of this study, countries and/or regions included in each basin are assigned the stated basin percentage environmental flow requirement (EFR). If a country is situated in more than one basin, the average EFR percentage of the basins is taken. For countries that are not covered, a regional average is used. Next, the global percentages of remote flow, uncaptured floodwater and accessible runoff are adjusted in order to account for the EFR in each country. The initial percentage flow is lessened by a weighted share of EFR, which is based on the initial quantity of that flow. The calculation for remote flow (RF) is shown below (the same is done for uncaptured flow and accessible runoff):

New % RF = initial % RF – (initial % RF x national %EFR)

National RF = national IRWR x new % RF

For example, if the initial percentage remote flow is 19 percent and the EFR in a country is 35 percent, then 7 percent of the remote flow is reserved for the environment and the new percentage remote flow applied in that country is 12 percent.

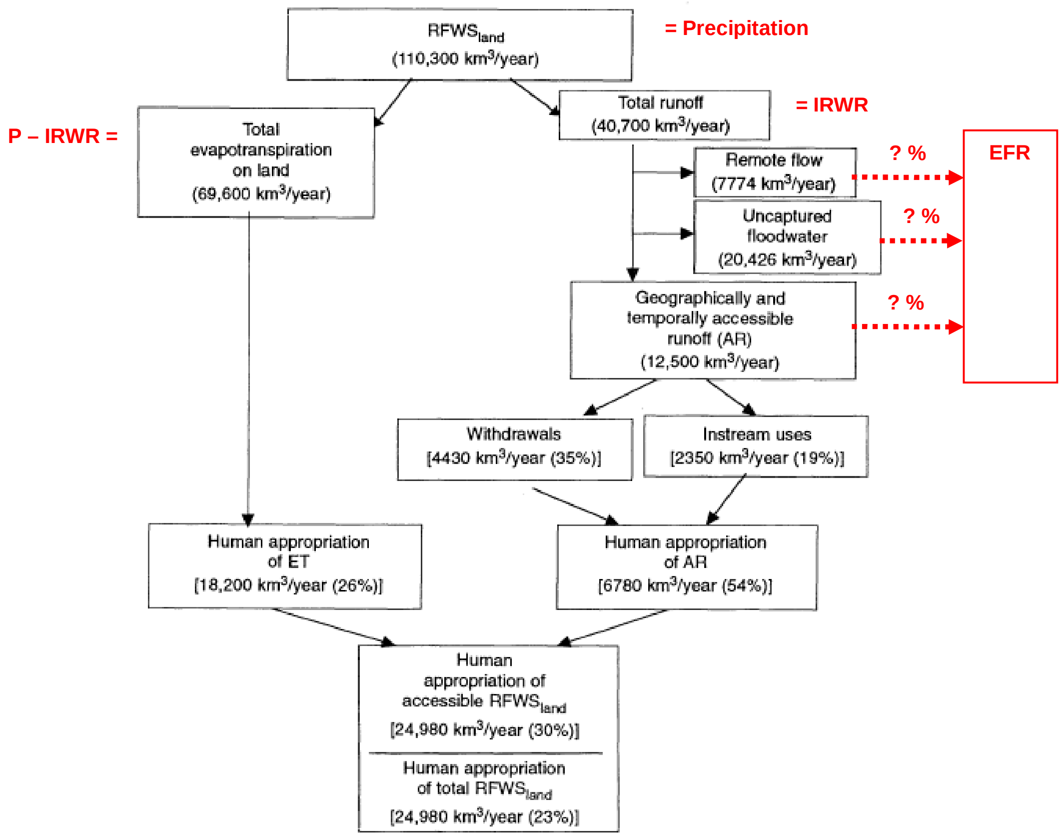


Figure 8: partitioning of renewable fresh water resources (source: Postel et al., 1996). The labels in red show supply notations used in AQUASTAT (FAO, 2008c) and consideration of environmental flow requirement (EFR) (based on: Smakhtin, Revenga & Döll, 2004)

Once the supply side of the balance is completed, the demands have to be taken into account. Data on water withdrawals for industrial, domestic and agricultural purposes is provided by AQUASTAT and is used in this study. Generally, in developed countries the largest withdrawals are for industry and in developing countries for agricultural purposes (FAO, 2008c). All these demands are subtracted from the accessible runoff (incl. EFR) to obtain the water available solely for the production of bio-energy. It has to be noted that this water can be used to satisfy the blue part of the bio-energy water footprint only. For the green component, it is assumed here that the whole evapotranspiration flow is ‘free’ for bio-energy. It is acknowledged that in reality this is not the case, since other sectors and the environment also use green water. But due to lack of data about such demands, this study could not take them into account.

Future growth in withdrawals is also incorporated in this study. Alcamo et al. (2003) present calculations of expected water withdrawals by all sectors for 200 countries in 2025, 2055 and 2075 based on changes in population, economy and technology according to the A2 and B2 IPCC scenarios (see paragraph 2.1.2). The B2 scenario emphasizes environmental values more and assumes substantially lower emissions in the future, which matches the intentions behind the Alternative Policy Scenario. Climate change is also considered in their numbers (reflected in irrigation requirements), using two different climate models (HadCM3 and ECHAM4). The HadCM3 climate model results in a slightly higher total global irrigation requirement, but regional differences are not very large. This research uses the results from the B2 scenario and the HadCM3 model combination. Linear interpolation between 2025 and 2055 is done to determine the expected water withdrawals for 2030.

On the supply side, future change in precipitation is not taken into account in this research. Although the numbers used are long-term averages and are not expected to vary largely in the coming years, it is recognized that climate change may lead to shifts in precipitation patterns around the globe in the long-run. Nevertheless, it was outside the scope of this research to take this into account. The only change incorporated on the supply side is a slight growth in global dam capacity as estimated by Postel et al. (1996). In the next 30 years, dam capacity is expected to increase by about 3.5 percent, which means that 3.5 percent more of the floodwater can be captured and added to the available runoff.

Once the water availability is calculated, the level of water stress in a country can be determined by checking if the demand for water will exceed the supply. Dividing the water footprint of bio-energy by the water available for that purpose allows a statement to be made about the water stress caused by the scenario. Blue water stress will occur when the ratio of blue water footprint to available runoff becomes larger than one, and green water stress will occur when the ratio of green water footprint to evapotranspiration flow exceeds one.

3.3 Data sources

To sum up, this research uses several different sources of data and information, as shown in the research model in paragraph 1.4. Information about energy scenarios is obtained from reports of renowned organizations and leading scientists (introduced in paragraph 2.1.2). Information about energy crop choice is primarily based on Dufey (2006), the FAO (2009a,b) and the USDA FAS (2006). Data about the water use of these crops comes from the research of Hoekstra, Chapagain, Gerbens-Leenes, Van der Meer and Van Meekeren (Hoekstra & Hung, 2002)(Chapagein et al., 2006)(Gerbens-Leenes et al., 2008)(Gerbens-Leenes et al., 2008a)(Van Meekeren, 2008). Figures for water availability and usage are based on data from the Food and Agricultural Organization of the UN (2008c), the World Resource Institute (2007) and research from Gleick (1993), Postel et al. (1996), Alcamo et al. (2003), Smakhtin, Revenga & Döll (2004). In the next chapter the outcome of this study is presented.

4 Results

In this chapter the results of the research are presented. First, an overview is given of the change in energy consumption according to the leading energy scenarios (presented in paragraph 2.1.2). A short description is given of the most notable changes relating to bio-energy. Then the selected Alternative Policy Scenario is treated in detail and the change in consumption of bio-energy between 2005 and 2030 in each region is presented. A distinction is also made between the different types of bio-energy. Thirdly, the change in water footprint corresponding to the bio-energy consumption of each region is presented.

Next, the water footprint corresponding to the bio-energy consumption in 2030 is compared to the water availability per region to evaluate the potential water stress. Last of all, the findings are compared on a national scale and an in-depth analysis of countries with water stress is included.

4.1 Change in bio-energy consumption

The numeric data corresponding to the energy scenarios introduced in paragraph 2.1.2 is found in Appendix C. Fossil fuels continue to dominate the energy mix, but bio-energy consumption rises in absolute terms in all scenarios. Figure 9 summarizes the contribution of energy from biomass (including waste) in the energy scenarios from the six prominent organizations. It can be seen that the share varies between 32 – 104 EJ, or 4 to 20 percent, with an average of 11 percent.

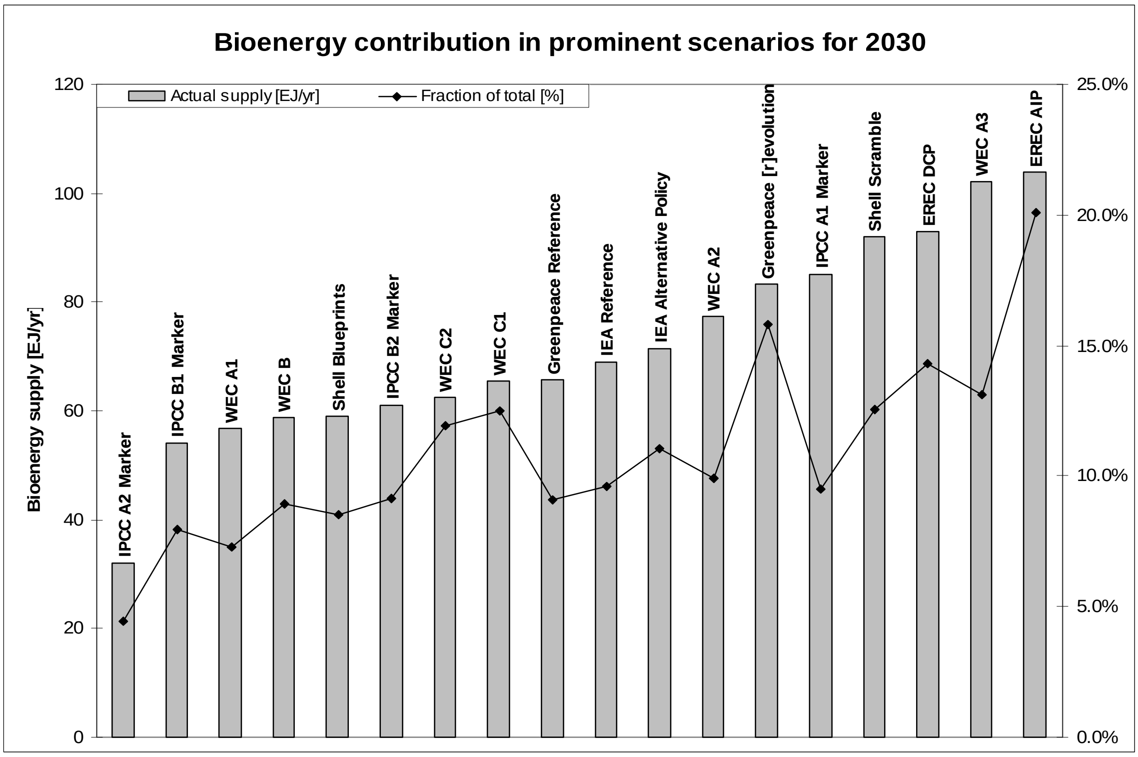


Figure 9: summary of bio-energy contribution in 2030 according to prominent scenarios.

Even though this range appears to be quite broad, there are researchers that claim much larger expected contributions. There are many studies that have calculated the (theoretical) future potential of its source (both economic and technical), and the findings of some leading ones are presented in Figure 10. This results in a much larger range, 34 – 933 EJ, for 2030. It seems some researchers are very optimistic about the contribution of bio-energy, but very few take into account the water factor. Most of them only consider food demand, land availability and agricultural management developments.

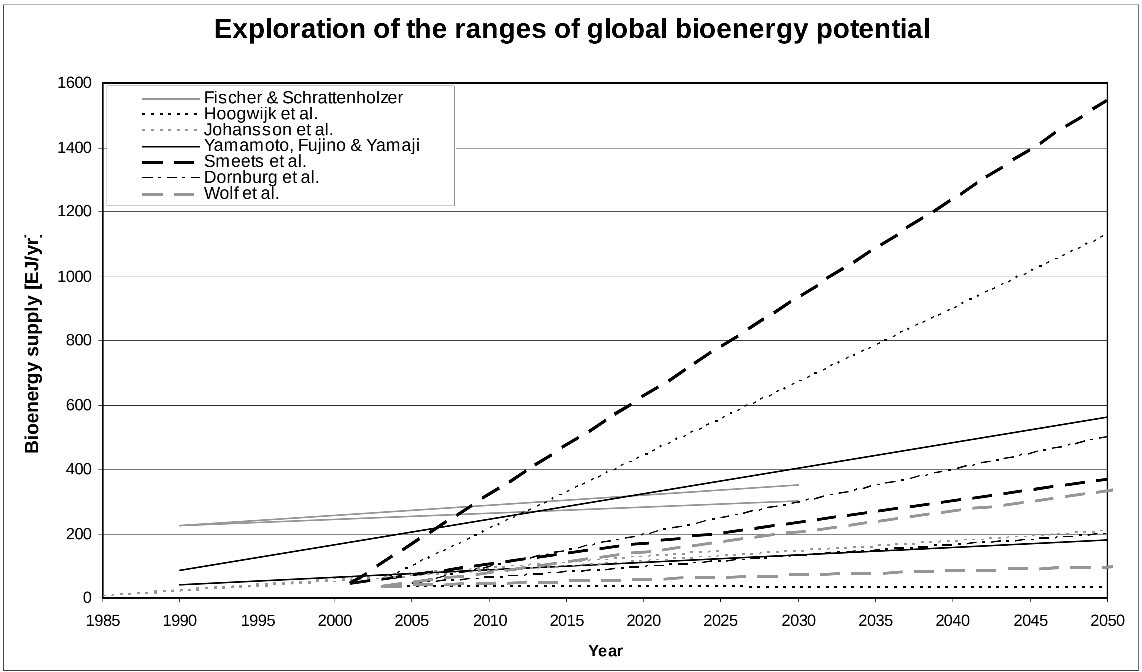


Figure 10: graph displaying the range of global bio-energy potential according to leading studies

The Alternative Policy scenario from the International Energy Agency comes closest to the average bio-energy share (11 percent) in global energy consumption of all scenarios. The general trend according to this scenario is an increase in bio-energy consumption in all regions, as seen in Figure 11. Change in the Pacific and Middle Eastern regions is especially large, where consumption increases with a factor 25 and 65 respectively. But this is only relative, since it is from a small base in 2005. In absolute terms Developing Asia remains the largest bio-energy consumer by far, followed by Africa. In 2005 Latin America was the third largest consumer, but the region is overtaken by North-America and Europe in 2030.

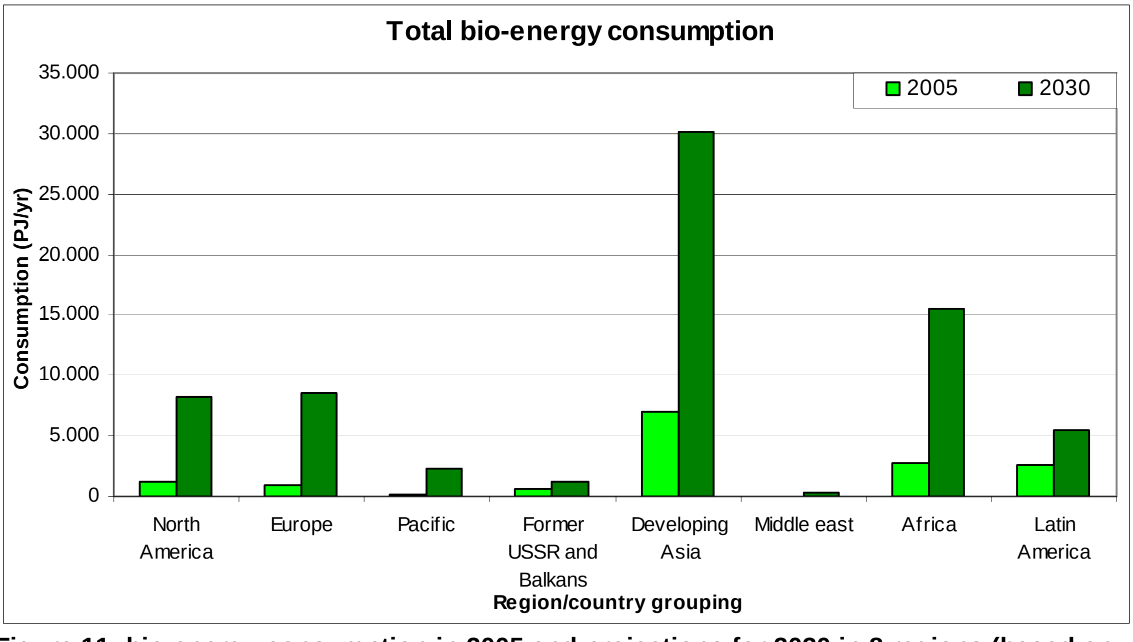


Figure 11: bio-energy consumption in 2005 and projections for 2030 in 8 regions (based on Alternative Policy Scenario)

Figure 12, Figure 13, and Figure 14 specify what bio-energy types make up the bio-energy consumption (= production) in each region, and hence show what the main contributors of change are. Note that the 2005 bio-electricity and heat consumption data in Figure 14 is based on wood fuel only, i.e. it excludes organic waste streams, whilst the projections for 2030 may include waste as a (partial) source (see also paragraph 3.2.3). This may cause some distortion in the apparent change in consumption. Nonetheless, it is clear that bio-electricity and heat continue to have the largest share in the bio-energy consumption mix. Developing Asia is the largest consumer of wood for energy, followed by Africa. In more developed regions, liquid bio-fuels form an important constituent in the bio-energy mix. Especially in North America and Europe, but also in Latin America they continue to play a prominent role. In 2030 it is expected that bio-ethanol consumption in Europe will overtake that in Latin America, thereby making it the largest bio-ethanol consumer after North America. Bio-diesel consumption in Developing Asia is expected to rise sharply and just surpass Europe, the former chief bio-diesel consumer (and producer), in 2030.

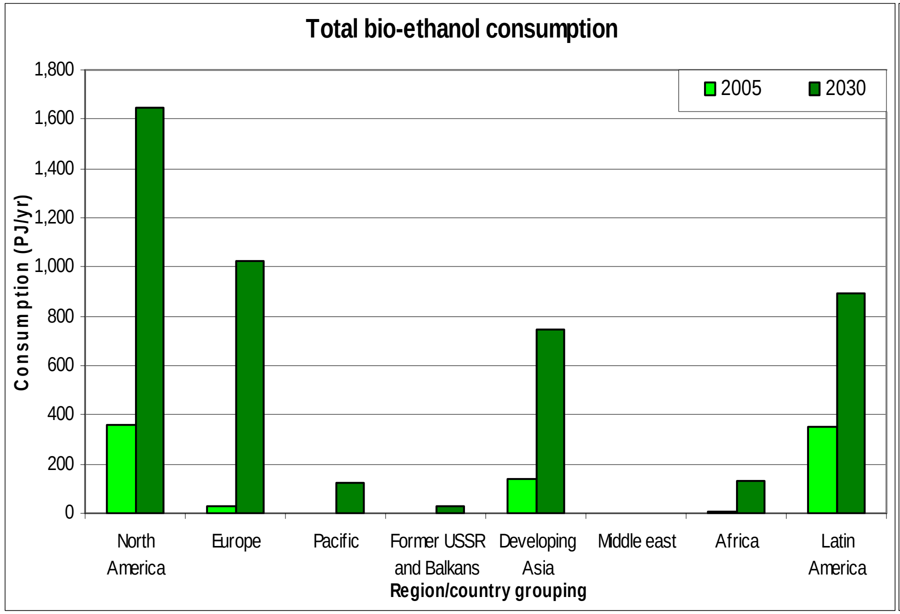


Figure 12: change in bio-ethanol consumption between 2005 and 2030 in all regions

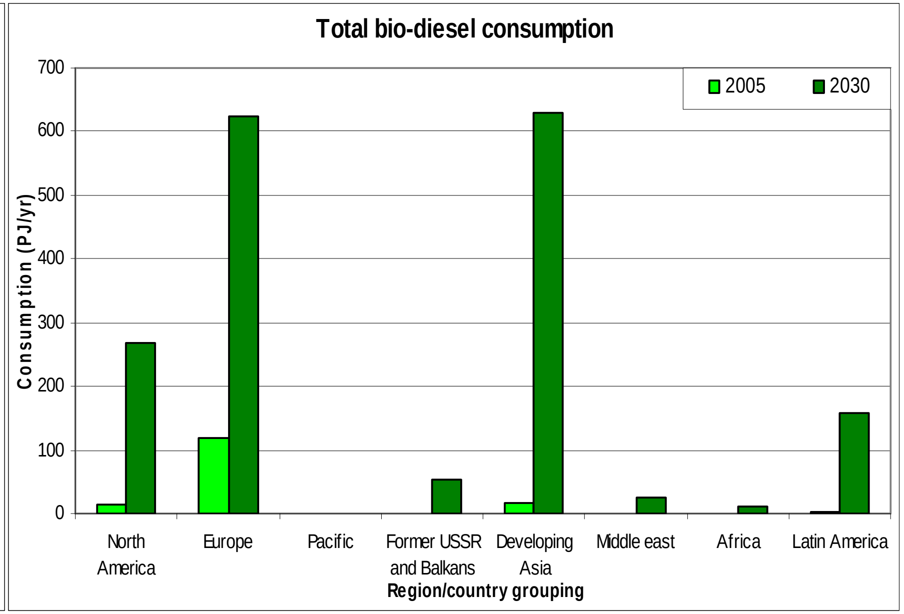
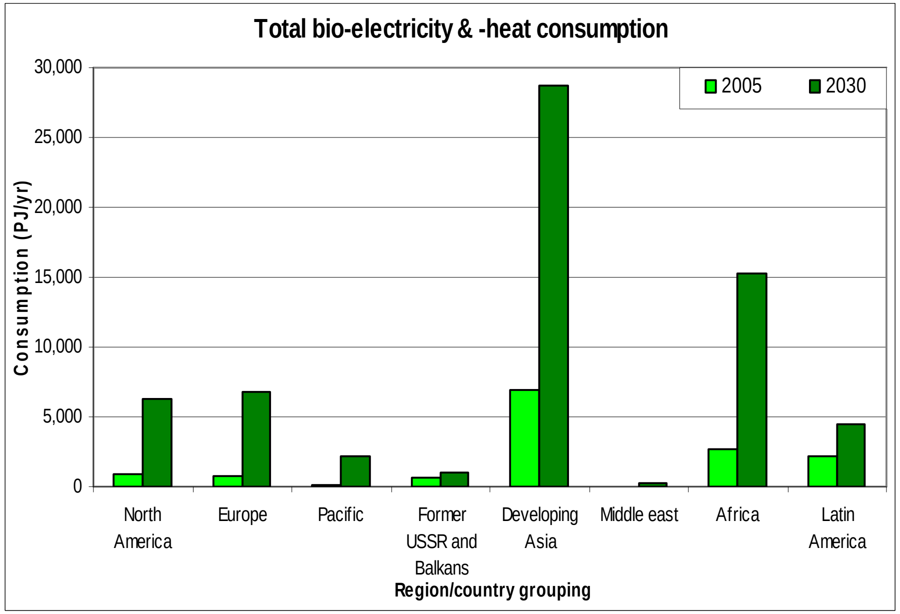
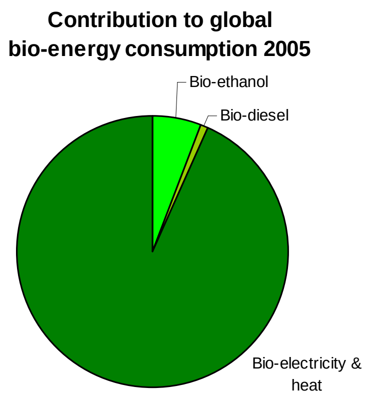


Figure 13: change in bio-diesel consumption between 2005 and 2030 in all regions





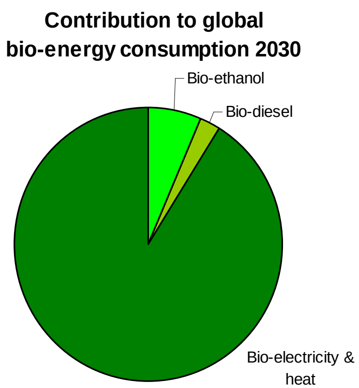


Figure 14: change in bio-electricity& heat consumption between 2005 and 2030 in all regions

4.2 Changes in water footprints

The increase in bio-energy consumption has a direct effect on the water use in a region. The water footprint changes per region are displayed in Figure 15, with a distinction made between blue and green. The overall picture is dominated by the green water footprint, mainly due to large consumption of rain fed plantation wood for bio-electricity and heat (see Figure 18). Developing Asia is by far the largest user of fresh water for bio-energy purposes, both in 2005 and 2030, followed by Africa. Furthermore, some interesting developments can be seen when comparing the changes in bio-energy consumption to the change in water footprint for some regions. In Figure 11 it was seen that the total bio-energy consumption of North America and Europe is expected to be about the same in 2030. In Figure 15 below, however, the water footprints of these two regions will be rather different in 2030. This can be explained by both the type of bio-energy that is consumed in the region and the crops that are used to produce that energy (see Appendix F). From Figure 13 it can be seen that North America consumes less bio-diesel than Europe, but it has a larger water footprint corresponding to that fuel in 2030 (see Figure 17). This is because North America uses predominantly soybean for the production of bio-diesel, whilst Europe uses rapeseed, and the virtual water content of soya in North America is much larger than that of rape in Europe.

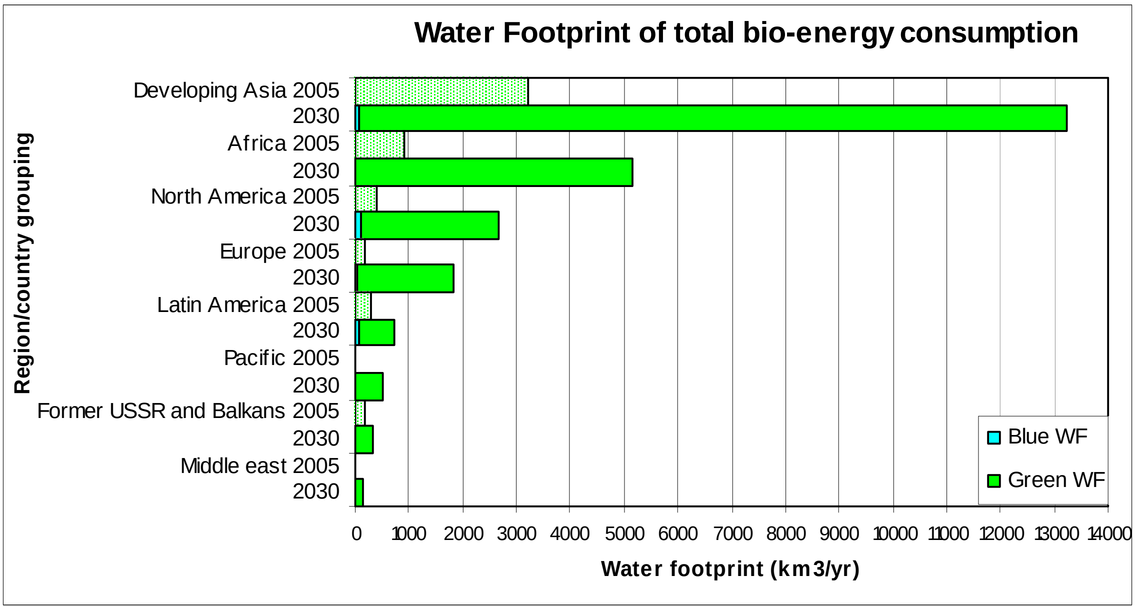


Figure 15: changes in water footprint of bio-energy consumption between 2005 and 2030 in all regions.

Another interesting result is found when comparing the consumption of bio-electricity and heat in North America and Europe to the corresponding water footprints. In 2005 Europe and North America consumed approximately the same amount of heat and electricity produced from biomass. In 2030 the consumption in Europe is about 500 PJ higher than in North America, but North America has a larger water footprint. Although both regions use predominantly poplar wood (55 and 56 percent respectively), energy from poplar in North America has a larger virtual water content, thus leading to a bigger water footprint.

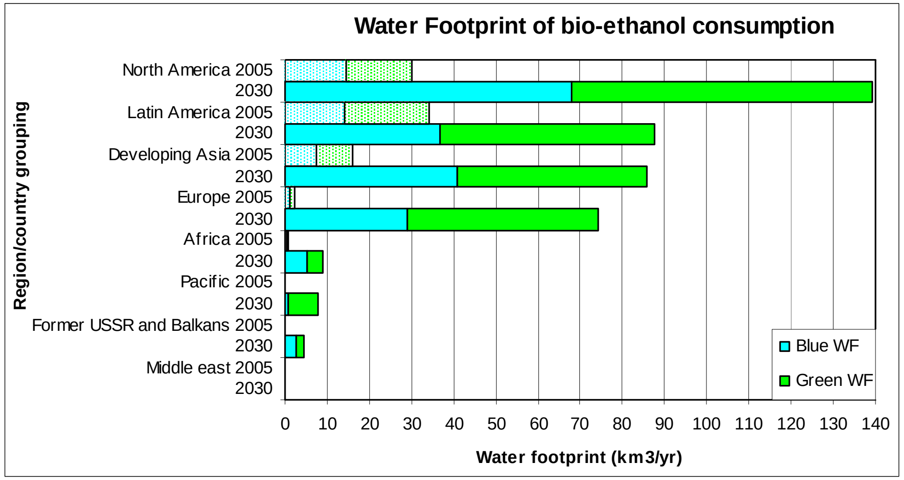


Figure 16: change in water footprint of bio-ethanol consumption between 2005 and 2030

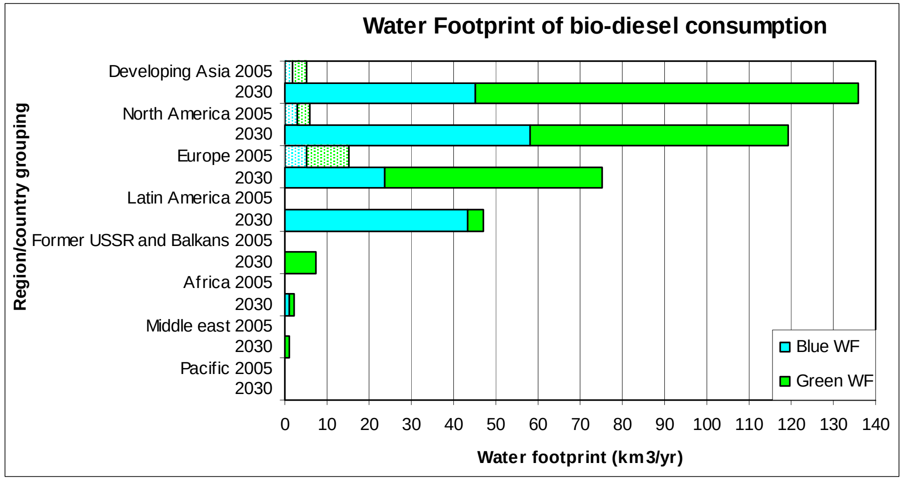


Figure 17: change in water footprint of bio-diesel consumption between 2005 and 2030

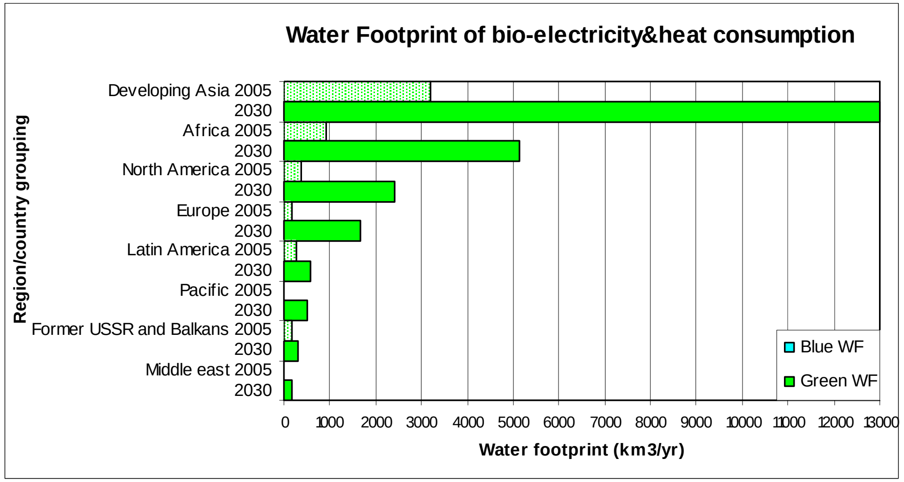
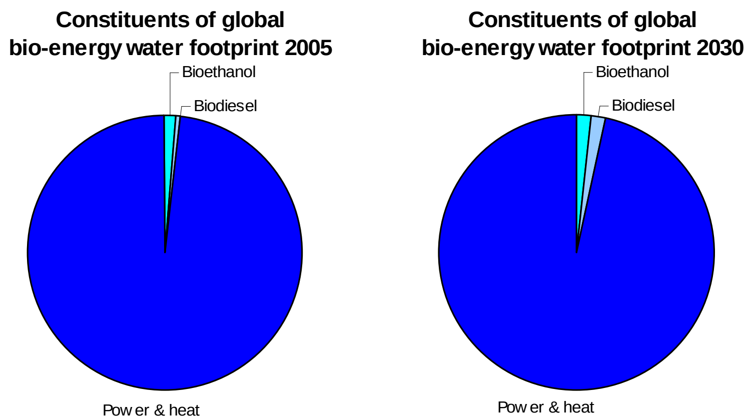


Figure 18: change in water footprint of bio-electricity & heat between 2005 and 2030



4.3 Water stress levels

In this paragraph the consequence of the change in water footprint is analyzed per country. A comparison is made between the blue and green water demands and supplies in 2030 to show where in the world water stress is likely to occur. For each country Tables 3 and 4 also show how much the bio-energy water footprint (WF) contributes to this water stress. In Pakistan for example, blue water demands exceed the available internal runoff by about 19 times, likely causing a high level of water stress. However, less than one percent of the water stress is caused by the blue WF of bio-energy, the rest is caused by withdrawals in the domestic, industrial and agricultural sectors. For green water stress, the contribution of bio-energy is always 100 percent, since no other green water demands were considered in this study. India for example, exceeds its available green water by about 100 percent solely because of the green water footprint of bio-energy (mainly from wood). In the following subparagraphs, the blue and green water demands and supplies are shown for the individual countries in each region.

	Blue water stress 2030	
Country	Excess demand (expressed as percentage accessible IRWR)	Contribution of blue bio-energy WF (expressed as percentage of excess demand)
Bahrain	35273,3%	0,0%
Bahamas	21071,2%	0,0%
Egypt	18363,6%	0,0%
Turkmenistan	5043,4%	0,0%
Libya	4272,8%	0,0%
Saudi Arabia	3724,4%	0,0%
United Arab Emirates	2371,3%	0,8%
Mauritania	2064,7%	0,0%
Pakistan	1944,3%	0,4%
Yemen	1363,8%	0,0%
Moldova	1350,0%	0,0%
Uzbekistan	1294,1%	0,0%
Qatar	1046,3%	0,0%
Jordan	958,2%	0,0%
Syria	931,8%	0,0%
Israel	911,9%	0,0%
Azerbaijan	796,9%	0,0%
Hungary	524,4%	0,9%
Iraq	403,2%	0,0%
Afghanistan	352,1%	0,0%
Tunisia	331,2%	0,0%
Algeria	320,4%	0,0%
Bulgaria	298,3%	6,1%
Czech Rep.	258,0%	21,8%
Romania	242,8%	4,4%
Belgium	237,7%	3,0%
Oman	237,1%	0,0%
Netherlands	228,3%	8,1%
Iran	219,8%	0,0%
Niger	205,4%	0,0%
Ukraine	205,2%	0,0%
India	193,2%	2,6%
Armenia	187,1%	0,0%
Barbados	180,1%	0,0%
Bangladesh	173,7%	0,0%
Poland	160,8%	34,1%
Cyprus	153,0%	46,8%
Spain	152,2%	33,2%
Sudan	147,2%	0,0%
Morocco	130,4%	0,0%
South Africa	121,7%	42,6%
Kazakhstan	116,3%	0,0%
Somalia	106,1%	0,0%
Germany	100,2%	37,5%
Lebanon	98,6%	0,0%
Trinidad and Tobago	94,4%	0,0%
Luxembourg	76,2%	100,0%
Slowak Rep.	72,1%	2,6%
Rep. Korea	60,2%	0,0%
Kenya	56,0%	1,0%
Denmark	52,7%	84,1%
Turkey	42,8%	0,0%
Greece	37,1%	14,3%
Macedonia	29,0%	0,0%
Eritrea	27,4%	0,0%
France	17,6%	100,0%
China	11,5%	74,5%
Cuba	11,1%	0,0%
UK	8,4%	100,0%
Portugal	2,8%	100,0%

	Green water stress 2030	
Country	Excess demand (expressed as percentage available green water)	Contribution of green bio-energy WF (expressed as percentage of excess demand)
Egypt	678,2%	100,0%
Lebanon	580,3%	100,0%
Jordan	389,0%	100,0%
Switzerland	228,7%	100,0%
Norway	227,5%	100,0%
Vietnam	221,9%	100,0%
Ethiopia	142,8%	100,0%
Pakistan	127,0%	100,0%
India	122,5%	100,0%
Slovenia	86,6%	100,0%
Rep. Korea	81,3%	100,0%
Philippines	68,6%	100,0%
Latvia	65,8%	100,0%
Nigeria	58,2%	100,0%
Denmark	53,4%	100,0%
Austria	47,3%	100,0%
Finland	46,6%	100,0%
Germany	38,2%	100,0%
Malta	31,1%	100,0%
China	27,6%	100,0%
Belgium	22,7%	100,0%
Sweden	20,7%	100,0%
Czech Rep.	19,8%	100,0%
Burkina Faso	16,1%	100,0%
Netherlands	14,2%	100,0%
Japan	14,0%	100,0%
Thailand	9,5%	100,0%
Portugal	8,6%	100,0%

Tables 3 and 4: Overview of countries which are likely to suffer from blue and/or green water stress, caused by water demands exceeding water supply in 2030. Blue water stress is indicated by how much bigger the total blue water demands (i.e. domestic, industrial, agricultural and bio-energy withdrawals) are compared to the accessible internal renewable water resources (IRWR). It is also shown how much the bio-energy water footprint (WF) contributes to the water stress. In the case of green water stress, only the green water demand (i.e. WF) of bio-energy is considered (hence the 100% contribution), and subsequently compared to the total green water availability.

4.3.1 North America

Although North America as a whole does not appear to encounter any water problems, it is likely that some individual countries in this region will face water stress in 2030, as can be seen in Figure 19. With the blue water footprint of bio-energy added to total runoff demand, the United States of America nearly uses all of its available runoff in 2030 and is thus likely to suffer some water stress. In Mexico the blue water demand will exactly equal the available runoff in 2030, but this happens even without extra demands from bio-energy. Only in Canada there is no water stress expected, since it has a very small energy water footprint and plenty of runoff available.

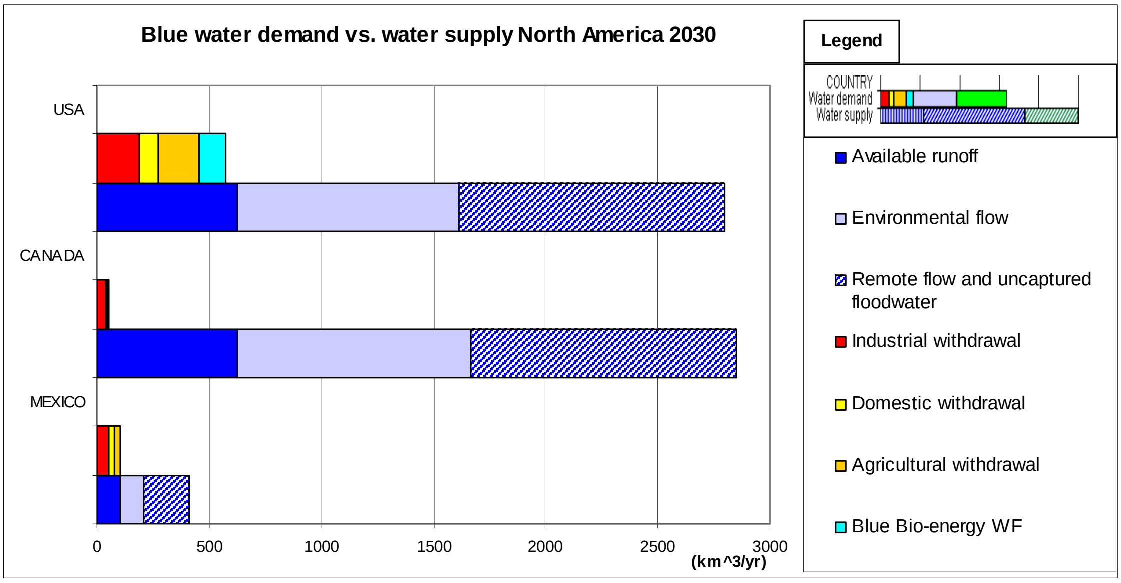


Figure 19: comparison of blue water demands and internal renewable blue water resources in North American countries.

The green part of the bio-energy water footprint does not seem to cause any water stress in North American countries. However, it has to be noted that some (unknown) part of the productive evapotranspiration flow occurs above precious ecosystems (i.e. as green environmental flow) and may face competition with green water needs of bio-energy crops in the future. In the USA, for example, the green WF means that 25 percent of the total land surface is covered with biomass for energy purposes in 2030 (primarily poplar for bio-electricity), using about 60 percent of the total green water supply. Note, that evaporation figures for poplar are based on world averages.

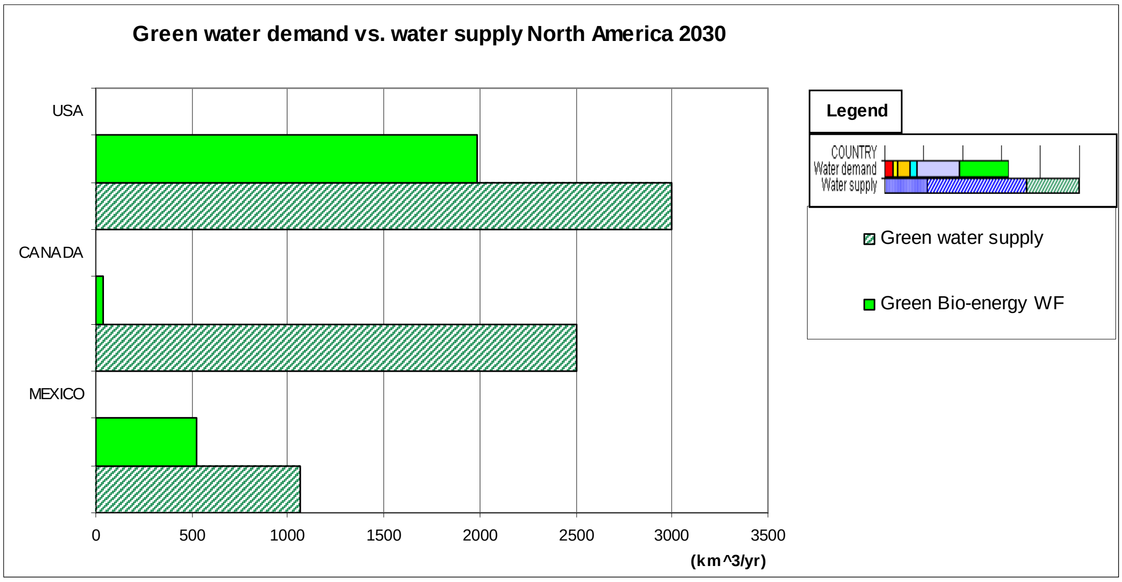


Figure 20: comparison of green bio-energy water footprints and total green water supply in North American countries

4.3.2 Europe

Although it is not expected that the consumption of bio-energy by Europe in 2030 will lead to regional water stress, there are a lot of individual countries that will likely suffer water stress in 2030. Blue water stress is expected in: Belgium, Czech Republic, Denmark, France, Germany, Greece, Hungary, Luxembourg, Netherlands, Poland, Portugal, Slovak Republic, Spain, Turkey and the United Kingdom (see Figure 21). In France, Luxembourg, Portugal and the UK water stress occurs solely due to the water demands from bio-energy, whilst in the remaining named countries water stress is already caused by water demands from other sectors. The main reason is that these countries use primarily sugarbeet for ethanol and rapeseed for bio-diesel, which both use a lot of irrigation water.

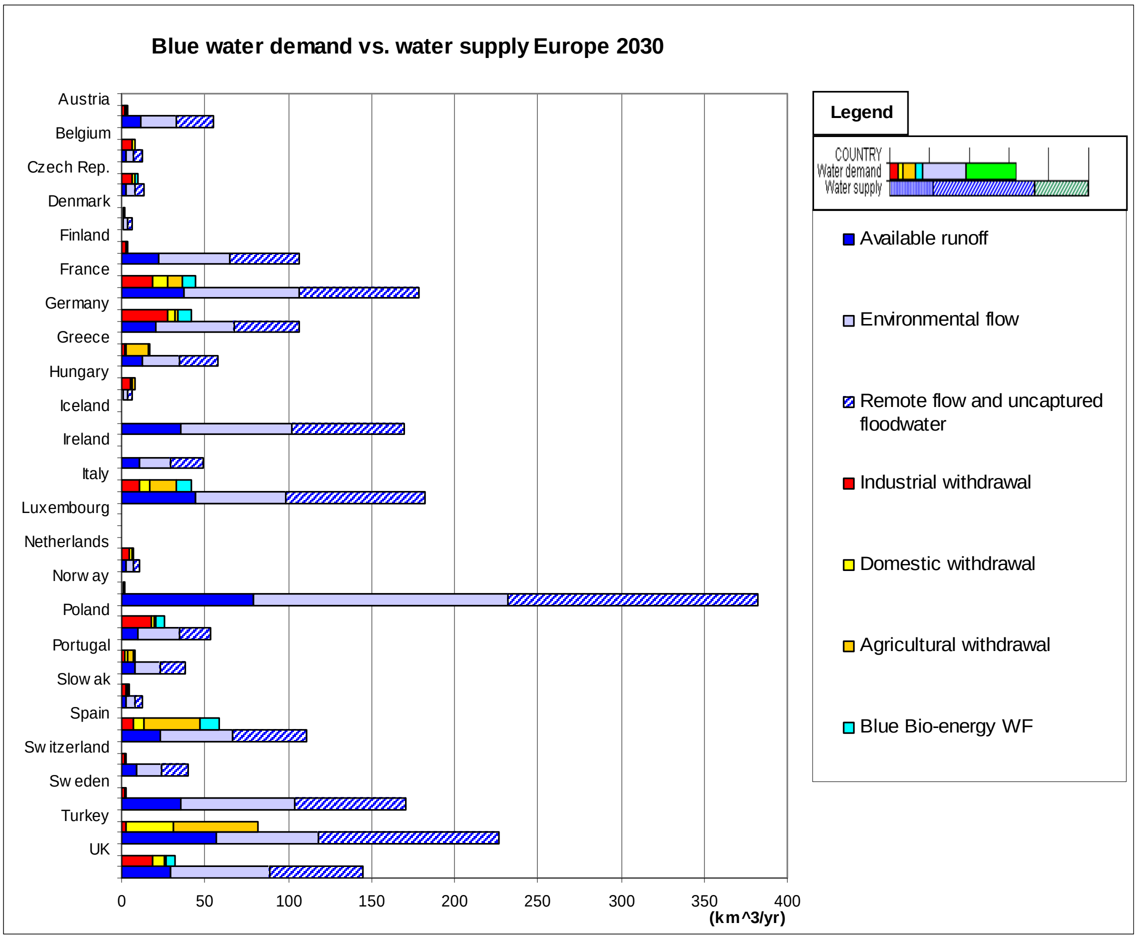


Figure 21: comparison of blue water demands and internal renewable blue water resources in European countries

Green water stress is expected to occur in the following countries: Austria, Belgium, Czech Republic, Denmark, Finland, Germany, the Netherlands, Norway, Portugal, Switzerland, and Sweden as can be seen from Figure 22. In these countries the green water footprint of bio-energy exceeds the green water supply, mainly due to the consumption of bio-electricity and heat from poplar and pine roundwood.

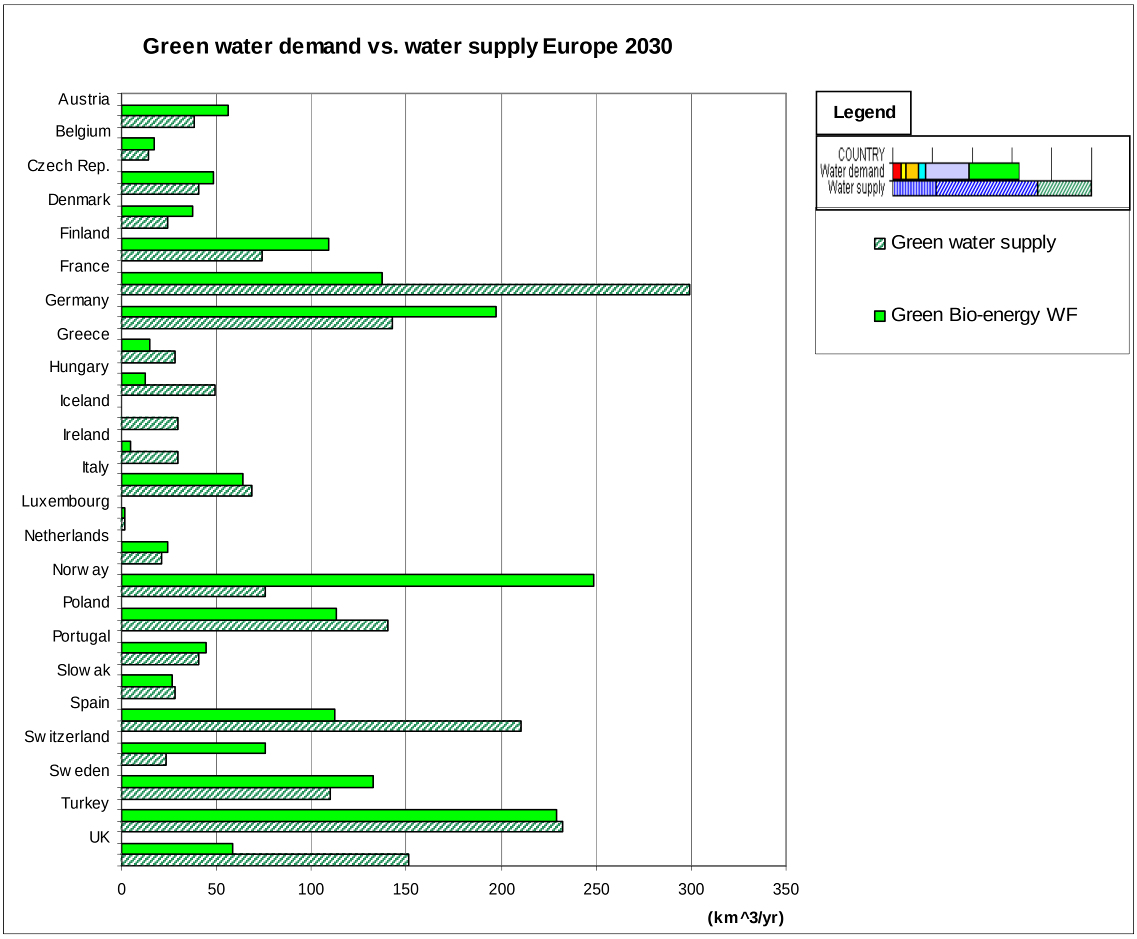


Figure 22: comparison of green bio-energy water footprints and total green water supply in European countries

4.3.3 Pacific

In the Pacific region as a whole there seems to be sufficient water and total water demand is expected to be relatively low. According to Figure 23, only the Republic of Korea is likely to face blue water stress in the future. However, this is not caused by its bio-energy water footprint, but by withdrawals in other sectors. Both in the Republic of Korea and Japan, bio-energy consumption is expected to cause green water stress (see and Figure 24). In these countries bio-electricity demand is projected to rise sharply. Australia will also be a noteworthy bio-energy consumer (ethanol and bio-electricity), but has plenty of water available for that purpose. Biomass is not expected to emerge as a major energy source in New Zealand, and will thus not lead to any problems in that country.

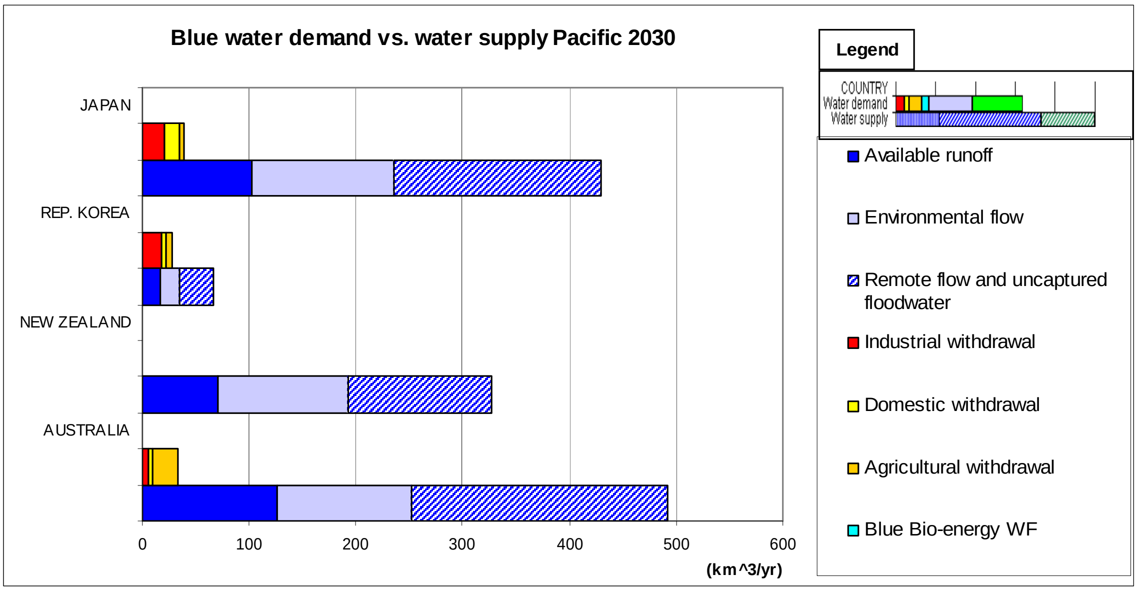


Figure 23: comparison of blue water demands and internal renewable blue water resources in Pacific countries

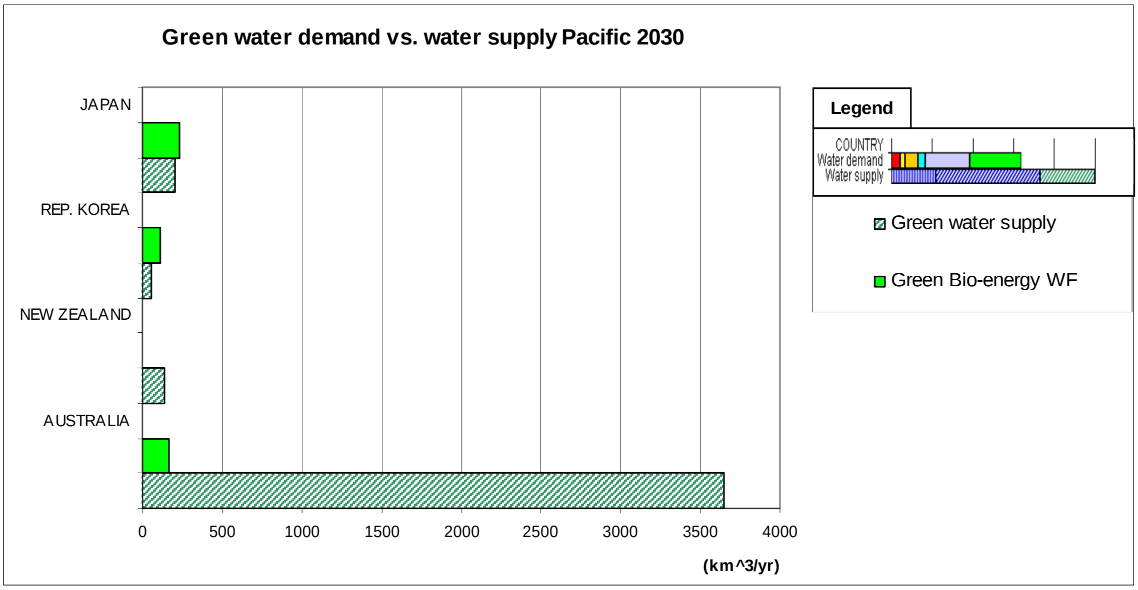


Figure 24: comparison of green bio-energy water footprints and total green water supply in Pacific countries

4.3.4 Former USSR and Balkans

The former USSR and Balkans are classified as transition economies, along with Cyprus, Gibraltar and Malta. No real water problems are expected in these economies, since bio-energy consumption remains low and the enormous water availability in Russia is overshadowing. On a national scale, however, it is likely that some water stress will occur. The countries in which blue water demand exceeds blue water supply are: Armenia, Azerbaijan, Bulgaria, Macedonia, Kazakhstan, Moldova, Romania, Turkmenistan, Ukraine, Uzbekistan, and Cyprus, but in none of these countries it is caused by the blue water footprint of bio-energy. Withdrawals by other sectors will already exceed the available runoff in 2030.

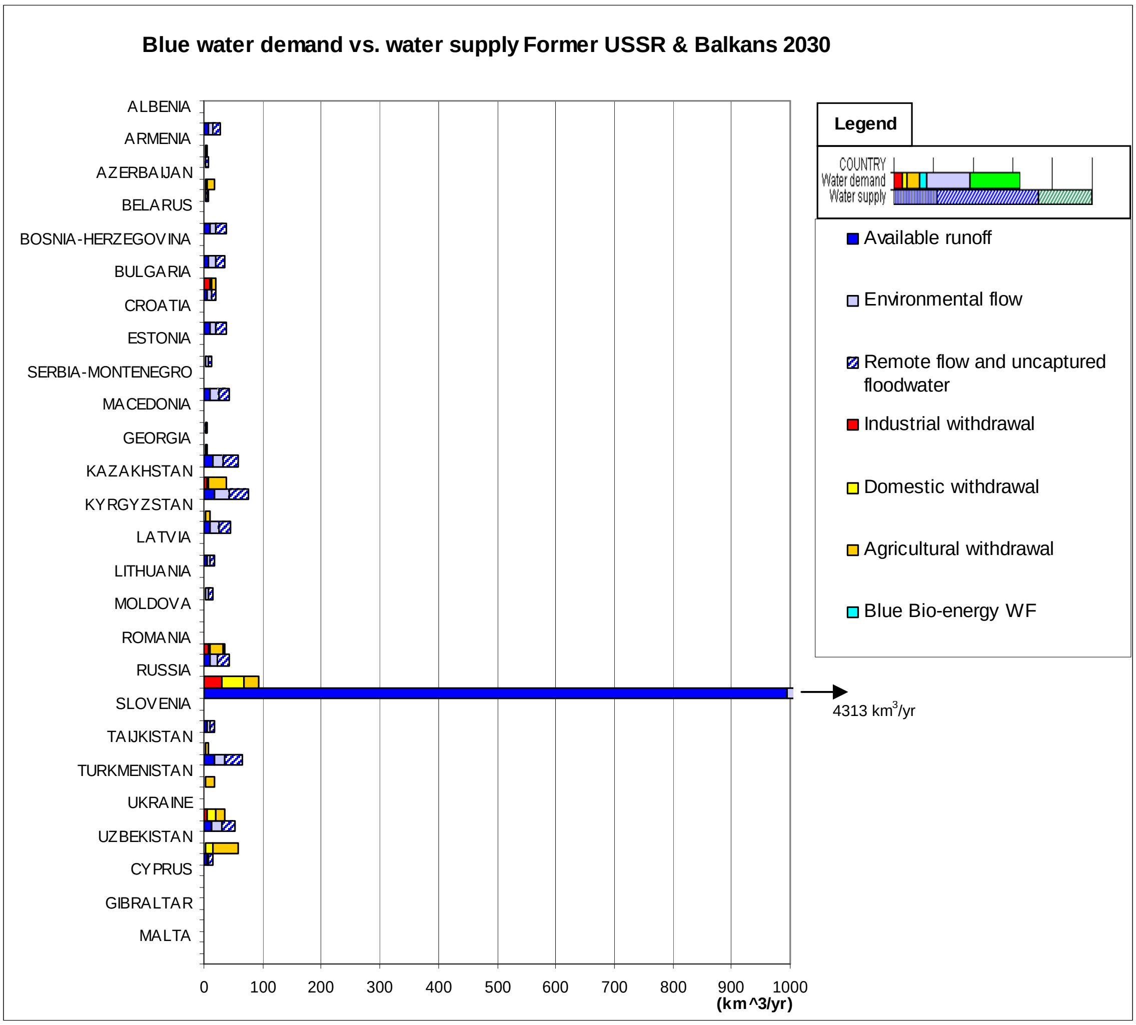


Figure 25: comparison of blue water demands and internal renewable blue water resources in Transition Economies

From Figure 26 it can be seen that green water stress is expected to occur in Latvia, Slovenia, and Malta. The main contributor to the green water stress in these countries is bio-electricity and heat mostly from pine in Latvia and Malta and poplar in Slovenia. In Latvia and Slovenia however, there is some green water demand by bio-ethanol production from sugarbeet and bio-diesel production from rapeseed, which is primarily rain fed.

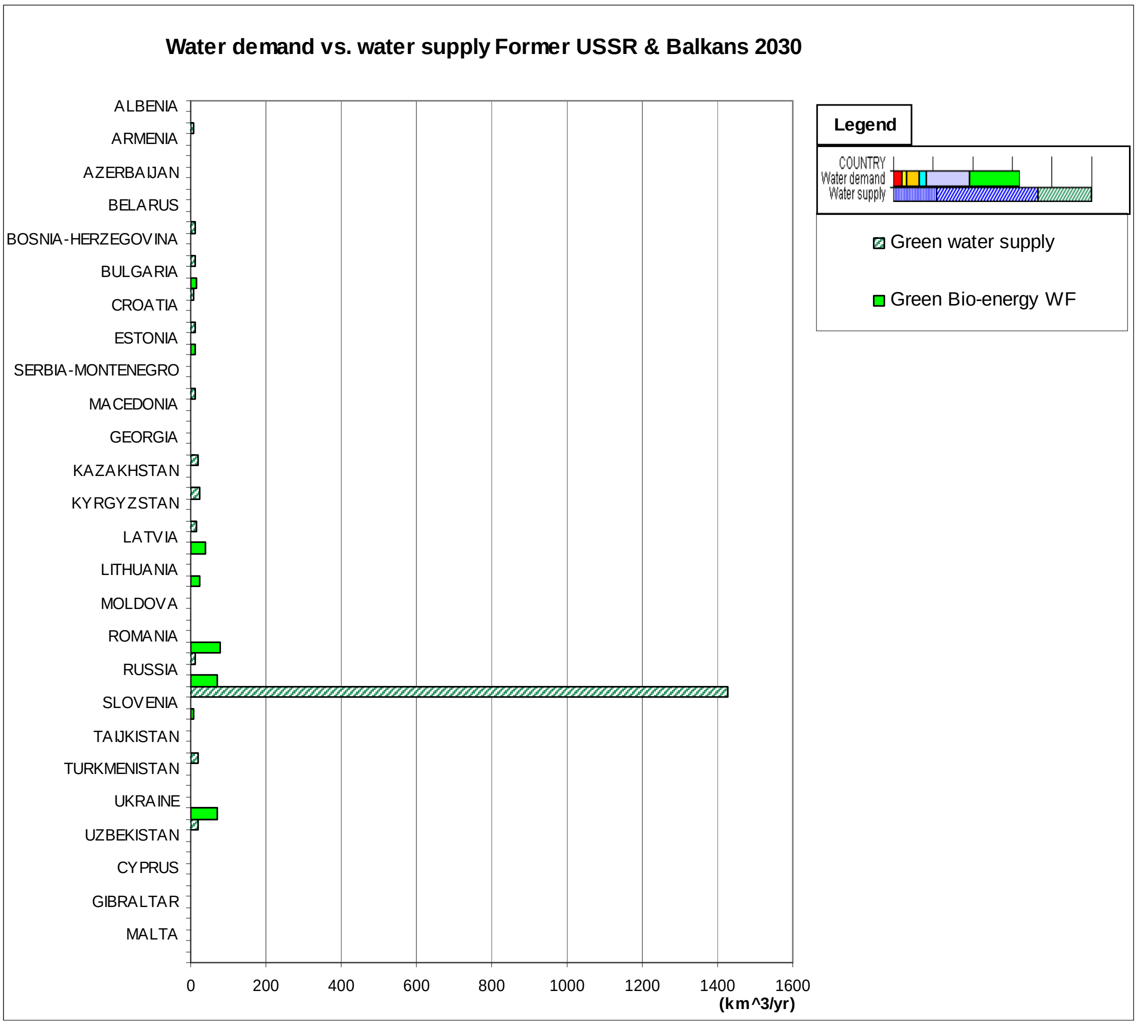


Figure 26: comparison of green bio-energy water footprints and total green water supply in Transition Economies

4.3.5 Developing Asia

It is expected that Developing Asia will face very large water problems in 2030. Afghanistan, Bangladesh, China, India, and Pakistan are the main contributors to those problems (see Figure 27). The enormous blue water demands in these countries are primarily caused by the agricultural sector. Compared to these withdrawals, the blue bio-energy water footprint is relatively small. Nonetheless, China and India in particular, will have a large blue bio-energy water footprint in comparison to other countries in the world.

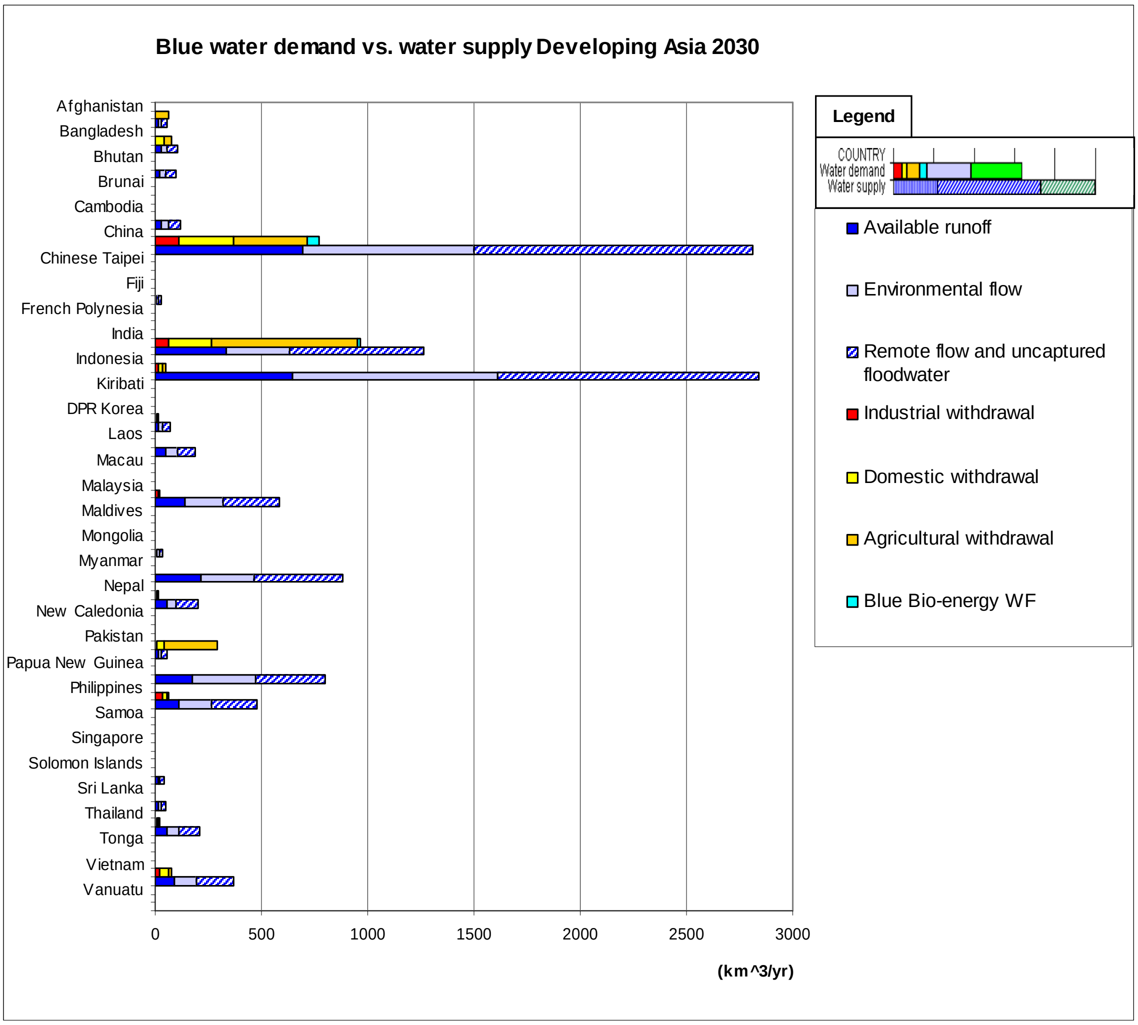


Figure 27: comparison of blue water demands and internal renewable blue water resources in Developing Asian countries

Regarding green water, the problems are expected to be even bigger. Countries in which the consumption of bio-energy is likely to cause green water stress are: China, India, Pakistan, the Philippines, Thailand and Vietnam (see Figure 28). The enormous amount of rain fed plantation wood that will be used to produce bio-electricity and heat in the future is the main contributor.

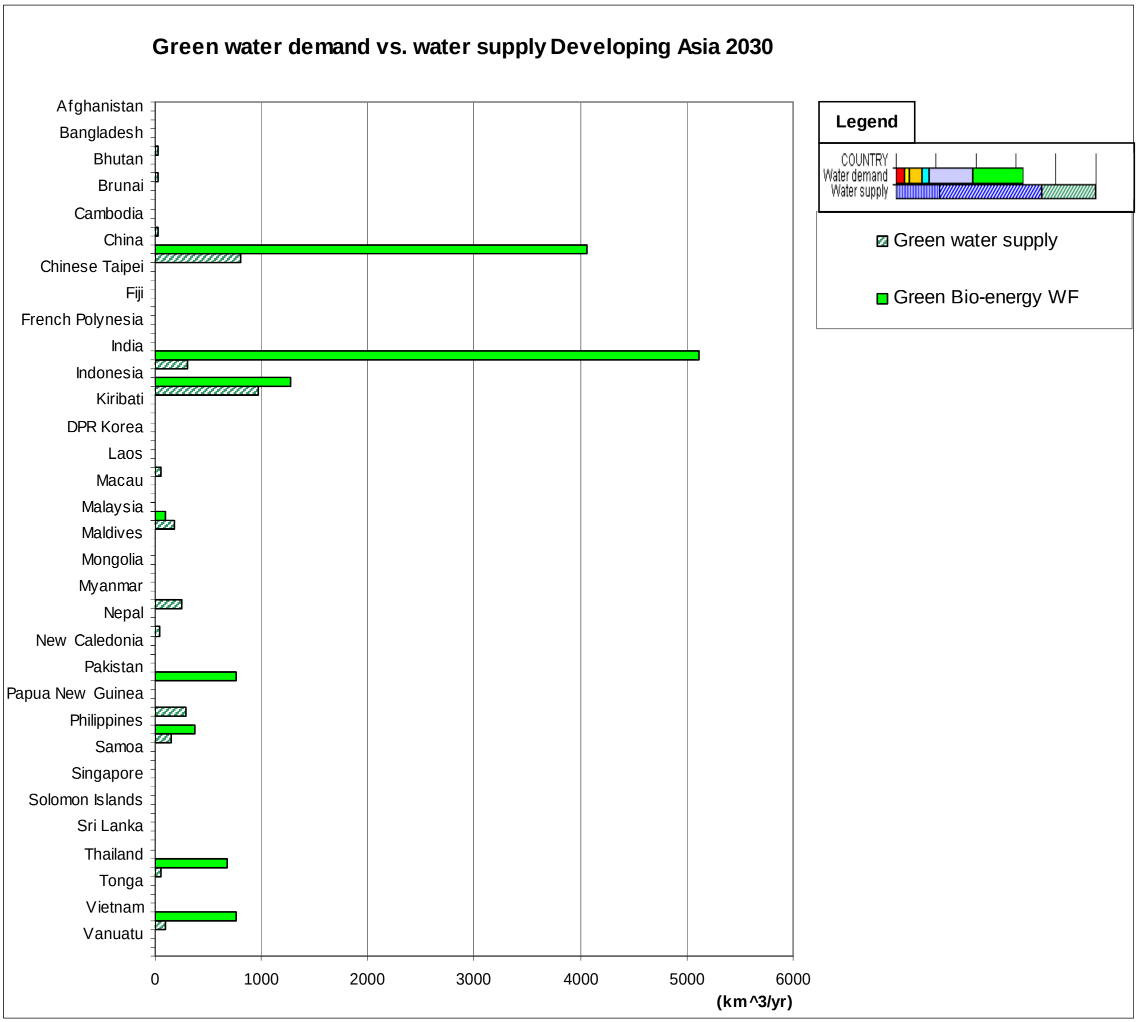


Figure 28: comparison of green bio-energy water footprints and total green water supply in Developing Asian countries

4.3.6 Middle East

According to scenario projections the Middle Eastern region will run into a serious water problem. Already in 2005 most countries in the region face water stress even without the consumption of bio-energy. Some countries hardly have any renewable fresh water resources to start off with, and in most cases the water that is available is used for other purposes. However, in 2030 Iran, Iraq, Jordan, Lebonon, Syria, the United Arab Emirates and Yemen are expected to use bio-electricity to some extent, leading to (increased) water stress (see Figure 29 and Figure 30). Only the United Arab Emirates have some projects lined up for the production of bio-diesel in the (near) future, but it is assumed that this will be done using oil palm, which is not irrigated.

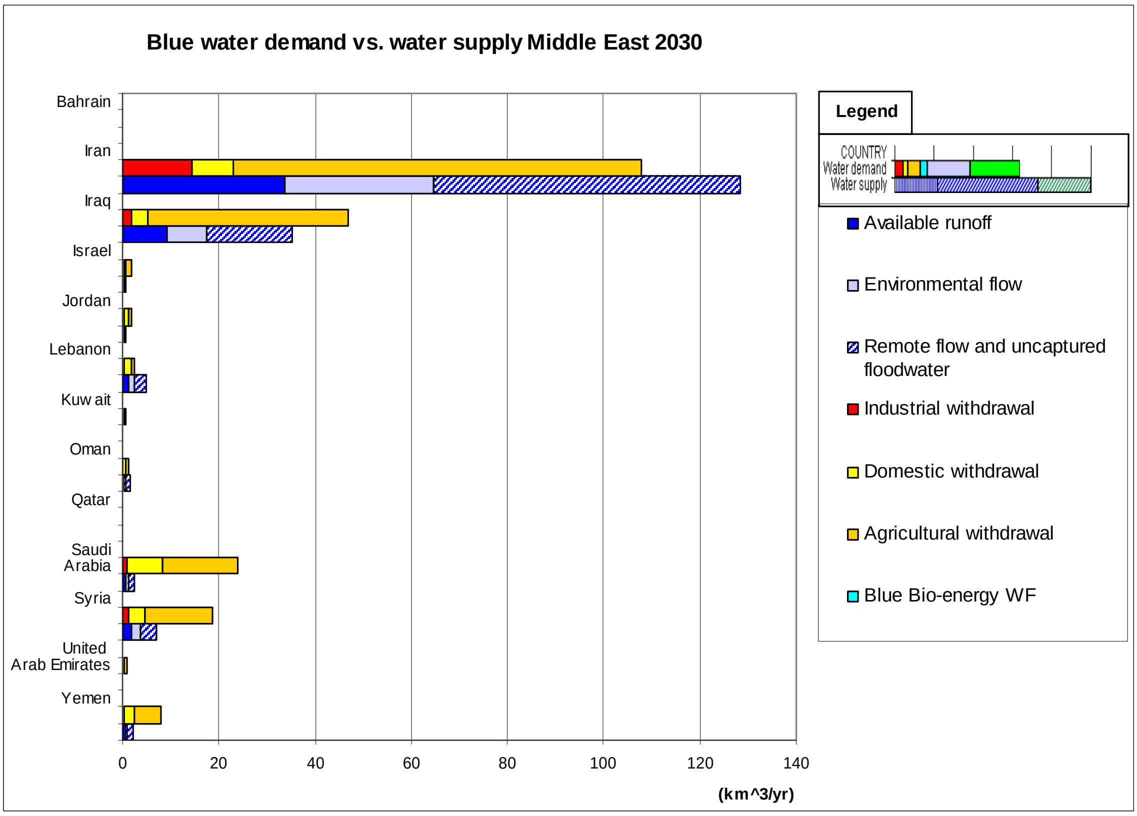


Figure 29: comparison of blue water demands and internal renewable blue water resources in Middle Eastern countries

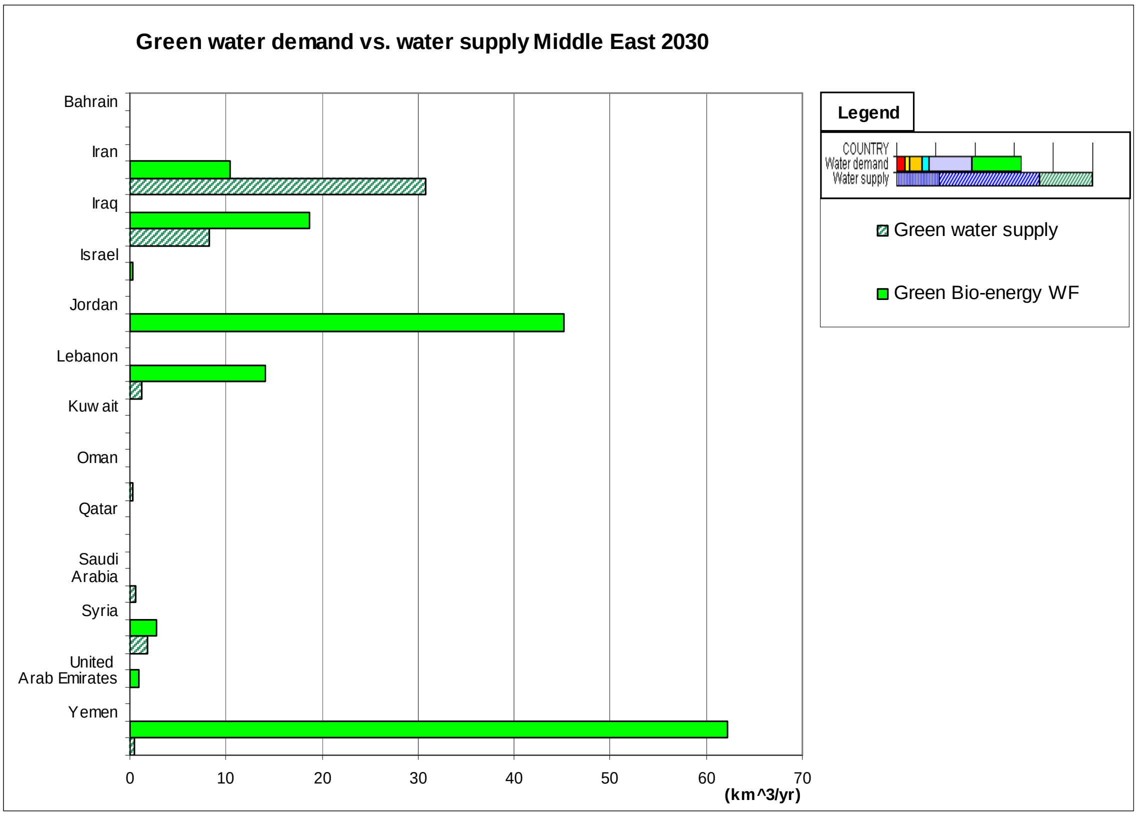


Figure 30: comparison of green bio-energy water footprints and total green water supply in Middle Eastern countries

4.3.7 Africa

Most African countries are not expected to face increased blue water stress due to bio-energy consumption, because it is not likely that they will produce large volumes of liquid bio-fuels in the future and use irrigated crops to do so. Only in South Africa a significant amount of bio-ethanol is expected to be produced, using a combination of partially irrigated sugar beet and sugar cane. Algeria, Egypt, Eritrea, Kenya, Libya, Mauritania, Morocco, Niger, Somalia, Sudan, and Tunisia are expected to face blue water stress, but this is not caused by extra water demands from bio-energy.

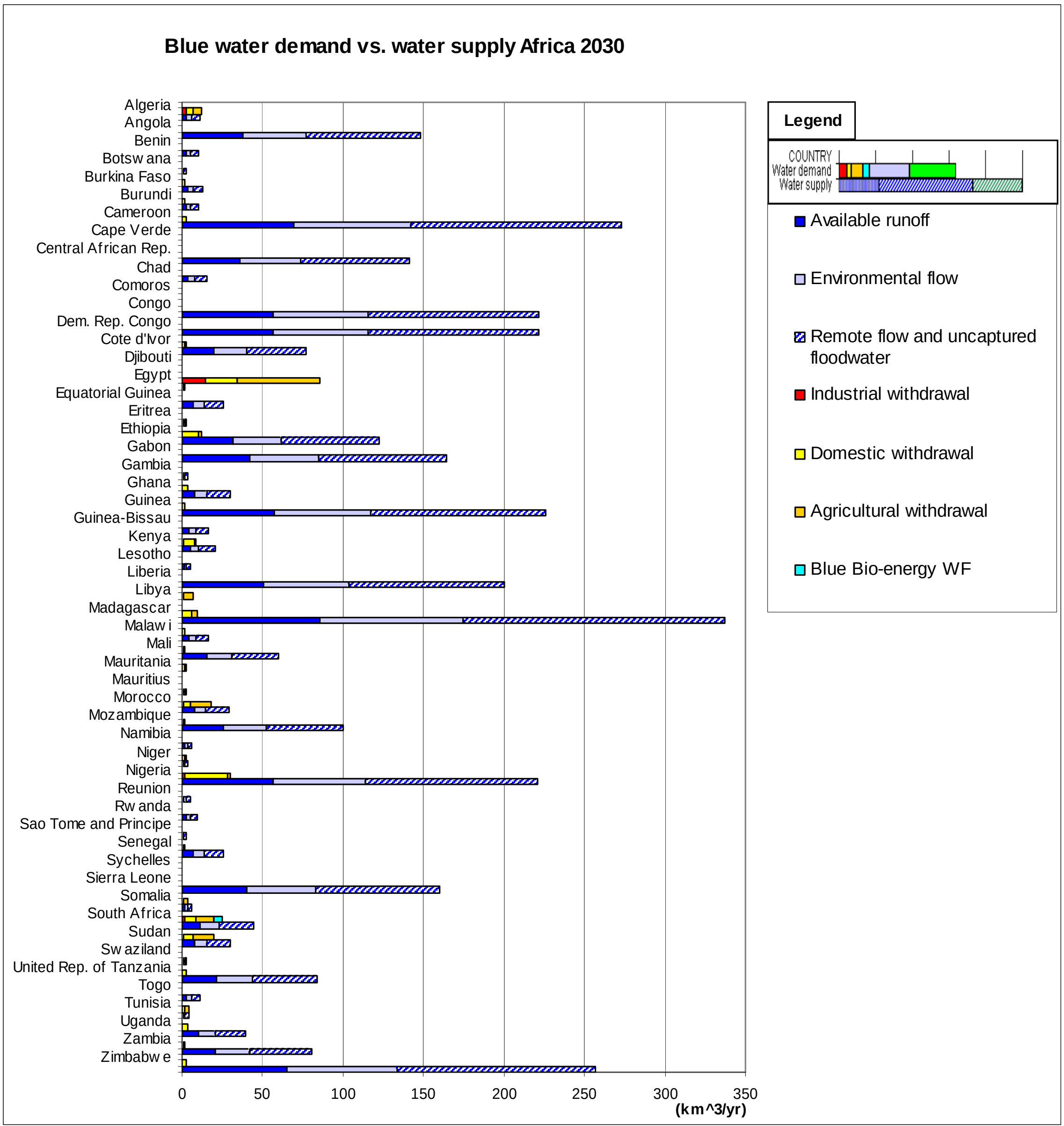


Figure 31: comparison of blue water demands and internal renewable blue water resources in African countries

The increased consumption of bio-electricity and heat from wood will lead to green water stress in Burkina Faso, Egypt, Ethiopia, and Nigeria (see Figure 32). Especially in the last two countries, the scenario projections for bio-electricity and heat will lead to green water demands exceeding total green water supply by nearly 2.5 and 1.5 times respectively.

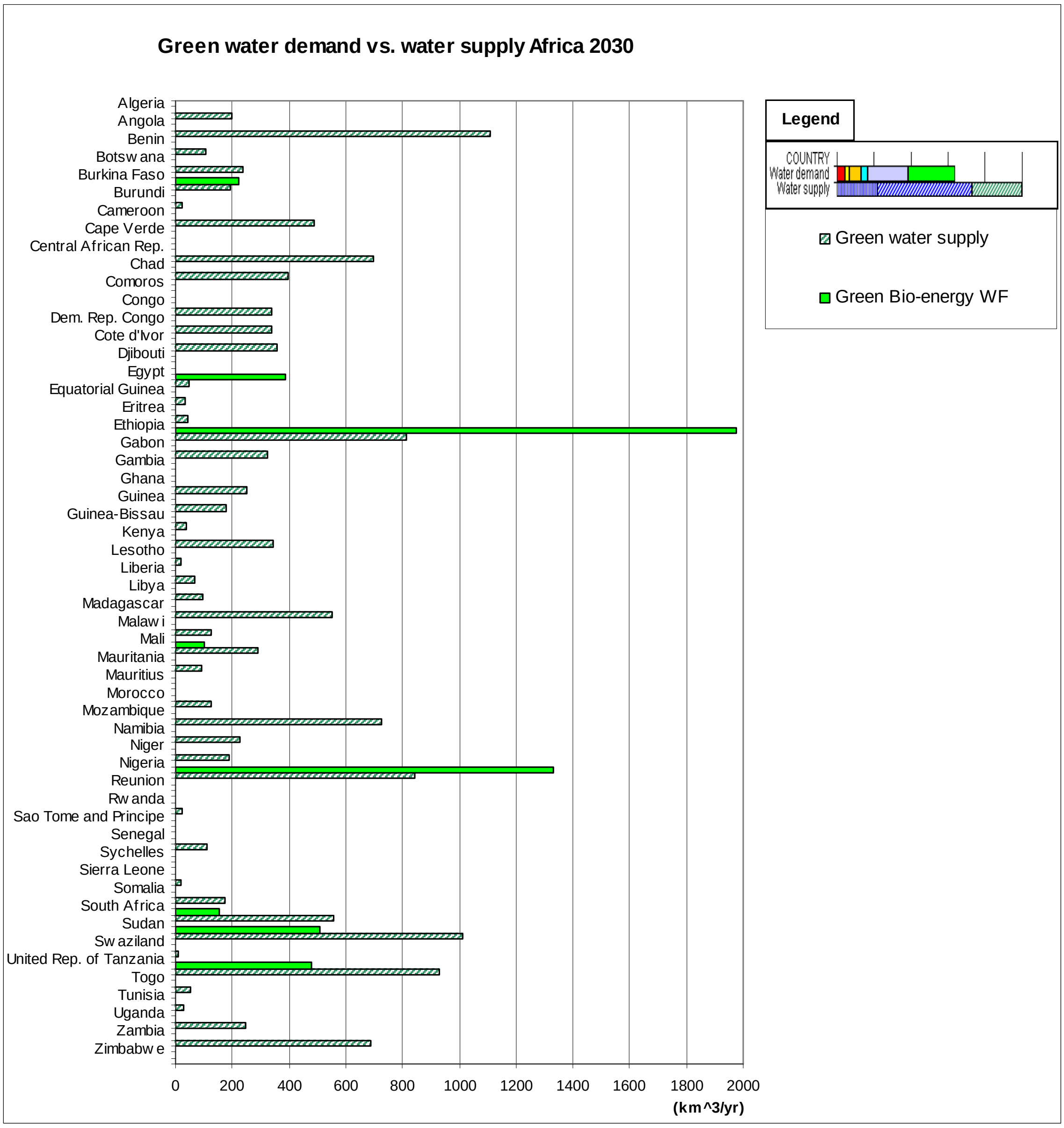


Figure 32: comparison of green bio-energy water footprints and total green water supply in African countries

4.3.8 Latin America

Latin America is not expected to suffer from any water stress in the future. It has about 50 percent of the total runoff available for bio-energy purposes in the world and contributes only 3 percent to the global bio-energy water footprint. Only the Bahamas, Cuba, and Trinidad and Tobago use more runoff than they have available, but this is not for bio-energy purposes. Brazil has a relatively large blue bio-energy water footprint in 2030, mainly because of the increase in production of bio-diesel using irrigated soybean, but it has access to plenty of blue water thus causing no water stress.

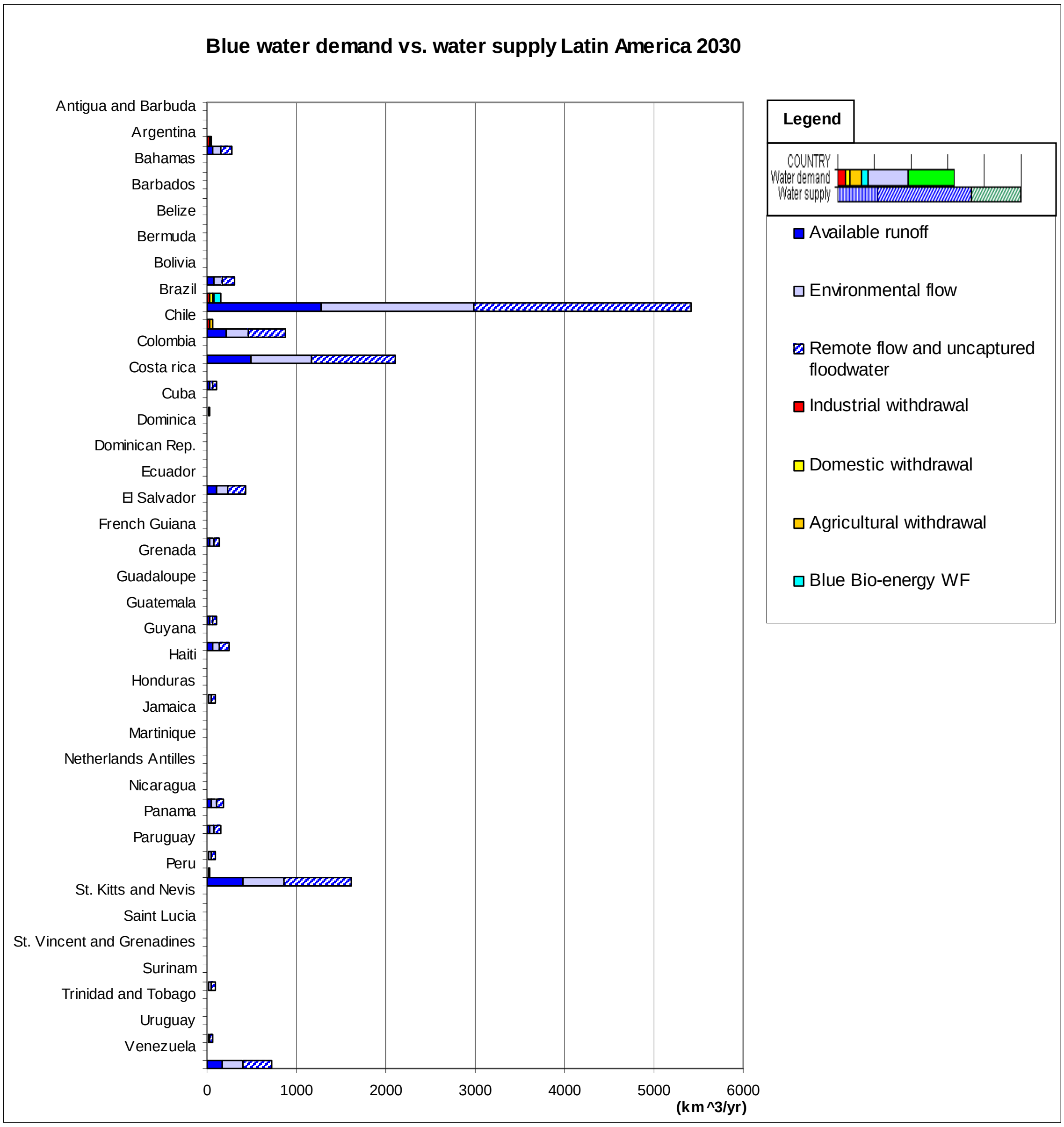


Figure 33: comparison of blue water demands and internal renewable blue water resources in Latin American countries

Figure 34 shows that none of the Latin American countries will face green water stress due to bio-energy production in the future. However, in Guatemala the use of wood for bio-electricity and heat nearly equals the total green water supply and this may lead to a problem if green environmental flows are considered.

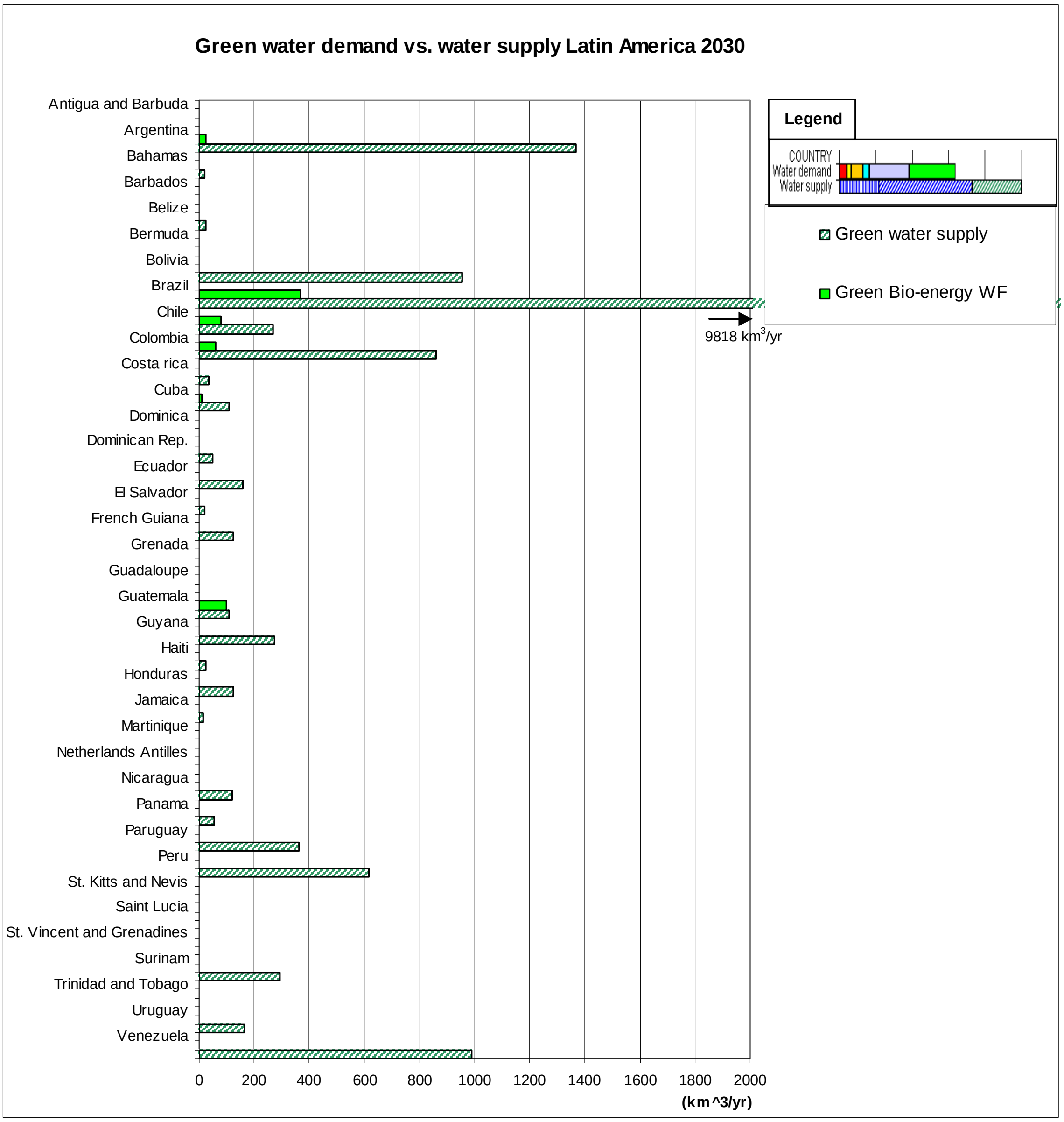


Figure 34: comparison of green bio-energy water footprints and green water availability in Latin American countries

In the above paragraphs the consequence of a transition to bio-energy on the water system has been illustrated on a national level. The competition for available runoff between blue water demands will lead to blue water stress in many countries, especially in Europe, Developing Asia and the Middle East. However, only in European countries bio-energy will be the main cause for this blue water stress; in most other countries over-consumption in other sectors proves to be the main reason. It is expected that the green bio-energy water footprint on the contrary, will cause green water stress in many more countries all over the world. The primary reason is the enormous increase in consumption of bio-electricity from rain fed plantation wood. This is expected to take up much of the green water supply in many countries. Although these results are meaningful, they need to be interpreted with some caution. In the next chapter some issues are discussed that will help to understand the full significance.

5 Discussion

5.1 Uncertainty in the results

It has to be realised that the results above are based on processed scenario data. The base scenario used was the Alternative Policy Scenario from the International Energy Agency (2006), which was supplemented by similar region-specific scenarios and extrapolated historic data. The fact remains, that these results are merely based on a particular view of the future. Although this is a reasonable, established projection, it does not guarantee that the future will actually unfold this way. These results should merely be used to get an idea of what the consequences might be if we indeed adhere to the storyline of the scenarios used.

The same goes for the data used for the water balance. Future water withdrawals are based on one particular combination of scenario and climate model, and although these are obtained from reliable, renowned sources, they remain just one interpretation of the future. Furthermore, no account is taken of possible changes in precipitation due to climate change. A hydrological scenario could have been used for this, but instead long-term averages from the past were used. It has to be recognized that this choice has an effect on the determination of the fresh water supply in a country.

Besides this, spatial and temporal variability in water supply are not reflected in the water availability data. Both temporal and spatial average supply and demand data is used in this research. Extreme rainfall events, like the monsoon in some tropic countries, are not taken into account, neither are microclimates in some countries. It is possible that the timing of water supply may not exactly coincide with water demand, which means that the full potential available fresh water can not be used. It is also noted once more that global average percentages for remote flow and uncaptured floodwater are used for all countries. It is realised that this may lead to an overestimation of available runoff for countries that do not have the technical or economical capability to capture such a share using the necessary structures (e.g. dams, basins, canals).

The conclusions about water stress are also particularly sensitive to the amount of flow required for the environment. Although, the spatial scale of the acquired data was quite small, some averages were used to realise world coverage in this study. The averages used were also not weighted according to the part of each country situated in a particular basin. This may have some effect on the precision of the percentages used for each country, but since these were just used to create a partition in the runoff supply shown in the water competition figures, the influence can be debated about. A further limitation in the results is the absence of a partitioning of green water supply. No data was found on green environmental flow requirements and determination of future green water demands by other sectors involved too much complexity. It should nonetheless be realized that part of the green water is needed to keep the ecosystem in good shape, which means that green water stress occurs even before it exceeds the total green water supply.

Although perhaps obvious, another debatable point is the priority each ‘water user’ has, or should get, compared to the other. As the results are presented now, the water demands by bio-energy come last, i.e. after domestic, industrial and agricultural needs. However, if a country were to give more priority to bio-energy and divert some water from say agriculture to satisfy its bio-energy water demands, then it could well be that the total water demand changes, leading to a different water stress level. It also has to be realized that no attention has been paid to competition for water between food and energy crops. This study considers first generation feedstocks viable for bio-energy production, but these are mainly crops that are also used for food and feed. This research does not deal with the balance that has to be found between the two.

Moreover, it is assumed that all water currently used for agriculture is solely applied for the production of crops for food, and is thus not seen as available for production of biomass for energy. This assumption may seem rough, but, based on FAO food balance sheets, the quantity of crop used for other purposes besides food, feed and seed (e.g. bio-energy) is relatively small. In the United States of America for example, the amount of corn used for other purposes, mainly ethanol, constitutes only 3 percent of the total domestic corn production (FAO, 2009b). Although this is only a small part, it leads to a slight overestimation of the water problem in countries that engage in both agriculture and bio-energy production.

Another minor overestimation of the water problems caused by bio-energy consumption comes from the fact that organic waste streams are not considered among the feedstocks for bio-energy in this study. Nowadays most bio-energy produced comes from these waste streams, but to satisfy the large projected future demands, organic waste is not sufficient and plantation wood will be used. For simplification, this research assumes that bio-electricity and heat will solely come from plantation round wood, and none from waste.

The overestimations discussed above may be (partially) counteracted by an underestimation caused by the fact that the grey water footprint is not accounted for in this study. The amount of water that is needed to assimilate pollution to an accepted standard is not included in the virtual water content of the bio-energy crops in this research, because the available data was not satisfactory for global coverage. In the study of Van Meekeren (2008), the grey virtual water content of energy crops was calculated on a smaller scale and the average percentage found for bio-ethanol, bio-diesel and bio-electricity feedstocks was 14, 11 and 7 percent respectively. Thus, on average the water footprint of bio-energy is about 10 percent higher than presented in this study.

Last of all, it has to be noted that the water footprints calculated in this research are based on a virtual water content database that has its weaknesses. To begin with, the study integrates data from several sources, each adding a degree of uncertainty. Virtual water content numbers from Van Meekeren (2008), for example, are often based on crop water use in the climatic conditions of the country's capital. This study uses these numbers to calculate the water footprint on a national scale, thus (incorrectly) implying that the whole country has a uniform climate regime, which may in fact not represent realistic growth conditions. Clearly, this strongly influences crop water use. Secondly, the database provides regional averages for countries with unknown virtual water content data. This also leads to some inaccuracy.

Moreover, the water footprints of future bio-energy consumption might actually turn out differently, because changes in crop choice, production techniques, and crop technology are not taken into account. For example, if second generation conversion processes start an early up rise, then more of the crop can be used for the production of bio-fuels, thus leading to a lower virtual water content (in m^3/GJ). The same applies if crop research enables the same yields with less irrigation. Switching to more water efficient crops will also have an effect of the water footprint, but it can be argued that this is unlikely to occur because countries are inherently reluctant to changing their traditional ways.

5.2 Suggestions for further research

This study is primarily intended as a first exploration of the effect a transition to bio-energy has on the water footprint of energy in a country. It provides insight in what could happen to the water balance in a country if it were to follow a particular energy scenario. However, considering the time span of this research, various assumptions have been made about some parameters in the calculations. It is suggested here that the effect of a change in these parameters on the results is done. For example, only first generation conversion processes are considered in the results. However, it would be interesting to see what effect the (early) commercial breakthrough of second generation would have on the water footprint of bio-energy. By merely using the sugar and starch parts of the crop in first generation conversion to ethanol, only a maximum efficiency of about 30 percent can be obtained. If, however, the whole crop could be used to produce bio-fuel, efficiency would probably approach 59 percent, the same order of magnitude as the production of electricity from biomass (Gerbens-Leenes et al., 2008). A comparison of energy content of ethanol crops in first and second generation conversion is shown in Table 5. It can be seen that in most cases more than twice as much energy can be obtained from the same amount of crop, which improves the water efficiency of bio-energy enormously.

Table 5: comparison of ethanol energy content of crops using first and second generation conversion technology.

	MJ ethanol / kg fresh crop	
Crop	***First generation***	***Second generation***
Sugar beet	2.6	3.4
Sugar cane	2.3	5.0
Maize (corn)	10.0	22.0
Wheat	10.2	23.2
Sorghum	10.0	23.2

The impact of switching to different crops also deserves some attention. Not only to more water efficient (food) crops, currently considered in this study, but also to grasses or woody biomass. It is suggested that the virtual water content of energy from such biomass is calculated using the improved conversion efficiency mentioned above.

Regarding technological change, it was pointed out that the agricultural technology is considered stable over time for the computations in this research. It is assumed that current sowing, irrigation and harvesting practices are still applicable in 2030, whereas in reality developments in the agricultural business are not on halt. For example, increased crop yields can be realized by applying more nutrients and irrigation water. OECD countries may already be achieving optimal yields by these methods, but developing nations may follow if returns on energy crops are high enough. The effect of such developments on the water footprint should therefore also get some attention. In the study of Van Meekeren (2008), crop water use in a high input (optimal yield) agricultural system is already investigated, and these results could be used in future research.

Another interesting development that could be investigated is trade in biomass or bio-energy. For this research it was assumed that all bio-energy consumed in a nation is produced domestically. However, there are indications of increasing trade in bio-energy and feedstock. Japan, for example, has limited possibilities for growing its own biomass for energy and has therefore recently signed an import pact with Brazil (IEA, 2004). This means that (extra) water is used in Brazil to produce bio-fuels for Japan, possibly leading to more stress on the Brazilian water system. So trade could have a significant effect on the energy water footprint of nations, and it is suggested that this is taken into account in further research.

Last but not least, the geographic scale could be made smaller. It would be interesting to zoom in even further and compare the locations of energy crop growth to the places where water is found, using GIS software for example. This would allow more precise statements about water stress on local water systems and allow better intervention.

6 Conclusion

This research uses water footprint analysis to investigate the change in water demand related to a transition to bio-energy. Information about these transitions is based on specific energy scenarios. A clear distinction is made between three different bio-energy carriers. The analysis includes the consumption of first generation bio-ethanol, bio-diesel and bio-electricity and heat in nearly all countries of the world. Each of these bio-energy types uses different biomass feedstocks (i.e. energy crops) and this research examines the probable feedstock choice per type in each country. Using blue and green virtual water content data of each crop per country, a translation is then made from bio-energy consumption to water consumption.

It is found that existing energy scenarios all project an absolute increase in bio-energy consumption in the future. In the global bio-energy mix, it is expected that about 91 percent is bio-electricity and heat, 6 percent is bio-ethanol and 3 percent is bio-diesel. Overall, this means that more biomass will be grown for energy purposes and, since biomass needs water to grow, the transition to bio-energy will lead to a larger water footprint of the global energy sector.

Together with the blue and green water demands from other sectors, the bio-energy water footprint is compared to the blue and green water availability. For each country, a balance is made of fresh water resources and uses, enabling the determination of the water volume available for bio-energy. The comparison allows a measure of water stress to be established corresponding to the (expected) bio-energy consumption.

The competition for available runoff between blue water users will likely cause blue water stress in many countries, especially in Europe, Developing Asia and the Middle East. In about half of the countries that are likely to suffer blue water stress in 2030, bio-energy consumption contributes to, or is fully responsible for, the water stress. It is expected that the green bio-energy water footprint, will cause green water stress in even more countries all over the world. The primary reason is the enormous projected increase in consumption of bio-electricity from rain fed plantation wood. This is expected to take up much of the productive green water supply in many countries. On a global level, the green bio-energy water footprint will comprise almost 40 percent of the total green water supply, whilst the blue bio-energy water footprint is expected to be about 4 percent of total available runoff for humans in 2030.

Hence, energy scenarios should not only be analyzed in the context of land availability, food production, biodiversity and the carbon dioxide balance, they also need to be looked at in a water perspective. This study shows the repercussion of extensive bio-energy consumption on the fresh water resources. It advocates that countries should consider the water factor thoroughly when investigating the extent to which bio-energy can satisfy their future energy demand.

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Appendices

A. Glossary

Ø *Energy scenario*

Scenarios are images of alternative futures, they are neither predictions nor forecasts. A scenario is an outline or model of an expected or supposed sequence of events (transition), it is a plausible description of how the future may develop, based on a coherent and internally consistent set of assumptions about key relationships and driving forces (e.g. GDP, rate of technology changes, prices) (IPCC, 1996). Energy scenarios provide a framework for exploring future energy perspectives.

Ø *Energy carrier*

An energy carrier is a substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes (ISO 13600). Oil, coal, gas, uranium, but also dammed or flowing water, sunlight and wind are energy carriers. They contain energy in different forms, which can be converted into a usable energy form if required (ENS, 2008). Primary energy carriers are energy carriers directly derived from a natural source without any conversion (e.g. biomass), while secondary energy carriers (e.g. bio-fuels, bio-electricity) are the product of a conversion process (Gerbens-Leenes et al., 2008).

Ø *Bio-energy*

Bio-energy is the collective name for energy from energy carriers that are directly or indirectly obtained from organic material (i.e. biomass). Biomass can be converted to energy in several ways: thermo-chemical, biological, physical or chemical.

Ø *Energy crop*

An energy crop is a crop that is specially grown for energy purposes. The most important product worldwide is wood (for heat and electricity), but crops are also grown for liquid bio-fuels (ethanol and bio-diesel). Examples of the latter are: sugar cane, sugar beet, corn (maize), potato, wheat, rapeseed and soybean (FAO, 2008e).

Ø *Bio-diesel*

Bio-diesel is a liquid bio-fuel made from the transesterification (a chemical process which removes glycerin from oil) of vegetable oils.

Ø *Bio-ethanol*

Bio-ethanol is a liquid bio-fuel obtained by fermentation of the sugar and starch part of crops (first generation), or by enzyme saccarification (and fermentation) of the cellulosic crop parts (second generation). The latter process is not yet commercially viable today.

Ø *Bio-electricity and heat*

This is electricity and heat produced by combustion of solid biomass and the renewable part of waste. In this study the main feedstock considered is round wood (from eucalyptus, pine and poplar) from productive plantations.

Ø *Water Footprint (WF)*

The Water Footprint is total volume (km^3) of fresh water that is consumed to produce the consumed goods and services.

Ø *Virtual water content*

The volume of fresh water used to produce a product, measured at the place where the product was actually produced. It refers to the sum of the water used in the various steps of the production chain, and consists of blue (surface and ground water), green (rainwater stored as soil moisture) and grey water (water required to assimilate pollution).

Ø *Internal Renewable Water resources (IRWR)*

Part of the fresh water supply that comes from indigenous precipitation. It is calculated by summing the surface runoff and groundwater recharge, minus the overlap, which both take place within the borders of the country of region (WRI, 2007) (FAO, 2008).

Ø *Environmental flow requirement (EFR)*

Part of the runoff from land to oceans that is to be reserved for maintaining ecosystems and biodiversity.

Ø *Water stress*

Water stress occurs when the demand for fresh water exceeds the available amount during a certain period or when poor quality restricts its use (UNEP, 2008). A distinction is made between blue and green water stress, depending on the type of water demand and supply involved.

B. Regional definitions and country groupings

OECD	Transition Economies	Developing Countries		
North America	**Former USSR and Balkans**	**Developing Asia**	**Africa**	**Latin America**
United States of America	Albenia	Afghanistan	Algeria	Antigua and Barbuda
Canada	Armenia	Bangladesh	Angola	Argentina
Mexico	Azerbaijan	Bhutan	Benin	Bahamas
Europe	Belarus	Brunai	Botswana	Barbados
Austria	Bosnia-Herzegovina	Cambodia	Burkina Faso	Belize
Belgium	Bulgaria	China	Burundi	Bermuda
Czech Republic	Croatia	Chinese	Cameroon	Bolivia
Denmark	Estonia	Taipei	Cape Verde	Brazil
Finland	Serbia-Montenegro	Fiji	Central African Republic	Chile
France	former Yugoslav Republic of Macedonia	French Polynesia	Chad	Colombia
Germany	Georgia	India	Comoros	Costa rica
Greece	Kazakhstan	Indonesia	Congo	Cuba
Hungary	Kyrgyzstan	Kiribati	Demographic Republic of Congo	Dominica
Iceland	Latvia	Democratic People's Republic of Korea	Cote d'Ivor	Dominican Republic
Ireland	Lithuania	Laos	Djibouti	Ecuador
Italy	Moldova	Macau	Egypt	El Salvador
Luxembourg	Romania	Malaysia	Equatorial Guinea	French Guiana
Netherlands	Russia	Maldives	Eritrea	Grenada
Norway	Slovenia	Mongolia	Ethiopia	Guadaloupe
Poland	Taijkistan	Myanmar	Gabon	Guatemala
Portugal	Turkmenistan	Nepal	Gambia	Guyana
Slowak Republic	Ukraine	New Caledonia	Ghana	Haiti
Spain	Uzbekistan	Pakistan	Guinea	Honduras
Switzerland	and also for statistical reasons:	Papua New Guinea	Guinea-Bissau	Jamaica
Sweden	Cyprus	Philippines	Kenya	Martinique
Turkey	Gibraltar	Samoa	Lesotho	Netherlands Antilles
United Kingdom	Malta	Singapore	Liberia	Nicaragua
Pacific		Solomon Islands	Libya	Panama
Japan		Sri Lanka	Madagascar	Paruguay
Korea, Republic		Thailand	Malawi	Peru
New Zealand		Tonga	Mali	St. Kitts and Nevis
Australia		Vietnam	Mauritania	Saint Lucia
		Vanuatu	Mauritius	St. Vincent and Grenadines
		Middle east	Morocco	Surinam
		Bahrain	Mozambique	Trinidad and Tobago
		Iran	Namibia	Uruguay
		Iraq	Niger	Venezuela
		Israel	Nigeria	
		Jordan	Reunion	
		Lebanon	Rwanda	
		Kuwait	Sao Tome and Principe	
		Oman	Senegal	
		Qatar	Sychelles	
		Saudi Arabia	Sierra Leone	
		Syria	Somalia	
		United Arab Emirates	South Africa	
		Yemen	Sudan	
			Swaziland	
			United Republic of Tanzania	
			Togo	
			Tunisia	
			Uganda	
			Zambia	
			Zimbabwe	

C. Global energy scenarios

Future energy sector according to IEA, 2006

	Contribution to World Primary Energy Demand					
Source	Today (2008) [EJ] *	Today (2008) [%]	Reference Scenario (2030) [EJ]	Reference Scenario (2030) [%]	Alternative Policy Scenario (2030) [EJ]	Alternative Policy Scenario (2030) [%]
Fossil fuels	412	*80,8%*	581	*81,2%*	496	*76,8%*
Nuclear energy	31	*6,2%*	36	*5,0%*	45	*6,9%*
Biomass (incl. waste)	52	*10,2%*	69	*9,6%*	71	*11,1%*
Hydropower	11	*2,2%*	17	*2,4%*	18	*2,7%*
Other renewables (solar, wind, geothermal, wave, tidal)	3	*0,6%*	12	*1,7%*	16	*2,4%*
Total	509	*100,0%*	716	*100,0%*	645	*100,0%*

* based on extrapolation from 2004 demands, using 2004-2015 growth rates stated for the reference scenario

Future energy sector according to Shell, 2008

	Contribution to World Primary Energy Demand					
Source	Today (2008) [EJ] *	Today (2008) [%]	Scramble Scenario (2030) [EJ]	Scramble Scenario (2030) [%]	Blueprints Scenario (2030) [EJ]	Blueprints Scenario (2030) [%]
Fossil fuels	408	*80,9%*	523	*71,4%*	521	*75,2%*
Nuclear energy	30	*6,0%*	36	*4,9%*	34	*4,9%*
Biomass (incl. waste)	47	*9,3%*	92	*12,6%*	59	*8,5%*
Hydropower **	10	*2,0%*	13	*1,8%*	13	*1,9%*
Other renewables (solar, wind, geothermal, wave, tidal)	9	*1,8%*	69	*9,4%*	66	*9,5%*
Total	505	*100,0%*	733	*100,0%*	693	*100,0%*

* based on interpolation between demands in 2000 and in 2010, using a calculated compound annual growth rate

** based on the fraction in the electricity consumption mix (blueprints scenario). Subtracted from 'other renewables'

Future energy sector according to WEC, 2007

	Contribution to World Primary Energy Production													
Source	Today (2008) [EJ] *	Today (2008) [%]	A1 Scenario (2030) [EJ]	A1 Scenario (2030) [%]	A2 Scenario (2030) [EJ]	A2 Scenario (2030) [%]	A3 Scenario (2030) [EJ]	A3 Scenario (2030) [%]	B Scenario (2030) [EJ]	B Scenario (2030) [%]	C1 Scenario (2030) [EJ]	C1 Scenario (2030) [%]	C2 Scenario (2030) [EJ]	C2 Scenario (2030) [%]
Fossil fuels	373	*77,5%*	588	*75,4%*	612	*78,4%*	523	*67,0%*	484	*73,6%*	365	*69,8%*	356	*68,1%*
Nuclear energy	27	*5,7%*	61	*7,8%*	29	*3,7%*	70,47	*9,0%*	58	*8,8%*	31,05	*5,9%*	49,2	*9,4%*
Biomass (incl. waste)	52	*10,8%*	57	*7,3%*	77	*9,9%*	102	*13,1%*	59	*8,9%*	65	*12,5%*	62	*11,9%*
Hydropower	24	*5,0%*	36	*4,6%*	34	*4,3%*	40	*5,1%*	32	*4,8%*	35,43	*6,8%*	33,64	*6,4%*
Other renewables (solar, wind, geothermal, wave, tidal)	5	*1,0%*	38	*4,9%*	29	*3,7%*	45	*5,7%*	25	*3,8%*	26	*5,0%*	22	*4,2%*
Total	481	*100,0%*	780	*100,0%*	780	*100,0%*	780	*100,0%*	659	*100,0%*	523	*100,0%*	523	*100,0%*

* based on interpolation between demands in 2000 and in 2010 from scenario B (reference), using a calculated compound annual growth rate

Future energy sector according to IPCC, 2008c

	Contribution to World Primary Energy Demand									
Source	Today (2008) [EJ] *	Today (2008) [%]	A1 Marker Scenario (2030) [EJ]	A1 Marker Scenario (2030) [%]	A2 Marker Scenario (2030) [EJ]	A2 Marker Scenario (2030) [%]	B1 Marker Scenario (2030) [EJ]	B1 Marker Scenario (2030) [%]	B2 Marker Scenario (2030) [EJ]	B2 Marker Scenario (2030) [%]
Fossil fuels	408	*85,7%*	716	*80,1%*	630	*87,4%*	546	*80,2%*	530	*79,3%*
Nuclear energy	14	*3,0%*	53	*5,9%*	32	*4,4%*	20	*2,9%*	23	*3,4%*
Biomass (incl. waste)	24	*5,1%*	85	*9,5%*	32	*4,4%*	54	*7,9%*	61	*9,1%*
Hydropower	24	*5,0%*	29	*3,3%*	26	*3,6%*	34	*5,1%*	23	*3,5%*
Other renewables (solar, wind, geothermal, wave, tidal) **	6	*1,2%*	11	*1,2%*	1	*0,2%*	27	*3,9%*	31	*4,6%*
Total	476	*100,0%*	894	*100,0%*	721	*100,0%*	681	*100,0%*	668	*100,0%*

* based on interpolation between the average demands in 2000 and in 2010 in all marker scenarios, using a calculated compound annual growth rate

** hydropower (electricity) share subtracted

Notes: - For the share of hydropower today, the 2005 value from IPCC AR4 wg chapter 4 (p.264) was used as closest estimate.

- The B1 nuclear energy value was obtained from B1 Message (Globally Harmonized Scenario), as it was not included in the marker.

Future energy sector according to Greenpeace, 2008

Source	Contribution to primary energy demand Today (2008) [EJ] *	Today (2008) [%]	Reference scenario (2030) [EJ]	Reference scenario (2030) [%]	[R]evolution scenario (2030) [EJ]	[R]evolution scenario (2030) [%]
Fossil fuels	413	*81,2%*	591	*82,0%*	355	*67,6%*
Nuclear energy	31	*6,0%*	35	*4,8%*	7	*1,4%*
Biomass (incl. waste)	51	*9,9%*	66	*9,1%*	83	*15,8%*
Hydropower	11	*2,3%*	17	*2,4%*	16	*3,0%*
Other renewables (solar, wind, geothermal, wave, tidal)	3	*0,6%*	12	*1,7%*	64	*12,2%*
Total	508	*100,0%*	721	*100,0%*	526	*100,0%*

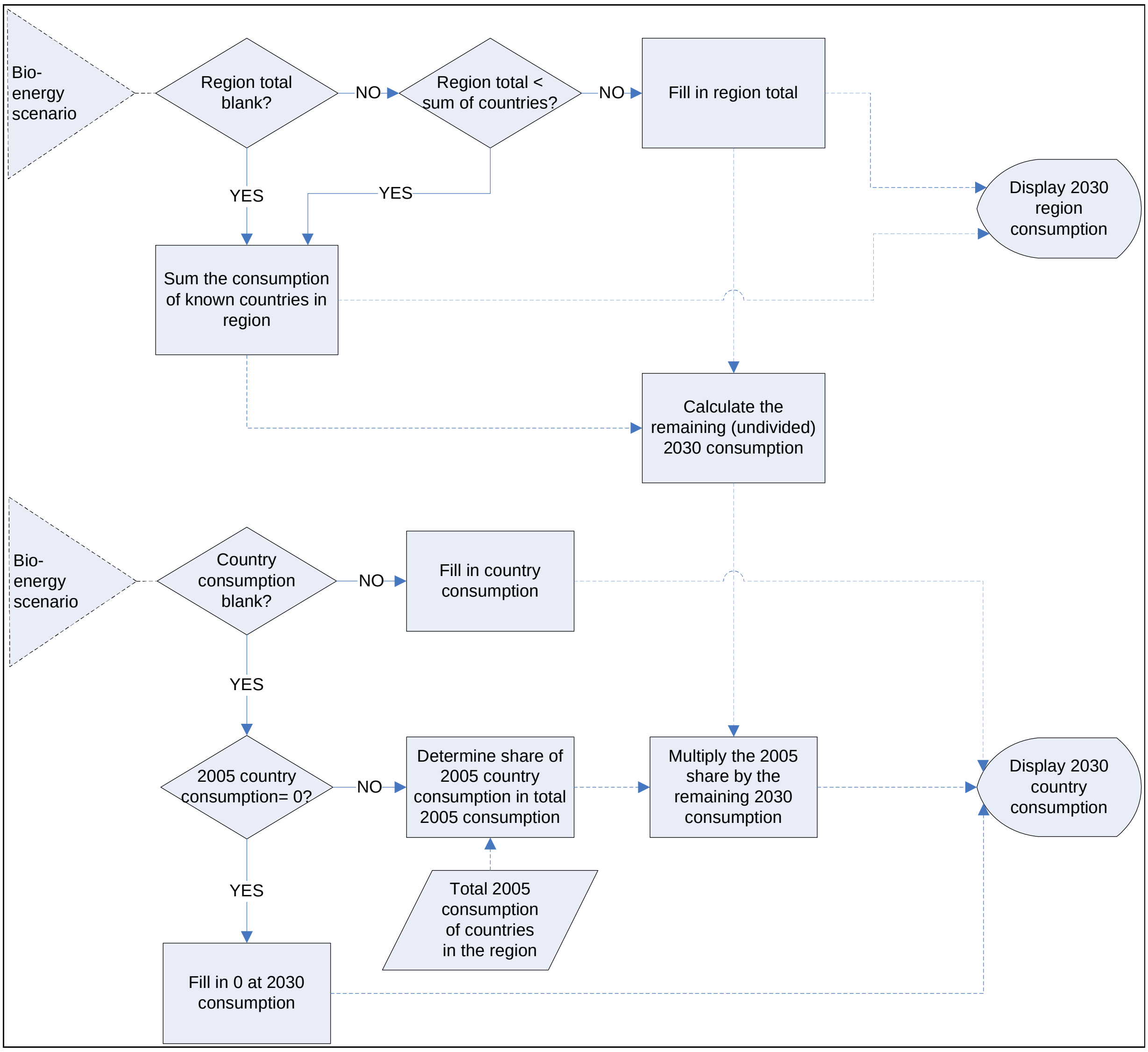
* based on interpolation between demands in 2005 and 2010 (reference scenario), using a calculated compound annual growth rate

Future renewable energy sector according to EREC, 2007

Source	Contribution to primary energy demand Today (2008) [EJ] *	Today (2008) [%]	Advanced International Policy scenario (2030) [EJ]	Advanced International Policy scenario (2030) [%]	Dynamic Current Policies scenario (2030) [EJ]	Dynamic Current Policies scenario (2030) [%]
Biomass (incl. waste)	51,94	*11,5%*	104,0	*20,1%*	93,0	*14,3%*
Hydropower	10,00	*2,2%*	14,3	*2,8%*	12,4	*1,9%*
Other renewables (solar, wind, geothermal, wave, tidal, SHP)	4,69	*1,0%*	61,3	*11,9%*	37,6	*5,8%*
Total RES	66,63	*14,8%*	179,6	*34,7%*	143,0	*22,0%*
World primary energy consumption	451,15	*100,0%*	517,2	*100,0%*	650,9	*100,0%*

* based on extrapolation between years 2001 and 2010 in the DCP scenario using given growth rates

D. Schematization of scenario data processing



E. Overview of bio-energy consumption

Overview of bioenergy consumption	Transport				Electricity and heat (for all sectors)			
	Bio-ethanol		**Bio-diesel**		**Bio-electricity & heat**		**Total bio-energy**	
	consumption 2005 (PJ/yr)	consumption 2030 (PJ/yr)	consumption 2005 (PJ/yr)	consumption 2030 (PJ/yr)	consumption 2005 (PJ/yr)	consumption 2030 (PJ/yr)	2005	2030
OECD								
North America	**360.4**	**1644**	**13.6**	**269**	**890**	**6293**	**1264**	**8206**
USA	352.6	1527	13.6	269	468	5070	834	6866
Canada	7.8	117	0	0	27	78	35	195
Mexico	0	0	0	0	395	1144	395	1144
Europe	**28.0**	**1025**	**119.0**	**624**	**809**	**6841**	**956**	**8490**
Austria	0	17	3.7	17	37	202	41	237
Belgium	0	20	0	15	7	101	7	136
Czech Republic	0	16	0.1	19	12	171	12	206
Denmark	0	8	0	12	0	123	0	143
Finland	0	8	0	6	0	421	0	435
France	4.6	84	15.3	106	352	627	372	817
Germany	7.7	165	81.8	84	65	658	155	908
Greece	0	11	0	14	0	67	0	92
Hungary	0.2	11	0	8	31	55	31	75
Iceland	0	0	0	0	0	0	0	0
Ireland	0	7	0.032	10	0	16	0	33
Italy	0	112	8.1	75	59	216	67	404
Luxembourg	0	3	0.037	7	0	3	0	13
Netherlands	0	26	0	25	4	116	4	167
Norway	0	0	0	0	54	1022	54	1022
Poland	1.6	37	0.6	44	36	431	38	513
Portugal	0	11	0.007	14	0	180	0	204
Slowak Republic	0	5	0.5	4	0	51	1	60
Spain	5.2	82	6.7	88	23	456	35	625
Switzerland	0.03	279	0.2	0.0	14	265	14	545
Sweden	6.6	19	0.3	15	60	469	67	502
Turkey	0	0	0	0	50	947	50	947
UK	2.1	104	1.6	58	5	243	9	405
Pacific	**0.9**	**121**	**0**	**0**	**93**	**2223**	**94**	**2345**
Japan	0	84	0	0	7	1047	7	1130
Korea (Rep.)	0	0	0	0	29	397	29	397
New Zealand	0	0	0	0	0	0	0	0
Australia	0.9	38	0	0	57	780	58	817
Transition Economies	**0**	**27**	**0.3**	**55**	**618.4**	**1068**	**619**	**1150**
Former USSR and Balkans								
Albenia	0	0	0	0	0	0	0	0
Armenia	0	0	0	0	0	0	0	0
Azerbaijan	0	0	0	0	0	0	0	0
Belarus	0	0	0	0	0	0	0	0
Bosnia-Herzegovina	0	0	0	0	0	0	0	0
Bulgaria	0	4	0	8	18	49	18	60
Croatia	0	0	0	0	0	0	0	0
Estonia	0	1	0	2	24.4	41	24	45
Serbia-Montenegro	0	0	0	0	0	0	0	0
former Yugoslav Republic of Macedonia	0	0	0	0	0	0	0	0
Georgia	0	0	0	0	0	0	0	0
Kazakhstan	0	0	0	0	2	6	2	6
Kyrgyzstan	0	0	0	0	0	0	0	0
Latvia	0	3	0.2	4	9	118	9	125
Lithuania	0	4	0.1	3	11	69	11	76
Moldova	0	0	0	0	0	0	0	0
Romania	0	11	0	15	0	284	0	310
Russia	0	0	0	17	470	230	470	247
Slovenia	0	4	0	5	2	30	2	39
Taijkistan	0	0	0	0	0	0	0	0
Turkmenistan	0	0	0	0	0	0	0	0
Ukraine	0	0	0	0	82	236	82	236
Uzbekistan	0	0	0	0	0	0	0	0
and also for statistical reasons:							0	
Cyprus	0	1	0	1	0	4	0	5
Gibraltar	0	0	0	0	0	0	0	0
Malta	0	0	0	0	0	0	0	1
Developing countries								
Developing Asia	**139.3**	**743**	**16.4**	**630**	**6916**	**28688**	**7072**	**30061**
Afghanistan	0	0	0	0	0	0	0	0
Bangladesh	0	0	0	0	0	0	0	0
Bhutan	0	0	0	0	0	0	0	0
Brunai	0	0	0	0	0	0	0	0
Cambodia	0	0	0	0	0	0	0	0

China	85.4	363	8.11	181	2129	9295	2222	9839
Chinese Taipei	*0*	0	*0*	0	*0*	0	0	0
Fiji	*0*	0	*0*	0	*0*	0	0	0
French Polynesia	*0*	0	*0*	0	*0*	0	0	0
India	40.9	188	0	0	3109	9902	3150	10090
Indonesia	3.9	13	0.3	84	737	4169	741	4265
Kiribati	*0*	0	*0*	0	*0*	0	0	0
Democratic People's Republic of Korea	*0*	0	0.6	25.5	*0*	0	1	26
Laos	*0*	0	*0*	0	*0*	0	0	0
Macau	*0*	0	*0*	0	*0*	0	0	0
Malaysia	0.0002	0.004	4.1	187	31	175	35	362
Maldives	*0*	0	*0*	0	*0*	0	0	0
Mongolia	*0*	0	*0*	0	*0*	0	0	0
Myanmar	*0*	0	*0*	0	*0*	0	0	0
Nepal	*0*	0	*0*	0	*0*	0	0	0
New Caledonia	*0*	0	*0*	0	*0*	0	0	0
Pakistan	0.6	12	*0*	0	267	1510	268	1522
Papua New Guinea	*0*	0	*0*	0	*0*	0	0	0
Philippines	1.9	38	0.1	5	136	769	138	812
Samoa	*0*	0	*0*	0	*0*	0	0	0
Singapore	*0*	0	*0*	0	*0*	0	0	0
Solomon Islands	*0*	0	*0*	0	*0*	0	0	0
Sri Lanka	*0*	0	*0*	0	*0*	0	0	0
Thailand	6.6	129	3.2	148	240	1358	250	1635
Tonga	*0*	0	*0*	0	*0*	0	0	0
Vietnam	*0*	0	*0*	0	267	1510	267	1510
Vanuatu	*0*	0	*0*	0	*0*	0	0	0
Middle east	**0**	**0**	**0**	**25**	**4.5**	**268**	**5**	**293**
Bahrain	*0*	0	*0*	0	*0*	0	0	0
Iran	*0*	0	*0*	0	0.3	18	0	18
Iraq	*0*	0	*0*	0	0.5	32	1	32
Israel	*0*	0	*0*	0	0.0	0	0	0
Jordan	*0*	0	*0*	0	1.3	78	1	78
Lebanon	*0*	0	*0*	0	0.4	25	0	25
Kuwait	*0*	0	*0*	0	*0*	0	0	0
Oman	*0*	0	*0*	0	*0*	0	0	0
Qatar	*0*	0	*0*	0	*0*	0	0	0
Saudi Arabia	*0*	0	*0*	0	*0*	0	0	0
Syria	*0*	0	*0*	0	0.1	6	0	6
United Arab Emirates	*0*	0	0	25	*0.0*	0	0	25
Yemen	*0*	0	*0*	0	1.8	108	2	108
Africa	**10.2**	**134**	**0**	**13**	**2742**	**15303**	**2752**	**15449**
Algeria	*0*	0	*0*	0	*0*	0	0	0
Angola	*0*	0	*0*	0	*0*	0	0	0
Benin	*0*	0	*0*	0	*0*	0	0	0
Botswana	*0*	0	*0*	0	*0*	0	0	0
Burkina Faso	*0*	0	*0*	0	121	675	121	675
Burundi	*0*	0	*0*	0	*0*	0	0	0
Cameroon	*0*	0	*0*	0	*0*	0	0	0
Cape Verde	*0*	0	*0*	0	*0*	0	0	0
Central African Republic	*0*	0	*0*	0	*0*	0	0	0
Chad	*0*	0	*0*	0	*0*	0	0	0
Comoros	*0*	0	*0*	0	*0*	0	0	0
Congo	*0*	0	*0*	0	*0*	0	0	0
Demographic Republic of Congo	*0*	0	*0*	0	*0*	0	0	0
Cote d'Ivor	*0*	0	*0*	0	*0*	0	0	0
Djibouti	*0*	0	*0*	0	*0*	0	0	0
Egypt	*0*	0	*0*	0	209	1166	209	1166
Equatorial Guinea	*0*	0	*0*	0	*0*	0	0	0
Eritrea	*0*	0	*0*	0	*0*	0	0	0
Ethiopia	*0*	0	*0*	0	1048	5849	1048	5849
Gabon	*0*	0	*0*	0	*0*	0	0	0
Gambia	*0*	0	*0*	0	*0*	0	0	0
Ghana	0.1	2	*0*	0	*0*	0	0	2
Guinea	*0*	0	*0*	0	*0*	0	0	0
Guinea-Bissau	*0*	0	*0*	0	*0*	0	0	0
Kenya	0.07	1	*0*	0	*0*	0	0	1
Lesotho	*0*	0	*0*	0	*0*	0	0	0
Liberia	*0*	0	*0*	0	*0*	0	0	0
Libya	*0*	0	*0*	0	*0*	0	0	0
Madagascar	*0*	0	*0*	0	*0*	0	0	0
Malawi	0.1	2	*0*	0	*0*	0	0	2
Mali	*0*	0	*0*	0	54	301	54	301
Mauritania	*0*	0	*0*	0	*0*	0	0	0
Mauritius	*0*	0	*0*	0	*0*	0	0	0

Morocco	0	0	0	0	0	0	0	0
Mozambique	0	0	0	0	0	0	0	0
Namibia	0	0	0	0	0	0	0	0
Niger	0	0	0	0	0	0	0	0
Nigeria	0	0	0	0	721	4024	721	4024
Reunion	0	0	0	0	0	0	0	0
Rwanda	0	0	0	0	0	0	0	0
Sao Tome and Principe	0	0	0	0	0	0	0	0
Senegal	0	0	0	0	0	0	0	0
Sychelles	0	0	0	0	0	0	0	0
Sierra Leone	0	0	0	0	0	0	0	0
Somalia	0	0	0	0	0	0	0	0
South Africa	9.7	128	0	13	125	698	135	838
Sudan	0	0	0	0	204	1138	204	1138
Swaziland	0	0	0	0	0	0	0	0
United Republic of Tanzania	0	0	0	0	260	1451	260	1451
Togo	0	0	0	0	0	0	0	0
Tunisia	0	0	0	0	0	0	0	0
Uganda	0	0	0	0	0	0	0	0
Zambia	0	0	0	0	0	0	0	0
Zimbabwe	0.1	2	0	0	0	0	0	2
Latin America	**348.1**	**893**	**1.4**	**158**	**2170**	**4434**	**2520**	**5485**
Antigua and Barbuda	0	0	0	0	0	0	0	0
Argentina	0	0	0	0	56	199	56	199
Bahamas	0	0	0	0	0	0	0	0
Barbados	0	0	0	0	0	0	0	0
Belize	0	0	0	0	0	0	0	0
Bermuda	0	0	0	0	0	0	0	0
Bolivia	0	0	0	0	0	0	0	0
Brazil	348.1	893	1.4	158	1674	2675	2024	3726
Chile	0	0	0	0	139	493	139	493
Colombia	0	0	0	0	118	418	118	418
Costa rica	0	0	0	0	0	0	0	0
Cuba	0	0	0	0	20	71	20	71
Dominica	0	0	0	0	0	0	0	0
Dominican Republic	0	0	0	0	0	0	0	0
Ecuador	0	0	0	0	0	0	0	0
El Salvador	0	0	0	0	0	0	0	0
French Guiana	0	0	0	0	0	0	0	0
Grenada	0	0	0	0	0	0	0	0
Guadaloupe	0	0	0	0	0	0	0	0
Guatemala	0	0	0	0	163	578	163	578
Guyana	0	0	0	0	0	0	0	0
Haiti	0	0	0	0	0	0	0	0
Honduras	0	0	0	0	0	0	0	0
Jamaica	0	0	0	0	0	0	0	0
Martinique	0	0	0	0	0	0	0	0
Netherlands Antilles	0	0	0	0	0	0	0	0
Nicaragua	0	0	0	0	0	0	0	0
Panama	0	0	0	0	0	0	0	0
Paruguay	0	0	0	0	0	0	0	0
Peru	0	0	0	0	0	0	0	0
St. Kitts and Nevis	0	0	0	0	0	0	0	0
Saint Lucia	0	0	0	0	0	0	0	0
St. Vincent and Grenadines	0	0	0	0	0	0	0	0
Surinam	0	0	0	0	0	0	0	0
Trinidad and Tobago	0	0	0	0	0	0	0	0
Uruguay	0	0	0	0	0	0	0	0
Venezuela	0	0	0	0	0	0	0	0
World total (sum of regions)	**887**	**4588**	**151**	**1774**	**14243**	**65117**	**15281**	**71479**

Source notes:

1) 2030 consumption data from IEA (2006), EU scenario, or extrapolated from 2005 data using method in Appendix D

2) 2005 consumption data from Van Meekeren (2008), USDA FAS GAIN reports, Eurostat and various bio-energy websites

3) data in italic is assumed or unknown

F. Feedstock use for bio-energy

Feedstock probable for bio-energy

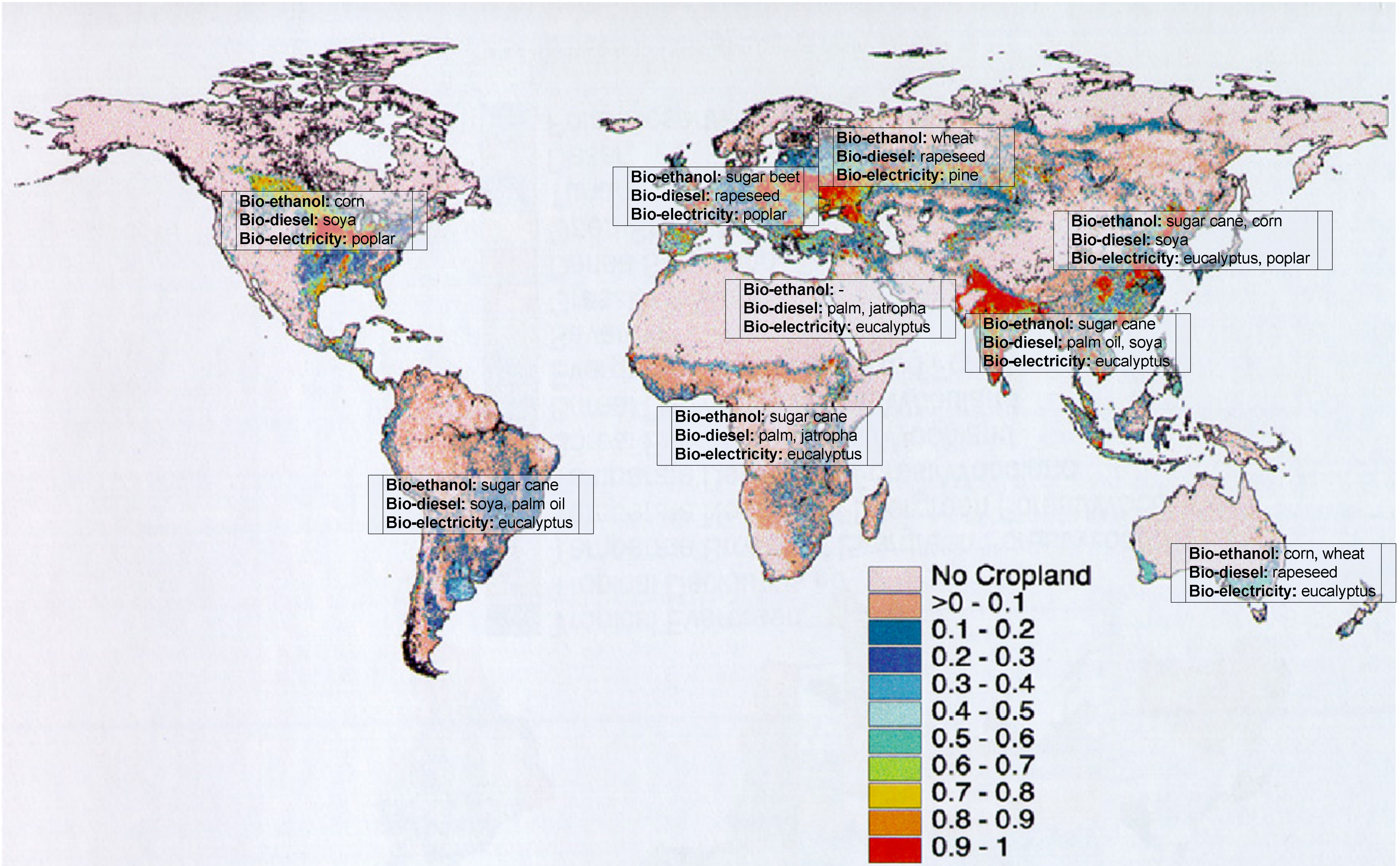
Source notes general:

	Bio-ethanol					Bio-diesel				Bio-electricity & heat			numbers in italic are assumed based on neighbouring countries
	wheat	corn	sorghum	sugarbeet	sugarcane	soya	rapeseed	palm	jatropha	eucalyptus	pine	poplar	Source notes for power and heat (all countries):
OECD													based on Van Meekeren (2008) and ForesSTAT (2009)
North America	**10%**	**55%**	**2%**	**0%**	**33%**	**33%**	**33%**	**33%**	**0%**	**23%**	**21%**	**55%**	Source notes for liquid biofuels (per row):
USA	0%	95%	5%	0%	0%	100%	0%	0%	0%	0%	19%	81%	based on Dufey (2006)
Canada	30%	70%	0%	0%	0%	0%	100%	0%	0%	0%	15%	85%	based on USDA FAS (2006) - GAIN Report Number: CA6029
Mexico	0%	0%	0%	0%	100%	0%	0%	*100%*	0%	70%	30%	0%	based on USDA FAS (2007) - GAIN Report Number: MX7042
Europe	**42%**	**6%**	**0%**	**51%**	**1%**	**2%**	**98%**	**0%**	**0%**	**7%**	**37%**	**56%**	
Austria	60%	13%	0%	0%	27%	0%	*100%*	0%	0%	0%	59%	41%	based on Konrad (2006)
Belgium	67%	0%	0%	33%	0%	0%	*100%*	0%	0%	0%	14%	86%	based on BioWanze (2008)
Czech Republic	0%	26%	0%	74%	0%	0%	100%	0%	0%	0%	58%	42%	based on Breyerová (2007) and Dufey (2006)
Denmark	62%	0%	0%	38%	0%	0%	100%	0%	0%	0%	76%	24%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Finland	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	50%	50%	based on Kautola et al. (date unknown)
France	10%	0%	0%	90%	0%	0%	100%	0%	0%	0%	10%	90%	based on Dufey (2006)
Germany	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	68%	32%	based on Dufey (2006)
Greece	0%	0%	0%	100%	0%	50%	50%	0%	0%	0%	10%	90%	based on USDA FAS (2007) - GAIN Report Number: GR7003
Hungary	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	3%	97%	based on USDA FAS (2006) - GAIN Report Number: HU6005
Iceland	0%	0%	0%	*100%*	0%	0%	*100%*	0%	0%	0%	0%	100%	assummed
Ireland	19%	0%	0%	81%	0%	0%	100%	0%	0%	0%	26%	74%	based on SEI (2004)
Italy	100%	0%	0%	0%	0%	0%	100%	0%	0%	93%	7%	0%	based on Dufey (2006)
Luxembourg	0%	0%	0%	*100%*	0%	0%	*100%*	0%	0%	0%	59%	41%	assumed
Netherlands	50%	0%	0%	50%	0%	0%	100%	0%	0%	0%	33%	67%	based on NOVEM (2003)
Norway	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	39%	61%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Poland	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	50%	50%	based on Dufey (2006)
Portugal	11%	55%	0%	34%	0%	0%	*100%*	0%	0%	0%	33%	67%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Slowak Rep.	60%	40%	0%	0%	0%	0%	100%	0%	0%	0%	50%	50%	based on Müllerová & Mikulík (2008)
Spain	100%	0%	0%	0%	0%	0%	100%	0%	0%	77%	23%	0%	based on Dufey (2006)
Switzerland	32%	0%	0%	68%	0%	0%	100%	0%	0%	0%	38%	62%	based on Biofuels Platform (2009)
Sweden	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	66%	34%	based on Dufey (2006)
Turkey	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	38%	62%	based on İçöz et al. (2008)
UK	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	33%	67%	based on Dufey (2006)
Pacific	**13%**	**47%**	**1%**	**0%**	**40%**	**45%**	**55%**	**0%**	**0%**	**50%**	**22%**	**29%**	
Japan	0%	0%	0%	0%	100%	100%	0%	0%	0%	100%	0%	0%	based on USDAFAS (2006) - GAIN Report Number: JA6024
Korea (Rep.)	12%	86%	2%	0%	0%	80%	20%	0%	0%	0%	36%	64%	based on FAOSTAT (2003) and USDA FAS (2007) - GAIN Report Number: KS7052
New Zealand	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	50%	50%	based on USDA FAS (2007) - GAIN Report Number: NZ7003
Australia	39%	1%	2%	0%	58%	1%	99%	0%	0%	100%	0%	0%	based on Dufey (2006) and FAOSTAT (2009)
Transition Economies													
Former USSR and Balkans	**58%**	**22%**	**0%**	**20%**	**0%**	**29%**	**71%**	**0%**	**0%**	**0%**	**31%**	**69%**	
Albania	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Armenia	93%	6%	0%	1%	0%	0%	*100%*	0%	0%	0%	0%	100%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Azerbaijan	73%	13%	0%	14%	0%	100%	0%	0%	0%	0%	0%	100%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Belarus	29%	2%	0%	69%	0%	0%	100%	0%	0%	0%	32%	68%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Bosnia-Herzegovina	45%	55%	0%	0%	0%	60%	40%	0%	0%	0%	1%	99%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Bulgaria	83%	17%	0%	0%	0%	0%	100%	0%	0%	0%	12%	88%	based on USDA FAS (2006) - GAIN Report Number: BU6006
Croatia	21%	52%	0%	27%	0%	74%	26%	0%	0%	0%	2%	98%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Estonia	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	41%	59%	based on BBN (2008) and USDA FAS (2006) - GAIN Report Number: SW6012
Serbia-Montenegro	30%	70%	0%	0%	0%	98%	2%	0%	0%	0%	6%	94%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
former Yugoslav Rep. of Macedonia	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	2%	98%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Georgia	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	12%	88%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Kazakhstan	3%	97%	0%	0%	0%	87%	13%	0%	0%	0%	100%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Kyrgyzstan	0%	100%	0%	0%	0%	12%	82%	0%	0%	0%	30%	70%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Latvia	0%	0%	0%	100%	0%	0	100%	0%	0%	0%	78%	22%	based on Ministry of Agricul. (2006) and USDA FAS (2006) - GAIN Report Number: SW6012
Lithuania	100%	0%	0%	0%	0%	0	100%	0%	0%	0%	45%	55%	based on USDA FAS (2007) - GAIN Report Number: LH7001
Moldova	0%	100%	0%	0%	0%	0	*100%*	0%	0%	0%	0%	100%	based on Vassilieva (date unknown)
Romania	0%	0%	0%	100%	0%	0	100%	0%	0%	0%	11%	89%	based on ENERO (2005)
Russia	50%	50%	0%	0%	0%	0	100%	0%	0%	0%	40%	60%	based on USDA FAS (2007) - GAIN Report Number: RS7044

Slovenia	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	18%	82%	based on NV Consultants (2007) and Reuters Limited (2006)
Taijkistan	87%	12%	1%	0%	0%	50%	50%	0%	0%	0%	50%	50%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Turkmenistan	90%	1%	0%	9%	0%	0%	100%	0%	0%	0%	5%	95%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Ukraine	0%	0%	0%	100%	0%	64%	36%	0%	0%	0%	40%	60%	based on USDA FAS (2006) - GAIN Report Number: UP6010
Uzbekistan	97%	3%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
and also for statistical reasons:													
Cyprus	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	70%	30%	based on Solsten (1991)
Gibraltar	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	assumed
Malta	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	assumed
Developing countries													
Developing Asia	**9%**	**24%**	**0%**	**0%**	**66%**	**24%**	**10%**	**60%**	**7%**	**87%**	**7%**	**6%**	
Afghanistan	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	30%	70%	assumed
Bangladesh	0%	100%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Bhutan	0%	0%	0%	0%	100%	100%	0%	0%	0%	100%	0%	0%	assumed
Brunai	100%	0%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Cambodia	0%	48%	0%	0%	52%	35%	0%	65%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
China	0%	90%	0%	0%	10%	90%	0%	0%	10%	0%	40%	60%	based on Dufey (2006)
Chinese Taipei	0%	100%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	assumed
Fiji	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
French Polynesia	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	assumed
India	0%	0%	0%	0%	100%	0%	0%	0%	100%	97%	3%	0%	based on Dufey (2006)
Indonesia	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	based on Dufey (2006)
Kiribati	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Democratic People's Rep. of Korea	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	64%	36%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Laos	0%	32%	0%	0%	68%	100%	0%	0%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Macau	0%	100%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	assumed
Malaysia	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) and USDA FAS (2007) - GAIN Report Number: MY7014
Maldives	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Mongolia	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	78%	22%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Myanmar	2%	10%	0%	0%	88%	24%	8%	68%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Nepal	100%	0%	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
New Caledonia	100%	0%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Pakistan	0%	0%	0%	0%	100%	0%	0%	100%	0%	96%	4%	0%	based on Dufey (2006) and USDA FAS (2007) - GAIN Report Number: SF7044
Papua New Guinea	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	assumed
Philippines	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	based on Dufey (2006)
Samoa	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Singapore	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	assumed
Solomon Islands	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Sri Lanka	0%	3%	0%	0%	97%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Thailand	0%	0%	0%	0%	100%	10%	0%	90%	0%	100%	0%	0%	based on Dufey (2006) and USDA FAS (2007) - GAIN Report Number: TH7070
Tonga	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	assumed
Vietnam	0%	0%	0%	0%	100%	0%	0%	0%	100%	100%	0%	0%	based on USDA FAS (2008) - GAIN Report Number: KS8063
Vanuatu	0%	100%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Middle east	**58%**	**12%**	**25%**	**3%**	**2%**	**15%**	**0%**	**77%**	**8%**	**87%**	**13%**	**0%**	
Bahrain	50%	0%	50%	0%	0%	0%	0%	100%	0%	100%	0%	0%	assumed
Iran	51%	6%	0%	22%	21%	100%	0%	0%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Iraq	50%	0%	50%	0%	0%	0%	0%	100%	0%	100%	0%	0%	assumed
Israel	0%	100%	0%	0%	0%	0%	0%	0%	100%	24%	76%	0%	based on USDA FAS (2007) - GAIN Report Number: IS7017
Jordan	79%	20%	1%	0%	0%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Lebanon	96%	3%	1%	0%	0%	0%	0%	100%	0%	95%	5%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Kuwait	86%	14%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Oman	50%	0%	50%	0%	0%	0%	0%	100%	0%	100%	0%	0%	assumed
Qatar	50%	0%	50%	0%	0%	0%	0%	100%	0%	100%	0%	0%	assumed
Saudi Arabia	90%	1%	9%	0%	0%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Syria	77%	4%	0%	19%	0%	100%	0%	0%	0%	16%	84%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
United Arab Emirates	50%	0%	50%	0%	0%	0%	0%	100%	0%	100%	0%	0%	assumed
Yemen	30%	9%	61%	0%	0%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Africa	**8%**	**28%**	**19%**	**2%**	**44%**	**22%**	**5%**	**63%**	**10%**	**97%**	**3%**	**0%**	
Algeria	100%	0%	0%	0%	0%	0%	100%	0%	0%	32%	68%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Angola	0%	60%	0%	0%	40%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Benin	0%	78%	16%	0%	6%	16%	0%	84%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Botswana	0%	6%	94%	0%	0%	100%	0%	0%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Burkina Faso	0%	24%	59%	0%	17%	100%	0%	0%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Burundi	0%	31%	18%	0%	51%	19%	0%	81%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Cameroon	0%	28%	20%	0%	52%	8%	0%	92%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Cape Verde	0%	46%	0%	0%	54%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003
Central African Rep.	0%	47%	17%	0%	36%	0%	0%	100%	0%	100%	0%	0%	based on FAOSTAT (2009) - Country Food Balance Sheet 2003

Chad	0%	11%	54%	0%	35%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Comoros	0%	100%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Congo	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Demographic Rep. of Congo	0%	0%	0%	0%	100%	15%	0%	85%	0%	100%	0%	0%	*based on USDA FAS (2009) - GAIN Report Number: E49042*
Cote d'Ivor	0%	41%	0%	0%	59%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Djibouti	0%	17%	0%	0%	83%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Egypt	0%	100%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	*based on USDA FAS (2005) - GAIN Report Number: EG5013*
Equatorial Guinea	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*assumed*
Eritrea	4%	6%	90%	0%	0%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Ethiopia	17%	34%	20%	0%	29%	56%	44%	0%	0%	93%	7%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Gabon	0%	12%	0%	0%	88%	76%	0%	24%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Gambia	0%	50%	50%	0%	0%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Ghana	0%	50%	0%	0%	50%	0%	0%	0%	100%	100%	0%	0%	*based on Dufey (2006)*
Guinea	0%	27%	0%	0%	73%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Guinea-Bissau	0%	56%	31%	0%	13%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Kenya	0%	0%	0%	0%	100%	0%	0%	0%	100%	90%	10%	0%	*based on Dufey (2006) and Oddobo (2008)*
Lesotho	28%	46%	26%	0%	0%	100%	0%	0%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Liberia	0%	0%	0%	0%	100%	14%	0%	86%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Libya	100%	0%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Madagascar	0%	11%	0%	0%	89%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Malawi	0%	0%	0%	0%	100%	0%	0%	0%	100%	100%	0%	0%	*based on Dufey (2006)*
Mali	0%	27%	48%	0%	25%	0%	0%	0%	100%	100%	0%	0%	*based on Oddobo (2008) and FAOSTAT (2009) - Country Food Balance Sheet 2003*
Mauritania	0%	8%	92%	0%	0%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Mauritius	0%	0%	0%	0%	100%	0%	0%	100%	0%	40%	60%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Morocco	53%	1%	0%	36%	10%	50%	50%	0%	0%	68%	32%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Mozambique	0%	64%	16%	0%	20%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Namibia	17%	70%	13%	0%	0%	100%	0%	0%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Niger	0%	0%	77%	0%	23%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Nigeria	0%	35%	59%	0%	6%	37%	0%	63%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Reunion	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*assumed*
Rwanda	0%	25%	53%	0%	22%	100%	0%	0%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Sao Tome and Principe	0%	100%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Senegal	0%	28%	13%	0%	59%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Sychelles	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*assumed*
Sierra Leone	0%	17%	36%	0%	47%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Somalia	0%	33%	33%	0%	34%	0%	0%	100%	0%	100%	0%	0%	*assumed*
South Africa	0%	0%	0%	50%	50%	80%	0%	0%	20%	100%	0%	0%	*based on Dufey (2006) and USDA FAS (2007) - GAIN Report Number: SF7044*
Sudan	3%	0%	57%	0%	40%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Swaziland	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
United Rep. of Tanzania	0%	50%	14%	0%	36%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Togo	0%	74%	26%	0%	0%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Tunisia	100%	0%	0%	0%	0%	0%	100%	0%	0%	90%	10%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Uganda	0%	37%	14%	0%	49%	100%	0%	0%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Zambia	0%	39%	0%	0%	61%	100%	0%	0%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Zimbabwe	0%	0%	0%	0%	100%	0%	0%	0%	100%	100%	0%	0%	*based on Dufey (2006)*
Latin America	**1%**	**9%**	**1%**	**0%**	**89%**	**17%**	**3%**	**80%**	**0%**	**95%**	**5%**	**0%**	
Antigua and Barbuda	0%	100%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Argentina	0%	0%	0%	0%	100%	100%	0%	0%	0%	100%	0%	0%	*based on USDA FAS (2007) - GAIN Report Number: AR7016*
Bahamas	0%	100%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Barbados	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Belize	0%	0%	0%	0%	100%	69%	0%	31%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Bermuda	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*assumed*
Bolivia	2%	12%	3%	0%	83%	100%	0%	0%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Brazil	0%	0%	0%	0%	100%	90%	0%	10%	0%	90%	10%	0%	*based on Dufey (2006)*
Chile	35%	23%	0%	0%	42%	0%	100%	0%	0%	85%	15%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Colombia	0%	0%	0%	0%	100%	0%	0%	100%	0%	78%	22%	0%	*based on Dufey (2006)*
Costa rica	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Cuba	0%	2%	0%	0%	98%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Dominica	0%	4%	0%	0%	96%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Dominican Rep.	0%	1%	0%	0%	99%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Ecuador	0%	0%	0%	0%	100%	0%	0%	100%	0%	80%	20%	0%	*based on Dufey (2006)*
El Salvador	0%	12%	3%	0%	85%	4%	0%	96%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
French Guiana	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*assumed*

Grenada	0%	4%	0%	0%	96%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Guadaloupe	0%	0%	0%	0%	*100%*	0%	0%	*100%*	0%	100%	0%	0%	*assumed*
Guatemala	0%	6%	0%	0%	94%	27%	0%	73%	0%	38%	62%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Guyana	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Haiti	0%	15%	7%	0%	78%	0%	0%	100%	0%	92%	8%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Honduras	0%	9%	0%	0%	91%	5%	0%	95%	0%	67%	33%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Jamaica	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Martinique	0%	0%	0%	0%	*100%*	0%	0%	*100%*	0%	100%	0%	0%	*assumed*
Netherlands Antilles	0%	0%	0%	0%	*100%*	0%	0%	*100%*	0%	100%	0%	0%	*assumed*
Nicaragua	0%	12%	2%	0%	86%	47%	0%	53%	0%	89%	11%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Panama	0%	4%	0%	0%	96%	1%	0%	99%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Paruguay	10%	22%	0%	0%	68%	100%	0%	0%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Peru	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*based on Dufey (2006)*
St. Kitts and Nevis	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Saint Lucia	0%	0%	0%	0%	*100%*	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
St. Vincent and Grenadines	0%	3%	0%	0%	97%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Surinam	0%	0%	0%	0%	100%	1%	0%	99%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Trinidad and Tobago	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*
Uruguay	0%	0%	0%	0%	100%	100%	0%	0%	0%	100%	0%	0%	*based on USDA FAS (2007) - GAIN Report Number: UY7002*
Venezuela	0%	15%	5%	0%	80%	2%	0%	98%	0%	100%	0%	0%	*based on FAOSTAT (2009) - Country Food Balance Sheet 2003*



General overview of (likely) bio-energy crop choice in different regions of the world

G. Virtual water content data

Virtual water content of liquid bio-fuels and power produced with first transformation of crops in the current system

	Bio-ethanol (m3/GJ)														
	Wheat			Corn			Sorghum			Sugarbeet			Sugarcane		
	blue	green	total	blue	green	total	blue	green	total	blue	green	total	blue	green	total
World average:	**111**	**125**	**236**	**30**	**105**	**135**	**112**	**164**	**275**	**34**	**30**	**64**	**40**	**39**	**79**
OECD															
North America	**119**	**93**	**212**	**66**	**64**	**130**	**108**	**72**	**180**	**15**	**32**	**47**	**64**	**32**	**96**
USA	211	95	306	37	41	78	100	64	164	28	27	54	71	33	104
Canada	91	130	221	40	33	74	*108*	*72*	*180*	0	32	32	*64*	*32*	*96*
Mexico	55	55	110	121	117	238	116	80	195	17	36	54	56	31	87
Europe	**33**	**64**	**97**	**8**	**33**	**42**	**9**	**61**	**70**	**19**	**21**	**40**	***40***	***39***	***79***
Austria	2	49	51	1	23	24	*9*	*61*	*70*	3	24	27	*40*	*39*	*79*
Belgium	0	60	61	0	25	25	*9*	*61*	*70*	25	24	49	*40*	*39*	*79*
Czech Republic	75	53	128	0	43	44	*9*	*61*	*70*	14	29	43	*40*	*39*	*79*
Denmark	24	26	50	*8*	*33*	*42*	*9*	*61*	*70*	11	23	34	*40*	*39*	*79*
Finland	*33*	*64*	*97*	*8*	*33*	*42*	*9*	*61*	*70*	*19*	*21*	*40*	*40*	*39*	*79*
France	36	32	68	21	21	42	27	30	57	12	14	26	*40*	*39*	*79*
Germany	22	36	58	21	26	47	*9*	*61*	*70*	17	20	36	*40*	*39*	*79*
Greece	*33*	*64*	*97*	*8*	*33*	*42*	*9*	*61*	*70*	34	11	44	*40*	*39*	*79*
Hungary	3	97	100	2	47	49	4	108	112	21	30	51	*40*	*39*	*79*
Iceland	*33*	*64*	*97*	*8*	*33*	*42*	*9*	*61*	*70*	*19*	*21*	*40*	*40*	*39*	*79*
Ireland	*33*	*64*	*97*	*8*	*33*	*42*	*9*	*61*	*70*	17	18	34	*40*	*39*	*79*
Italy	59	86	145	22	22	43	4	40	44	30	20	50	*40*	*39*	*79*
Luxembourg	*33*	*64*	*97*	*8*	*33*	*42*	*9*	*61*	*70*	*19*	*21*	*40*	*40*	*39*	*79*
Netherlands	2	54	56	4	31	34	*9*	*61*	*70*	21	14	35	*40*	*39*	*79*
Norway	*33*	*64*	*97*	*8*	*33*	*42*	*9*	*61*	*70*	*19*	*21*	*40*	*40*	*39*	*79*
Poland	51	57	108	0	40	40	*9*	*61*	*70*	34	26	61	*40*	*39*	*79*
Portugal	*33*	*64*	*97*	*8*	*33*	*42*	*9*	*61*	*70*	*19*	*21*	*40*	*40*	*39*	*79*
Slowak Republic	6	86	92	4	56	60	11	102	112	30	32	62	*40*	*39*	*79*
Spain	144	87	231	23	18	41	0	24	24	2	19	21	*40*	*39*	*79*
Switzerland	0	78	79	0	39	40	*9*	*61*	*70*	0	24	24	*40*	*39*	*79*
Sweden	2	54	57	*8*	*33*	*42*	*9*	*61*	*70*	19	19	38	*40*	*39*	*79*
Turkey	85	134	219	8	43	51	*9*	*61*	*70*	29	19	48	*40*	*39*	*79*
UK	24	30	54	*8*	*33*	*42*	*9*	*61*	*70*	21	16	37	*40*	*39*	*79*
Pacific	**1**	**125**	**126**	**0**	**79**	**80**	**45**	**164**	**209**	**0**	**37**	**37**	**16**	**39**	**55**
Japan	0	116	116	0	138	138	*45*	*164*	*209*	0	37	37	0	40	40
Korea	2	177	179	1	119	120	6	252	258	*0*	*37*	*37*	*16*	*39*	*55*
New Zealand	1	51	52	0	28	28	*45*	*164*	*209*	*0*	*37*	*37*	*16*	*39*	*55*
Australia	0	157	157	0	32	32	83	76	159	*0*	*37*	*37*	32	38	70
Transition Economies	**258**	**78**	**336**	**79**	**96**	**176**	**33**	**191**	**224**	**66**	**43**	**109**	***40***	***39***	***79***
Former USSR and Balkans															
Albenia	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Armenia	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Azerbaijan	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Belarus	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	42	42	84	*40*	*39*	*79*
Bosnia-Herzegovina	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Bulgaria	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Croatia	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Estonia	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Serbia-Montenegro	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	50	32	82	*40*	*39*	*79*
former Yugoslav Rep. of Macedonia	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Georgia	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Kazakhstan	982	19	1001	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Kyrgyzstan	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Latvia	0	122	122	*79*	*96*	*176*	*33*	*191*	*224*	0	36	36	*40*	*39*	*79*
Lithuania	0	117	117	*79*	*96*	*176*	*33*	*191*	*224*	0	42	42	*40*	*39*	*79*
Moldova	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	90	56	146	*40*	*39*	*79*
Romania	*258*	*78*	*336*	104	71	175	*33*	*191*	*224*	94	48	142	*40*	*39*	*79*
Russia	88	120	208	2	146	171	*33*	*191*	*224*	144	30	174	*40*	*39*	*79*
Slovenia	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Taijkistan	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Turkmenistan	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Ukraine	124	81	205	132	72	204	33	191	224	108	54	162	*40*	*39*	*79*
Uzbekistan	354	7	361	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
and also for statistical reasons:															
Cyprus	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Gibraltar	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*
Malta	*258*	*78*	*336*	*79*	*96*	*176*	*33*	*191*	*224*	*66*	*43*	*109*	*40*	*39*	*79*

	Bio-diesel (m3/GJ)												**Bio-electricity & heat** (m3/GJ)								
	Soyabean			Rapeseed			Palm			Jatropha			Eucalyptus			Pine			Poplar		
	blue	green	total	blue	green	total	blue	green	total	blue	green	total	blue	green	total	blue	green	total	blue	green	total
World average:	**53**	**124**	**177**	**75**	**173**	**251**	**0**	**57**	**57**	**372**	**269**	**641**	**0**	**323**	**323**	**0**	**471**	**474**	**0**	**272**	**272**
OECD																					
North America	**170**	**146**	**316**	**195**	**159**	**355**	**0**	**40**	**42**	***372***	***269***	***641***	**0**	***323***	***323***	**0**	**770**	**770**	**0**	***272***	***272***
USA	216	227	443	298	152	450	*0*	*40*	*40*	*372*	*269*	*641*	0	*323*	*323*	0	770	770	0	*272*	*272*
Canada	293	136	428	288	155	444	*0*	*40*	*40*	*372*	*269*	*641*	*0*	*323*	*323*	0	*770*	*770*	*0*	*272*	*272*
Mexico	1	76	78	0	171	171	0	40	46	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*770*	*770*	*0*	*272*	*272*
Europe	**11**	**94**	**105**	**28**	**78**	**106**	***0***	***57***	***57***	***372***	***269***	***641***	**0**	**192**	**192**	**0**	**323**	**324**	**0**	**193**	**193**
Austria	1	47	48	2	52	54	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Belgium	*11*	*94*	*105*	0	49	49	*0*	*57*	*57*	*372*	*269*	*641*	0	*192*	*192*	0	210	210	0	142	142
Czech Republic	1	87	88	72	90	162	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Denmark	*11*	*94*	*105*	39	96	135	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Finland	*11*	*94*	*105*	*28*	*78*	*106*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
France	0	39	40	62	74	136	*0*	*57*	*57*	*372*	*269*	*641*	0	*192*	*192*	0	298	298	0	*194*	*194*
Germany	1	58	59	49	78	127	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Greece	*11*	*94*	*105*	*28*	*78*	*106*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Hungary	1	60	61	3	93	96	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Iceland	*11*	*94*	*105*	*28*	*78*	*106*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Ireland	*11*	*94*	*105*	*28*	*78*	*106*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Italy	117	108	225	24	174	199	*0*	*57*	*57*	*372*	*269*	*641*	0	192	192	0	176	176	0	167	167
Luxembourg	*11*	*94*	*105*	*28*	*78*	*106*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Netherlands	*11*	*94*	*105*	5	44	49	*0*	*57*	*57*	*372*	*269*	*641*	0	*192*	*192*	0	309	309	0	135	135
Norway	*11*	*94*	*105*	*28*	*78*	*106*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Poland	3	434	436	93	88	182	*0*	*57*	*57*	*372*	*269*	*641*	0	*192*	*192*	0	324	324	0	179	179
Portugal	*11*	*94*	*105*	*28*	*78*	*106*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Slowak Republic	1	84	84	5	79	84	*0*	*57*	*57*	*372*	*269*	*641*	0	*192*	*192*	0	674	674	0	341	341
Spain	0	26	26	0	48	48	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Switzerland	0	54	54	0	68	68	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Sweden	*11*	*94*	*105*	3	61	64	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
Turkey	1	38	38	*28*	*78*	*106*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*192*	*192*	*0*	*323*	*323*	*0*	*193*	*193*
UK	*11*	*94*	*105*	61	73	134	*0*	*57*	*57*	*372*	*269*	*641*	0	*192*	*192*	0	268	290	*0*	*193*	*193*
Pacific	**0**	**91**	**92**	**65**	**149**	**213**	***0***	***57***	***57***	***372***	***269***	***641***	**0**	**215**	**215**	**0**	**278**	**278**	**0**	***272***	***272***
Japan	0	86	86	0	116	116	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*215*	*215*	*0*	*278*	*278*	*0*	*272*	*272*
Korea	0	146	146	1	191	192	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*215*	*215*	*0*	*278*	*278*	*0*	*272*	*272*
New Zealand	*0*	*91*	*92*	1	73	73	*0*	*57*	*57*	*372*	*269*	*641*	0	*215*	*215*	0	188	188	*0*	*272*	*272*
Australia	0	43	43	257	216	473	*0*	*57*	*57*	*372*	*269*	*641*	0	215	215	0	368	368	*0*	*272*	*272*
Transition Economies	**2**	**111**	**113**	**1**	**131**	**132**	***0***	***57***	***57***	***372***	***269***	***641***	**0**	***323***	***323***	**0**	**366**	**366**	**0**	**256**	**256**
Former USSR and Balkans																					
Albenia	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Armenia	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Azerbaijan	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Belarus	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Bosnia-Herzegovina	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Bulgaria	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Croatia	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Estonia	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Serbia-Montenegro	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
former Yugoslav Rep. of Macedonia	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Georgia	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Kazakhstan	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Kyrgyzstan	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Latvia	1	99	100	0	105	105	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Lithuania	*2*	*111*	*113*	0	103	103	*0*	*57*	*57*	*372*	*269*	*641*	0	*323*	*323*	0	366	366	0	*256*	*256*
Moldova	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Romania	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Russia	2	124	126	3	160	163	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Slovenia	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Taijkistan	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Turkmenistan	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Ukraine	*2*	*111*	*113*	2	156	158	*0*	*57*	*57*	*372*	*269*	*641*	0	324	324	0	367	367	0	256	256
Uzbekistan	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
and also for statistical reasons:																					
Cyprus	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Gibraltar	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*
Malta	*2*	*111*	*113*	*1*	*131*	*132*	*0*	*57*	*57*	*372*	*269*	*641*	*0*	*323*	*323*	*0*	*366*	*366*	*0*	*256*	*256*

Developing countries																																				
Developing Asia	**38**	**217**	**255**	**37**	**157**	**194**	**93**	**289**	**382**	**18**	**59**	**77**	**48**	**67**	**116**	**106**	**278**	**384**	**237**	**316**	**552**	**0**	**58**	**58**	**612**	**380**	**992**	**0**	**490**	**490**	**0**	**939**	**939**	**0**	**263**	**263**
Afghanistan	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Bangladesh	38	217	255	37	157	194	93	289	382	18	59	77	44	106	150	106	278	384	0	667	667	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Bhutan	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Brunai	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Cambodia	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
China	94	75	169	41	76	117	49	89	138	36	62	97	25	58	83	208	332	540	238	186	423	0	28	28	612	380	992	0	661	661	0	606	606	0	308	308
Chinese Taipei	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Fiji	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
French Polynesia	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
India	31	169	200	87	269	356	213	579	792	18	59	77	87	31	118	343	833	1176	591	256	847	0	58	58	1116	575	1691	0	488	488	0	1408	1408	0	217	217
Indonesia	38	217	255	43	151	194	93	289	382	18	59	77	43	68	111	403	311	714	237	316	552	0	68	68	109	184	293	0	305	305	0	873	873	0	263	263
Kiribati	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
DPR of Korea	2	177	179	1	119	120	6	252	258	18	59	77	48	67	116	0	146	146	1	191	192	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Laos	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Macau	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Malaysia	38	217	255	0	194	194	93	289	382	18	59	77	0	87	87	0	369	370	237	316	552	0	64	64	612	380	992	0	490	490	0	939	939	0	263	263
Maldives	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Mongolia	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Myanmar	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Nepal	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
New Caledonia	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Pakistan	58	16	74	78	112	190	199	293	491	0	55	55	93	37	130	0	119	119	353	280	633	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Papua New Guinea	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Philippines	38	217	255	0	250	250	93	289	382	18	59	77	38	62	100	0	111	111	237	316	552	0	80	80	612	380	992	0	490	490	0	513	513	0	263	263
Samoa	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Singapore	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Solomon Islands	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Sri Lanka	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Thailand	3	651	654	80	71	151	0	232	232	18	59	77	55	64	119	0	89	89	237	316	552	0	48	48	612	380	992	0	490	490	0	939	939	0	263	263
Tonga	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Vietnam	38	217	255	0	175	175	93	289	382	18	59	77	50	93	143	0	192	192	237	316	552	0	58	58	612	380	992	0	506	506	0	1292	1292	0	263	263
Vanuatu	38	217	255	37	157	194	93	289	382	18	59	77	48	67	116	106	278	384	237	316	552	0	58	58	612	380	992	0	490	490	0	939	939	0	263	263
Middle east	**377**	**125**	**502**	**2**	**22**	**24**	**414**	**0**	**414**	**130**	**17**	**147**	**24**	**13**	**38**	**0**	**38**	**38**	**75**	**173**	**267**	**0**	**57**	**57**	**372**	**269**	**641**	**0**	**576**	**576**	**0**	**471**	**488**	**0**	**475**	**475**
Bahrain	377	125	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Iran	316	186	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Iraq	377	125	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Israel	377	125	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Jordan	377	125	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Lebanon	377	125	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Kuwait	377	125	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Oman	377	125	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Qatar	377	125	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Saudi Arabia	377	125	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Syria	438	64	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
United Arab Emirates	377	125	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Yemen	377	125	502	2	22	24	414	0	414	130	17	147	24	13	38	0	38	38	75	173	248	0	57	57	372	269	641	0	576	576	0	471	471	0	475	475
Africa	**6**	**192**	**199**	**34**	**251**	**285**	**180**	**301**	**481**	**15**	**15**	**30**	**33**	**29**	**62**	**1**	**137**	**138**	**0**	**284**	**284**	**0**	**70**	**70**	**372**	**269**	**641**	**0**	**331**	**331**	**0**	**433**	**433**	**0**	**272**	**272**
Algeria	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Angola	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Benin	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Botswana	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Burkina Faso	6	192	198	0	259	259	100	538	638	15	15	30	33	29	62	0	133	133	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Burundi	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Cameroon	6	192	198	34	251	285	128	165	293	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Cape Verde	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Central African Republic	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Chad	6	192	198	34	251	285	0	632	632	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Comoros	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Congo	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Demographic Rep. Congo	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Cote d'Ivor	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Djibouti	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Egypt	32	21	53	28	20	48	25	28	53	26	12	37	66	5	72	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Equatorial Guinea	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Eritrea	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Ethiopia	1	281	291	0	204	205	0	283	283	15	15	30	0	38	39	0	44	45	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Gabon	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Gambia	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Ghana	6	192	198	34	251	285	48	355	403	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Guinea	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Guinea-Bissau	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Kenya	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Lesotho	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Liberia	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Libya	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Madagascar	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Malawi	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Mali	0	233	253	6	248	253	136	420	556	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Mauritania	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Mauritius	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272

Morocco	6	192	198	34	251	285	180	301	481	4	18	22	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Mozambique	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Namibia	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Niger	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Nigeria	0	243	243	226	151	377	0	367	367	15	15	30	33	29	62	2	151	155	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Reunion	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Rwanda	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Sao Tome and Principe	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Senegal	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Sychelles	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Sierra Leone	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Somalia	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
South Africa	4	124	128	0	93	93	89	101	190	15	15	30	63	35	98	0	61	63	0	284	284	0	70	70	372	269	641	0	213	213	0	433	450	0	272	272
Sudan	6	195	201	13	547	560	1416	135	1551	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	449	449	0	433	433	0	272	272
Swaziland	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
United Rep. Tanzania	2	246	249	0	484	484	176	321	497	15	15	30	1	39	40	3	294	301	0	284	284	0	70	75	372	269	641	0	331	331	0	433	433	0	272	272
Togo	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Tunisia	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Uganda	6	192	198	34	251	285	42	269	312	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Zambia	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Zimbabwe	6	192	198	34	251	285	180	301	481	15	15	30	33	29	62	1	137	138	0	284	284	0	70	70	372	269	641	0	331	331	0	433	433	0	272	272
Latin America	**57**	**104**	**161**	**11**	**135**	**145**	**12**	**231**	**243**	**11**	**14**	**25**	**55**	**53**	**108**	**136**	**96**	**233**	**0**	**93**	**93**	**0**	**57**	**57**	**132**	**158**	**290**	**0**	**132**	**132**	**0**	**192**	**192**	**0**	**176**	**176**
Antigua and Barbuda	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Argentina	285	0	285	6	60	66	8	70	78	11	14	25	90	4	94	115	128	243	0	93	93	0	57	57	132	158	290	0	127	127	0	201	201	0	164	164
Bahamas	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Barbados	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Belize	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Bermuda	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Bolivia	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	312	148	460	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Brazil	0	113	113	51	90	140	60	223	283	11	14	25	41	57	98	305	16	321	0	161	161	0	95	95	91	160	251	0	109	109	0	183	183	0	248	248
Chile	0	50	50	0	15	15	12	231	243	11	14	25	55	53	108	136	96	233	0	25	25	0	57	57	132	158	290	0	159	159	0	193	193	0	116	116
Colombia	0	148	148	0	162	162	0	81	81	11	14	25	59	19	78	0	66	66	0	93	93	0	45	45	132	158	290	0	132	132	0	192	192	0	176	176
Costa rica	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Cuba	57	104	161	8	246	254	5	538	543	11	14	25	84	141	225	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Dominica	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Dominican Republic	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Ecuador	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
El Salvador	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
French Guiana	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Grenada	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Guadaloupe	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Guatemala	0	210	210	0	235	235	0	298	298	11	14	25	41	42	83	0	64	64	0	93	93	0	45	45	174	156	329	0	132	132	0	192	192	0	176	176
Guyana	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Haiti	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Honduras	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Jamaica	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Martinique	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Netherlands Antilles	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Nicaragua	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Panama	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Paruguay	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	85	157	242	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Peru	57	104	161	11	135	145	12	231	243	11	14	25	3	43	46	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
St. Kitts and Nevis	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Saint Lucia	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
St. Vincent and Grenadines	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Surinam	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Trinidad and Tobago	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Uruguay	57	104	161	11	135	145	12	231	243	11	14	25	55	53	108	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176
Venezuela	57	104	161	11	135	145	0	176	176	11	14	25	66	68	134	136	96	233	0	93	93	0	57	57	132	158	290	0	132	132	0	192	192	0	176	176

Source notes:

1) shaded values are from Gerbens-Leenes et al. (2008)

2) unshaded values in black print are from Van Meekeren (2008)

3) values in thin italic print are regional averages (used for countries with missing data)

4) values in bold italic print are global averages (used for regions with missing data)

H. Water footprint of bio-energy

Water footprint of bio-energy from first generation crops (km3/yr)

	Bio-ethanol						Bio-diesel						Bio-electricity & heat						Total bio-energy					
	2005			2030			2005			2030			2005			2030			2005			2030		
	blue	green	total	blue	green	total	blue	green	total	blue	green	total	blue	green	total	blue	green	total	blue	green	total	blue	green	total
OECD																								
North America	**14.6**	**15.3**	**29.9**	**67.8**	**71.6**	**139.5**	**2.9**	**3.1**	**6.0**	**58.2**	**61.2**	**119.4**	**0.0**	**361.6**	**361.6**	**0.0**	**2410.8**	**2410.8**	**17.5**	**380.0**	**397.6**	**126.0**	**2543.6**	**2669.6**
USA	14.2	14.9	29.0	61.3	64.35	125.6	2.9	3.1	6.0	58.2	61.16	119.4	0.0	171.8	171.8	0.0	1860.8	1860.8	17.1	189.7	206.8	119.5	1986.4	2105.9
Canada	0.4	0.5	0.9	6.5	7.3	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	9.4	0.0	27.2	27.2	0.4	9.9	10.3	6.5	34.4	41.0
Mexico	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	180.5	180.5	0.0	522.8	522.8	0.0	180.5	180.5	0.0	522.8	522.8
Europe	**1.1**	**1.3**	**2.4**	**28.8**	**45.3**	**73.7**	**5.3**	**9.7**	**15.0**	**23.7**	**51.7**	**75.4**	**0.0**	**183.0**	**183.1**	**0.0**	**1668.7**	**1670.4**	**6.5**	**194.0**	**200.4**	**52.5**	**1765.6**	**1819.5**
Austria	0.0	0.0	0.0	0.2	0.7	1.0	0.0	0.2	0.2	0.0	0.9	0.9	0.0	10.0	10.0	0.0	54.5	54.5	0.0	10.2	10.2	0.3	56.1	56.4
Belgium	0.0	0.0	0.0	0.2	1.0	1.1	0.0	0.0	0.0	0.0	0.8	0.8	0.0	1.1	1.1	0.0	15.3	15.3	0.0	1.1	1.1	0.2	17.0	17.2
Czech Republic	0.0	0.0	0.0	0.2	0.5	0.7	0.0	0.0	0.0	1.4	1.7	3.1	0.0	3.2	3.2	0.0	45.9	45.9	0.0	3.2	3.2	1.6	48.2	49.7
Denmark	0.0	0.0	0.0	0.1	0.2	0.3	0.0	0.0	0.0	0.5	1.1	1.6	0.0	0.0	0.0	0.0	36.0	36.0	0.0	0.0	0.0	0.6	37.3	37.9
Finland	0.0	0.0	0.0	0.1	0.2	0.3	0.0	0.0	0.0	0.2	0.5	0.7	0.0	0.0	0.0	0.0	108.4	108.4	0.0	0.0	0.0	0.3	109.1	109.4
France	0.1	0.1	0.1	1.2	1.3	2.5	0.9	1.1	2.1	6.6	7.8	14.4	0.0	71.8	71.8	0.0	127.9	127.9	1.0	73.0	74.1	7.8	137.1	144.9
Germany	0.2	0.3	0.4	3.6	6.0	9.6	4.0	6.4	10.4	4.1	6.6	10.7	0.0	18.3	18.3	0.0	185.0	185.0	4.2	24.9	29.1	7.8	197.6	205.3
Greece	0.0	0.0	0.0	0.4	0.1	0.5	0.0	0.0	0.0	0.3	1.2	1.5	0.0	0.0	0.0	0.0	13.8	13.8	0.0	0.0	0.0	0.6	15.2	15.8
Hungary	0.0	0.0	0.0	0.0	1.1	1.1	0.0	0.0	0.0	0.0	0.8	0.8	0.0	6.1	6.1	0.0	10.9	10.9	0.0	6.1	6.1	0.1	12.7	12.8
Iceland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ireland	0.0	0.0	0.0	0.1	0.2	0.3	0.0	0.0	0.0	0.3	0.8	1.1	0.0	0.0	0.0	0.0	3.5	3.5	0.0	0.0	0.0	0.4	4.5	4.9
Italy	0.0	0.0	0.0	6.6	9.7	16.3	0.2	1.4	1.6	1.8	13.1	14.9	0.0	11.2	11.2	0.0	41.2	41.2	0.2	12.7	12.9	8.5	64.0	72.4
Luxembourg	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.2	0.6	0.8	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.0	0.0	0.3	1.3	1.6
Netherlands	0.0	0.0	0.0	0.3	0.9	1.2	0.0	0.0	0.0	0.1	1.1	1.2	0.0	0.8	0.8	0.0	22.3	22.3	0.0	0.8	0.8	0.4	24.3	24.7
Norway	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.1	13.1	0.0	248.8	248.8	0.0	13.1	13.1	0.0	248.8	248.8
Poland	0.1	0.0	0.1	1.3	1.0	2.2	0.1	0.1	0.1	4.1	3.9	8.1	0.0	9.1	9.1	0.0	108.5	108.5	0.1	9.2	9.3	5.4	113.4	118.9
Portugal	0.0	0.0	0.0	0.4	0.7	0.5	0.0	0.0	0.0	0.4	1.1	1.4	0.0	0.0	0.0	0.0	42.4	42.4	0.0	0.0	0.0	0.7	44.1	44.3
Slowak Republic	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0	25.6	25.6	0.0	0.0	0.0	0.0	26.3	26.4
Spain	0.7	0.5	1.2	11.8	7.1	18.9	0.0	0.3	0.3	0.0	4.2	4.2	0.0	5.1	5.1	0.0	101.1	101.1	0.8	5.9	6.6	11.8	112.4	124.2
Switzerland	0.0	0.0	0.0	0.0	11.6	11.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	3.4	0.0	64.2	64.2	0.0	3.4	3.4	0.0	75.8	75.8
Sweden	0.0	0.4	0.4	0.0	1.0	1.1	0.0	0.0	0.0	0.0	0.9	1.0	0.0	16.7	16.7	0.0	130.5	130.5	0.0	17.1	17.1	0.1	132.5	132.5
Turkey	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.1	12.1	0.0	229.1	229.1	0.0	12.1	12.1	0.0	229.1	229.1
UK	0.0	0.0	0.1	2.2	1.7	3.9	0.1	0.1	0.2	3.5	4.2	7.8	0.0	1.1	1.1	0.0	52.9	54.7	0.1	1.2	1.4	5.7	58.8	66.3
Pacific	**0.0**	**0.1**	**0.1**	**0.6**	**7.0**	**7.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**21.7**	**21.7**	**0.0**	**501.2**	**501.2**	**0.0**	**21.8**	**21.8**	**0.6**	**508.3**	**508.6**
Japan	0.0	0.0	0.0	0.0	3.4	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5	0.0	224.9	224.9	0.0	1.5	1.5	0.0	228.2	228.2
Korea (Rep.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	8.0	0.0	108.9	108.9	0.0	8.0	8.0	0.0	108.9	108.9
New Zealand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Australia	0.0	0.1	0.1	0.6	3.7	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	12.2	0.0	167.5	167.5	0.0	12.3	12.3	0.6	171.2	171.5
Transition Economies	**0.0**	**0.0**	**0.0**	**2.7**	**1.7**	**4.5**	**0.0**	**0.0**	**0.0**	**0.1**	**7.5**	**7.6**	**0.0**	**185.5**	**185.5**	**0.0**	**314.9**	**314.9**	**0.0**	**185.5**	**185.5**	**2.8**	**324.1**	**326.9**
Former USSR and Balkans																								
Albenia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Armenia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Azerbaijan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belarus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bosnia-Herzegovina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria	0.0	0.0	0.0	0.9	0.3	1.2	0.0	0.0	0.0	0.0	1.0	1.0	0.0	4.8	4.8	0.0	13.2	13.2	0.0	4.8	4.8	0.9	14.5	15.4
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estonia	0.0	0.0	0.0	0.4	0.1	0.5	0.0	0.0	0.0	0.0	0.3	0.3	0.0	7.3	7.3	0.0	12.4	12.4	0.0	7.3	7.3	0.4	12.8	13.2
Serbia-Montenegro	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
former Yugoslav Rep. of Macedonia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Georgia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kazakhstan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	2.1	2.1	0.0	0.7	0.7	0.0	2.1	2.1
Kyrgyzstan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Latvia	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.4	0.4	0.0	3.1	3.1	0.0	40.3	40.3	0.0	3.1	3.1	0.0	40.9	40.9
Lithuania	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.3	0.3	0.0	3.4	3.4	0.0	21.1	21.1	0.0	3.4	3.4	0.0	21.9	21.9
Moldova	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Romania	0.0	0.0	0.0	1.1	0.5	1.6	0.0	0.0	0.0	0.0	2.0	2.0	0.0	0.0	0.0	0.0	76.0	76.0	0.0	0.0	0.0	1.1	78.6	79.7
Russia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.7	0.0	140.9	140.9	0.0	69.1	69.1	0.0	140.9	140.9	0.0	71.7	71.8
Slovenia	0.0	0.0	0.0	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.6	0.6	0.0	8.3	8.3	0.0	0.6	0.6	0.3	9.1	9.3
Taijkistan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turkmenistan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.6	24.6	0.0	71.0	71.0	0.0	24.6	24.6	0.0	71.0	71.0
Uzbekistan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
and also for statistical reasons:																								
Cyprus	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	1.2	1.2	0.0	0.0	0.0	0.1	1.3	1.5
Gibraltar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.2	0.2
Developing countries																								
Developing Asia	**7.6**	**8.4**	**16.0**	**40.9**	**44.7**	**85.6**	**2.0**	**3.3**	**5.3**	**45.1**	**90.8**	**135.6**	**0.0**	**3209.4**	**3209.4**	**0.0**	**13015.0**	**13015.0**	**9.6**	**3221.1**	**3230.7**	**86.0**	**13150.4**	**13236.2**
Afghanistan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bangladesh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bhutan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brunai	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cambodia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
China	3.4	6.3	9.7	14.3	26.9	41.2	2.0	2.7	4.7	45.1	61.1	106.2	0.0	910.0	910.0	0.0	3972.8	3972.8	5.4	919.1	924.4	59.4	4060.8	4120.2
Chinese Taipei	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fiji	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
French Polynesia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
India	3.6	1.3	4.8	16.4	5.8	22.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1603.9	1603.9	0.0	5108.2	5108.2	3.6	1605.2	1608.7	16.4	5114.1	5130.4
Indonesia	0.2	0.3	0.4	0.5	0.9	1.4	0.0	0.0	0.02	0.0	5.7	5.7	0.0	225.1	225.1	0.0	1273.5	1273.5	0.2	225.4	225.6	0.5	1280.0	1280.5
Kiribati	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DPR Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	3.9	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	3.9	3.7
Laos	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Macau	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malaysia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	12.0	12.0	0.0	15.2	15.2	0.0	86.0	86.0	0.0	15.5	15.5	0.0	97.9	97.9
Maldives	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mongolia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Myanmar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nepal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
New Caledonia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pakistan	0.1	0.0	0.1	1.1	0.4	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	135.7	135.7	0.0	767.5	767.5	0.1	135.7	135.8	1.1	767.9	769.0
Papua New Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Philippines	0.1	0.1	0.2	1.5	2.4	3.8	0.0	0.0	0.0	0.0	0.4	0.4	0.0	66.7	66.7	0.0	377.1	377.1	0.1	66.8	66.9	1.5	379.9	381.3
Samoa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Singapore	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solomon Islands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sri Lanka	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thailand	0.4	0.4	0.8	7.1	8.3	15.4	0.0	0.2	0.2	0.0	7.7	7.7	0.0	117.7	117.7	0.0	665.5	665.5	0.4	118.2	118.6	7.1	681.4	688.6
Tonga	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vietnam	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	135.2	135.2	0.0	764.5	764.5	0.0	135.2	135.2	0.0	764.5	764.5
Vanuatu	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Middle east	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.9**	**1.4**	**0.0**	**2.6**	**2.6**	**0.0**	**153.7**	**153.7**	**0.0**	**2.6**	**2.6**	**0.0**	**154.7**	**155.1**
Bahrain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Iran	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	10.5	10.5	0.0	0.2	0.2	0.0	10.5	10.5
Iraq	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	18.7	18.7	0.0	0.3	0.3	0.0	18.7	18.7
Israel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.2	0.2
Jordan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.0	45.2	45.2	0.0	0.8	0.8	0.0	45.2	45.2
Lebanon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	14.1	14.1	0.0	0.2	0.2	0.0	14.1	14.1
Kuwait	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Qatar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Saudi Arabia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Syria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.7	0.0	0.0	0.0	0.0	2.7	2.7
United Arab Emirates	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.4
Yemen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	1.1	0.0	62.2	62.2	0.0	1.1	1.1	0.0	62.2	62.2
Africa	**0.4**	**0.3**	**0.7**	**5.2**	**3.6**	**8.7**	**0.0**	**0.0**	**0.0**	**0.9**	**1.3**	**2.2**	**0.0**	**923.6**	**923.6**	**0.0**	**5154.7**	**5154.7**	**0.4**	**923.9**	**924.3**	**6.1**	**5159.5**	**5165.7**
Algeria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Angola	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Benin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Botswana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	40.0	0.0	223.3	223.3	0.0	40.0	40.0	0.0	223.3	223.3
Burundi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cameroon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cape Verde	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Central African Republic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Comoros	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Congo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Demographic Rep. of Congo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cote d'Ivor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Djibouti	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Egypt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	69.1	69.1	0.0	385.8	385.8	0.0	69.1	69.1	0.0	385.8	385.8
Equatorial Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eritrea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ethiopia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	354.1	354.1	0.0	1976.0	1976.0	0.0	354.1	354.1	0.0	1976.0	1976.0
Gabon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ghana	0.0	0.0	0.0	0.1	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.3
Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guinea-Bissau	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kenya	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Lesotho	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Libya	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Madagascar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malawi	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
Mali	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.9	17.9	0.0	99.7	99.7	0.0	17.9	17.9	0.0	99.7	99.7
Mauritania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mauritius	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Morocco	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mozambique	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Namibia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	238.5	238.5	0.0	1330.8	1330.8	0.0	238.5	238.5	0.0	1330.8	1330.8
Reunion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rwanda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sao Tome and Principe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Senegal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sychelles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Somalia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Africa	0.4	0.2	0.6	4.9	3.2	8.1	0.0	0.0	0.0	0.9	1.3	2.2	0.0	26.6	26.6	0.0	148.5	148.5	0.4	26.8	27.2	5.9	153.0	158.9
Sudan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	91.5	91.5	0.0	510.7	510.7	0.0	91.5	91.5	0.0	510.7	510.7
Swaziland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
United Rep. of Tanzania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	86.0	86.0	0.0	479.9	479.9	0.0	86.0	86.0	0.0	479.9	479.9
Togo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tunisia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uganda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zimbabwe	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
Latin America	**14.3**	**19.8**	**34.1**	**36.6**	**50.9**	**87.5**	**0.4**	**0.0**	**0.4**	**43.3**	**3.8**	**47.0**	**0.0**	**272.1**	**272.1**	**0.0**	**585.4**	**585.4**	**14.7**	**291.9**	**306.6**	**79.9**	**640.0**	**719.9**
Antigua and Barbuda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Argentina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	7.1	0.0	25.3	25.3	0.0	7.1	7.1	0.0	25.3	25.3
Bahamas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Barbados	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belize	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bermuda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bolivia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brazil	14.3	19.8	34.1	36.6	50.9	87.5	0.4	0.0	0.4	43.3	3.8	47.0	0.0	194.7	194.7	0.0	311.2	311.2	14.7	214.6	229.3	79.9	365.9	445.8
Chile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.8	22.8	0.0	80.9	80.9	0.0	22.8	22.8	0.0	80.9	80.9
Colombia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	17.1	0.0	60.7	60.7	0.0	17.1	17.1	0.0	60.7	60.7
Costa rica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cuba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.6	0.0	9.3	9.3	0.0	2.6	2.6	0.0	9.3	9.3
Dominica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dominican Republic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ecuador	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
El Salvador	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
French Guiana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grenada	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guadaloupe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guatemala	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.6	27.6	0.0	97.8	97.8	0.0	27.6	27.6	0.0	97.8	97.8
Guyana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haiti	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Honduras	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jamaica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Martinique	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands Antilles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nicaragua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Panama	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paruguay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peru	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
St. Kitts and Nevis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Saint Lucia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
St. Vincent and Grenadines	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surinam	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trinidad and Tobago	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uruguay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Venezuela	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
World total (sum of regions)			**83.2**			**406.9**			**26.8**			**388.6**			**5159.5**			**23806.1**	**48.7**	**5220.8**	**5269.5**	**353.9**	**24246.3**	**24601.6**

I. Water balance data

Fresh water supply and demand (km3/yr)

	Total supply	Usable supply (productive flows)		Unusable supply				Available for humans		Human appropriation per sector							
		Initial runoff partitioning (Postel et al.,1996):		50%	46.5%	19%		31%	34.5%								
	Average precipitation (km3/yr)	**Total Internal Renewable Water Resources (km^3/yr)**	**Total evaporation (=P- runoff) (km3/yr)**	**Uncaptured floodwater (km3/yr)**	**Uncaptured floodwater (km3/yr)**	**Remote flow (km3/yr)**	**Environmental flow (km3/yr)**	**Accessible IRWR (km3/yr)**	**Accessible IRWR (km3/yr)**	**Industry (withdrawal) (km3/yr)**		**Domestic (withdrawal) (km3/yr)**		**Agriculture (withdrawal) (km3/yr)**		**Runoff 'free' for bio-energy (km3/yr)**	
	long term	***long term avg.***	***long term avg.***	***current***	***2030***	***constant***	***basin avg.***	***current***	***2030***	***current***	***2030***	***current***	***2030***	***current***	***2030***	***current***	***2030***
OECD																	
North America	**12625.0**	**6059.0**	**6566.0**	**1960.2**	**1823.0**	**744.9**	**2138.6**	**1215.3**	**1352.5**	**256.6**	**281.6**	**83.4**	**110.9**	**263.5**	**214.0**	**611.8**	**746.1**
USA	5800.8	2800.0	3000.8	903.5	840.2	343.3	993.1	560.1	623.4	220.69	191.20	60.85	81.57	197.75	181.80	80.9	168.8
Canada	5352.2	2850.0	2502.2	905.9	842.5	344.2	1038.2	561.7	625.1	31.57	36.52	8.99	8.09	5.41	3.57	515.7	576.9
Mexico	1472.0	409.0	1063.0	150.8	140.3	57.3	107.4	93.5	104.1	4.29	53.84	13.59	21.19	60.34	28.62	15.3	0.4
Europe	**4009.5**	**2137.0**	**1872.5**	**664.0**	**617.6**	**252.3**	**808.9**	**411.7**	**458.2**	**138.5**	**143.3**	**44.9**	**75.9**	**110.5**	**134.2**	**117.8**	**104.9**
Austria	93.1	55.0	38.1	16.7	15.6	6.4	21.5	10.4	11.5	1.35	1.99	0.74	0.74	0.02	0.19	8.3	8.6
Belgium	25.8	12.0	13.8	3.6	3.3	1.4	4.9	2.2	2.5	7.68	6.63	0.99	1.25	0.36	0.26	-6.8	-5.7
Czech Rep.	53.4	13.2	40.2	4.0	3.7	1.5	5.1	2.5	2.8	1.47	6.10	1.05	2.14	0.06	0.10	-0.1	-5.6
Denmark	30.3	6.0	24.3	1.8	1.7	0.7	2.4	1.1	1.2	0.32	0.30	0.41	0.40	0.54	0.64	-0.2	-0.1
Finland	181.4	107.0	74.4	32.1	29.9	12.2	42.8	19.9	22.1	2.07	2.50	0.34	0.43	0.07	0.10	17.4	19.1
France	478.0	178.5	299.5	54.7	50.8	20.8	69.2	33.9	37.7	29.76	19.11	6.28	8.61	3.92	8.86	-6.1	1.1
Germany	250.0	107.0	143.0	30.0	27.9	11.4	47.1	18.6	20.7	31.93	27.89	5.81	4.21	9.31	1.51	-28.5	-12.9
Greece	86.1	58.0	28.1	17.7	16.4	6.7	22.7	10.9	12.2	0.25	2.18	1.27	0.87	6.25	13.01	3.2	-3.9
Hungary	54.8	6.0	48.8	1.8	1.7	0.7	2.3	1.1	1.3	4.48	5.17	0.71	1.04	2.45	1.60	-6.5	-6.5
Iceland	199.8	170.0	29.8	51.7	48.1	19.7	66.5	32.1	35.7	0.1	0.05	0.05	0.03	0.00	0.00	31.9	35.6
Ireland	78.6	49.0	29.6	14.9	13.9	5.7	19.2	9.2	10.3	0.87	0.52	0.26	0.16	0.00	0.06	8.1	9.6
Italy	250.8	182.5	68.3	63.9	59.4	24.3	54.8	39.6	44.1	16.29	10.67	8.07	6.36	20.01	15.97	-4.8	11.1
Luxembourg	2.4	1.0	1.4	0.3	0.3	0.1	0.4	0.2	0.2		0.05		0.05	0.00	0.00	0.2	0.1
Netherlands	32.3	11.0	21.3	3.3	3.0	1.2	4.5	2.0	2.3	4.76	4.05	0.49	2.14	2.69	0.80	-5.9	-4.7
Norway	458.0	382.0	76.0	114.6	106.6	43.5	152.8	71.1	79.1	1.46	1.19	0.5	0.37	0.23	0.17	68.9	77.4
Poland	194.0	53.6	140.4	14.2	13.2	5.4	25.2	8.8	9.8	12.75	17.55	2.1	2.24	1.35	0.39	-7.4	-10.4
Portugal	78.6	38.0	40.6	11.6	10.8	4.4	14.9	7.2	8.0	1.37	1.87	1.08	1.35	8.81	4.24	-4.1	0.5
Slowak Rep.	40.4	12.6	27.8	3.8	3.6	1.5	4.9	2.4	2.6		2.95		1.01	0.00	0.54	2.4	-1.9
Spain	321.7	111.2	210.5	33.8	31.5	12.9	43.5	21.0	23.4	6.6	7.45	4.79	5.50	24.24	34.12	-14.6	-23.7
Switzerland	63.5	40.4	23.1	12.3	11.4	4.7	15.8	7.6	8.5	1.9	2.04	0.62	0.79	0.05	0.02	5.1	5.6
Sweden	280.7	171.0	109.7	51.3	47.7	19.5	68.4	31.8	35.4	1.61	1.41	1.09	1.00	0.26	0.23	28.8	32.8
Turkey	459.5	227.0	232.5	82.9	77.1	31.5	61.3	51.4	57.2	4.3	2.61	6.2	28.07	29.60	50.96	11.3	-24.5
UK	296.3	145.0	151.3	43.1	40.1	16.4	58.7	26.7	29.8	7.19	19.00	2.07	7.16	0.28	0.38	17.2	3.2
Pacific	**5362.6**	**1316.0**	**4046.6**	**458.5**	**426.4**	**174.2**	**399.1**	**284.2**	**316.3**	**21.5**	**44.8**	**23.7**	**22.2**	**79.1**	**32.8**	**160.0**	**216.6**
Japan	630.2	430.0	200.2	148.4	138.0	56.4	133.3	92.0	102.4	15.8	20.93	17.4	13.95	55.23	3.37	3.5	64.1
Korea (Republic)	127.0	67.0	60.0	24.5	22.7	9.3	18.1	15.2	16.9	3.05	17.47	1.79	4.63	4.96	4.94	5.4	-10.2
New Zealand	468.4	327.0	141.4	103.0	95.8	39.1	121.0	63.9	71.1	0.2	0.31	1.02	0.62	0.89	0.46	61.8	69.7
Australia	4136.9	492.0	3644.9	182.7	169.9	69.4	126.7	113.2	126.0	2.4	6.13	3.52	2.96	18.01	23.99	89.3	93.0
Transition Economies	**10138.4**	**4960.3**	**5178.1**	**1667.2**	**1550.5**	**633.5**	**1625.9**	**1033.6**	**1150.3**	**91.9**	**74.3**	**29.5**	**89.7**	**191.2**	**194.9**	**721.1**	**791.5**
Former USSR and Balkans																	
Albania	42.7	26.9	15.8	9.4	8.7	3.6	8.2	5.8	6.5	0.19	0.12	0.46	0.13	1.06	2.51	4.1	3.7
Armenia	16.8	6.9	9.9	2.4	2.2	0.9	2.1	1.5	1.6	0.13	0.32	0.88	1.71	1.94	2.70	-1.5	-3.1
Azerbaijan	38.7	8.1	30.6	2.8	2.6	1.1	2.5	1.8	1.9	2.36	2.29	0.521	2.40	9.33	12.78	-10.5	-15.5
Belarus	128.3	37.2	91.1	12.9	12.0	4.9	11.3	8.0	8.9	1.3	0.54	0.65	1.30	0.84	0.34	5.2	6.7
Bosnia-Herzegovina	52.6	35.5	17.1	12.4	11.5	4.7	10.8	7.7	8.5		1.06		0.52	0.00	0.02	7.7	6.9
Bulgaria	67.4	21.0	46.4	7.3	6.8	2.8	6.4	4.5	5.0	8.21	9.56	0.32	2.34	1.97	7.27	-6.0	-14.1
Croatia	62.9	37.7	25.2	13.1	12.2	5.0	11.5	8.1	9.1		1.36		0.65	0.00	0.04	8.1	7.0
Estonia	28.2	12.7	15.5	4.4	4.1	1.7	3.9	2.7	3.1	0.06	0.76	0.09	0.36	0.01	0.02	2.6	1.9
Serbia-Montenegro	81.2	44.0	37.2	15.3	14.2	5.8	13.4	9.5	10.6					0.00		9.5	10.6
former Yugoslav Rep. of Macedonia	15.9	5.4	10.5	1.9	1.7	0.7	1.6	1.2	1.3		0.69		0.21	0.00	0.77	1.2	-0.4
Georgia	71.5	58.1	13.4	20.2	18.8	7.7	17.7	12.5	14.0	0.208	0.66	0.358	2.36	1.06	1.71	10.9	9.2
Kazakhstan	680.4	75.4	605.0	25.3	23.6	9.6	24.8	15.7	17.5	5.78	5.94	0.59	1.73	28.63	30.13	-19.3	-20.3
Kyrgyzstan	106.5	46.5	60.1	15.8	14.7	6.0	14.9	9.8	10.9	0.31	0.35	0.32	1.12	9.45	7.94	-0.3	1.5
Latvia	41.4	16.7	24.7	5.8	5.4	2.2	5.1	3.6	4.0	0.1	0.09	0.16	0.60	0.04	0.04	3.3	3.3
Lithuania	42.8	15.6	27.2	5.4	5.0	2.1	4.7	3.4	3.7	0.04	2.44	0.21	0.30	0.02	0.06	3.1	0.9
Moldova	15.2	1.0	14.2	0.3	0.3	0.1	0.3	0.2	0.2	1.33	0.82	0.22	1.30	0.76	1.36	-2.1	-3.2
Romania	152.0	42.3	109.7	14.7	13.7	5.6	12.9	9.1	10.2	7.97	6.62	2	3.66	13.21	23.45	-14.1	-23.6
Russia	7854.7	4312.7	3542.0	1443.0	1342.0	548.3	1426.8	894.6	995.6	48.66	30.50	14.38	38.65	13.64	22.87	818.0	903.6
Slovenia	23.5	18.7	4.9	6.5	6.0	2.5	5.7	4.0	4.5		0.81		0.23	0.00	0.01	4.0	3.4
Taijkistan	98.9	66.3	32.6	24.2	22.5	9.2	17.9	15.0	16.7	0.56	0.96	0.44	1.30	10.96	6.21	3.0	8.2
Turkmenistan	78.7	1.4	77.4	0.5	0.5	0.2	0.3	0.3	0.3	0.19	0.32	0.42	0.97	24.04	16.68	-24.3	-17.6
Ukraine	341.0	53.1	287.9	17.2	16.0	6.5	18.8	10.6	11.8	13.28	6.08	4.56	15.31	19.69	14.77	-26.9	-24.3
Uzbekistan	92.3	16.3	76.0	6.0	5.5	2.3	4.4	3.7	4.1	1.2	2.00	2.77	12.40	54.37	42.97	-54.6	-53.3

and also for statistical reasons:																	
Cyprus	4.6	0.8	3.8	0.3	0.3	0.1	0.2	0.2	0.2	0.0035	0.02	0.0675	0.09	0.18	0.23	-0.1	-0.2
Gibraltar	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					0.00		0.0	0.0
Malta	0.2	0.05	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0005	0.00	0.04	0.00	0.01	0.00	0.0	0.0
Developing countries																	
Developing Asia	**23608.2**	**11281.4**	**12326.8**	**3946.6**	**3670.3**	**1499.7**	**3388.2**	**2446.9**	**2723.1**	**229.7**	**282.1**	**123.3**	**636.2**	**1547.6**	**1439.1**	**546.3**	**365.8**
Afghanistan	213.4	55.0	158.4	20.5	19.1	7.8	13.9	12.7	14.2		0.80		2.60	22.84	60.66	-10.1	-49.9
Bangladesh	383.8	105.0	278.8	39.4	36.6	15.0	26.3	24.4	27.2	0.52	0.47	2.53	38.35	76.35	35.54	-55.0	-47.2
Bhutan	103.4	95.0	8.4	34.1	31.7	13.0	26.8	21.1	23.5	0.005	0.00	0.02	0.51	0.40	0.13	20.7	22.9
Brunai	15.7	8.5	7.2	3.1	2.8	1.2	2.4	1.9	2.1		0.00		0.00	0.00	0.00	1.9	2.1
Cambodia	344.6	120.6	224.1	43.3	40.3	16.4	34.0	26.8	29.9	0.02	0.09	0.06	0.30	4.00	1.54	22.8	27.9
China	5994.7	2812.4	3182.3	1002.7	932.5	381.0	806.9	621.7	691.9	161.97	113.08	41.47	255.36	426.85	343.75	-8.6	-20.3
Chinese Taipei	87.4		87.4	0.0	0.0	0.0	0.0	0.0	0.0							0.0	0.0
Fiji	47.4	28.6	18.8	10.3	9.5	3.9	8.0	6.4	7.1	0.01	0.01	0.01	0.01	0.05	0.00	6.3	7.1
French Polynesia	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0					0.00		0.0	0.0
India	3558.8	1260.5	2298.3	478.5	445.0	181.8	303.5	296.7	330.2	35.21	60.82	52.24	203.90	558.39	686.86	-349.2	-621.4
Indonesia	5146.5	2838.0	2308.5	936.5	871.0	355.9	964.9	580.7	646.2	0.56	14.50	6.62	21.09	75.60	15.31	497.9	595.3
Kiribati	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					0.00		0.0	0.0
DPR Korea	127.0	67.0	60.0	24.5	22.7	9.3	18.1	15.2	16.9	3.05	3.83	1.79	5.79	4.96	2.29	5.4	5.0
Laos	434.4	190.4	243.9	68.4	63.6	26.0	53.7	42.4	47.2	0.17	0.52	0.13	1.14	2.70	0.61	39.4	44.9
Macau	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0							0.0	0.0
Malaysia	948.2	580.0	368.2	197.2	183.4	74.9	185.6	122.3	136.1	1.9	13.61	1.52	3.70	5.60	0.32	113.2	118.4
Maldives	0.6	0.03	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0001		0.00332		0.00		0.0	0.0
Mongolia	377.4	34.8	342.6	12.0	11.2	4.6	10.8	7.4	8.3	0.12	0.02	0.09	0.05	0.23	1.03	7.0	7.2
Myanmar	1414.6	880.6	534.0	317.0	294.8	120.5	246.6	196.5	218.7	0.18	0.36	0.41	1.57	32.64	5.54	163.3	211.3
Nepal	220.8	198.2	22.6	76.3	71.0	29.0	45.6	47.3	52.7	0.06	0.04	0.3	7.38	9.82	6.29	37.1	38.9
New Caledonia	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.01		0.03	0.00	0.00	0.0	0.0
Pakistan	393.3	55.0	338.3	20.8	19.3	7.9	13.5	12.9	14.3	3.47	7.17	3.27	33.80	162.65	250.77	-156.5	-277.4
Papua New Guinea	1454.1	801.0	653.1	252.3	234.7	95.9	296.4	156.4	174.1	0.03	0.03	0.04	0.10	0.00	0.00	156.4	174.0
Philippines	704.3	479.0	225.3	165.3	153.7	62.8	148.5	102.5	114.0	2.69	36.43	4.73	19.40	21.10	4.19	73.9	54.0
Samoa	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.00		0.00	0.00	0.00	0.0	0.0
Singapore	1.5	0.6	0.9	0.2	0.2	0.1	0.2	0.1	0.1	0.0969		0.0855		0.01		-0.1	0.1
Solomon Islands	87.5	44.7	42.8	16.0	14.9	6.1	12.6	10.0	11.1		0.00		0.00	0.00	0.00	10.0	11.1
Sri Lanka	112.3	50.0	62.3	18.5	17.2	7.0	13.0	11.5	12.8	0.31	0.56	0.3	1.55	12.00	5.19	-1.1	5.5
Thailand	832.4	210.0	622.4	76.0	70.6	28.9	58.1	47.1	52.4	2.14	5.92	2.17	2.16	82.75	6.55	-40.0	37.8
Tonga	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.00		0.00	0.00	0.00	0.0	0.0
Vietnam	604.0	366.5	237.5	133.8	124.4	50.8	99.0	82.9	92.3	17.23	23.79	5.54	37.41	48.62	12.48	11.5	18.6
Vanuatu	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.00		0.00	0.00	0.00	0.0	0.0
Middle east	**791.0**	**183.2**	**607.8**	**69.6**	**64.7**	**26.4**	**44.1**	**43.1**	**48.0**	**12.6**	**20.3**	**17.2**	**28.9**	**184.5**	**165.6**	**-171.2**	**-166.9**
Bahrain	0.1	0.004	0.1	0.0	0.0	0.0	0.00	0.0	0.0	0.0203	0.03	0.1779	0.34	0.16	0.00	-0.4	-0.4
Iran	372.4	128.5	243.9	48.8	45.4	18.6	30.84	30.3	33.7	1.1	14.52	6.2	8.55	86.00	84.70	-63.0	-74.1
Iraq	94.7	35.2	59.5	13.5	12.5	5.1	8.3	8.3	9.3	9.7	1.98	4.3	3.12	52.00	41.64	-57.7	-37.5
Israel	9.2	0.8	8.4	0.3	0.3	0.1	0.185	0.2	0.2	0.113	0.19	0.712	0.55	1.13	1.24	-1.8	-1.8
Jordan	9.9	0.7	9.2	0.3	0.2	0.1	0.16	0.2	0.2	0.0384	0.41	0.2913	0.69	0.61	0.81	-0.8	-1.7
Lebanon	6.9	4.8	2.1	1.8	1.7	0.7	1.25	1.1	1.2	0.15	0.30	0.38	1.62	0.78	0.52	-0.2	-1.2
Kuwait	2.2	0.00	2.2	0.0	0.0	0.0	0.000	0.0	0.0	0.0208	0.18	0.4005	0.49	0.49	0.03	-0.9	-0.7
Oman	26.6	1.4	25.2	0.5	0.5	0.2	0.344	0.3	0.4	0.019	0.07	0.134	0.48	1.17	0.68	-1.0	-0.9
Qatar	0.8	0.1	0.8	0.0	0.0	0.0	0.014	0.0	0.0	0.008	0.02	0.174	0.11	0.26	0.03	-0.4	-0.2
Saudi Arabia	126.8	2.4	124.4	0.9	0.8	0.3	0.590	0.6	0.6	0.70998	0.94	2.12994	7.37	20.83	15.56	-23.1	-23.3
Syria	46.7	7.1	39.5	2.6	2.5	1.0	1.85	1.6	1.8	0.595	1.35	1.426	3.19	14.67	14.24	-15.1	-17.0
United Arab Emirates	6.5	0.2	6.4	0.1	0.1	0.0	0.037	0.0	0.0	0.069	0.05	0.617	0.32	3.31	0.58	-4.0	-0.9
Yemen	88.3	2.1	86.2	0.8	0.7	0.3	0.517	0.5	0.5	0.068	0.27	0.272	2.11	3.06	5.62	-2.9	-7.5
Africa	**17310.6**	**3502.4**	**13808.2**	**1289.1**	**1198.9**	**489.9**	**924.2**	**799.2**	**889.5**	**9.0**	**26.5**	**21.5**	**128.7**	**184.3**	**120.0**	**584.5**	**614.3**
Algeria	211.5	11.2	200.3	4.2	3.9	1.6	2.76	2.6	2.9	0.8	2.45	1.33	4.03	3.94	5.83	-3.4	-9.4
Angola	1258.8	148.0	1110.8	54.3	50.5	20.7	39.31	33.7	37.5	0.06	0.07	0.08	0.54	0.21	0.45	33.3	36.4
Benin	117.0	10.3	106.7	3.8	3.5	1.4	2.74	2.3	2.6	0.03	0.05	0.041	0.83	0.06	0.07	2.2	1.7
Botswana	241.8	2.4	239.4	0.9	0.8	0.3	0.64	0.5	0.6	0.035	0.03	0.079	0.12	0.08	0.09	0.4	0.4
Burkina Faso	204.9	12.5	192.4	4.6	4.3	1.7	3.32	2.8	3.2	0.006	0.00	0.104	1.60	0.69	0.24	2.0	1.3
Burundi	35.5	10.1	25.4	3.7	3.4	1.4	2.67	2.3	2.5	0.017	0.00	0.049	1.49	0.22	0.02	2.0	1.0
Cameroon	762.5	273	489.5	100.2	93.2	38.1	72.52	62.2	69.2	0.08	0.25	0.18	1.93	0.73	0.35	61.2	66.6
Cape Verde	0.9	0.3	0.6	0.1	0.1	0.0	0.08	0.1	0.1	0.0004	0.00	0.0016	0.02	0.02	0.00	0.0	0.1
Central African Republic	836.7	141	695.7	51.8	48.1	19.7	37.45	32.1	35.7	0.004	0.01	0.02	0.29	0.00	0.09	32.1	35.3
Chad	413.2	15.0	398.2	5.5	5.1	2.1	3.98	3.4	3.8		0.01	0.04	0.77	0.19	0.38	3.2	2.6
Comoros	2.0	1.2	0.8	0.4	0.4	0.2	0.32	0.3	0.3	0.0005	0.00	0.0048	0.00	0.00	0.00	0.3	0.3
Congo	562.9	222.0	340.9	81.5	75.8	31.0	58.97	50.5	56.2	0.01	0.02	0.032	0.08	0.00	0.04	50.5	56.1
Demographic Rep. of Congo	562.9	222	340.9	81.5	75.8	31.0	58.97	50.5	56.2	0.06	0.02	0.19	0.08	0.00	0.04	50.3	56.1
Cote d'Ivor	434.7	76.84	357.8	28.2	26.2	10.7	20.41	17.5	19.5	0.11	0.31	0.22	1.71	0.60	0.17	16.6	17.3
Djibouti	5.1	0.3	4.8	0.1	0.1	0.0	0.08	0.1	0.1		0.02		0.03	0.00	0.00	0.1	0.0
Egypt	51.4	1.8	49.6	0.7	0.6	0.3	0.45	0.4	0.5	4	14.43	5.3	19.61	59.00	51.96	-67.9	-85.5
Equatorial Guinea	60.5	26	34.5	9.5	8.9	3.6	6.91	5.9	6.6	0.017	0.00	0.09	0.46	0.00	0.00	5.8	6.1
Eritrea	45.1	2.8	42.3	1.1	1.0	0.4	0.67	0.7	0.7	0.001	0.02	0.031	0.56	0.55	0.35	0.1	-0.2
Ethiopia	936.0	122.0	814.0	46.1	42.8	17.5	29.89	28.6	31.8	0.021	0.37	0.333	10.06	5.20	1.26	23.0	20.1
Gabon	490.0	164.0	326.0	60.2	56.0	22.9	43.56	37.3	41.6	0.01	0.06	0.06	0.10	0.05	0.01	37.2	41.4
Gambia	9.5	3.0	6.5	1.1	1.0	0.4	0.80	0.7	0.8	0.0036	0.00	0.007	0.23	0.02	0.02	0.7	0.5
Ghana	283.2	30.3	252.9	11.1	10.3	4.2	8.05	6.9	7.7	0.095	0.24	0.235	2.78	0.65	0.08	5.9	4.6
Guinea	405.9	226.0	179.9	83.0	77.2	31.5	60.03	51.5	57.3	0.03	0.08	0.12	1.37	1.36	0.24	49.9	55.6
Guinea-Bissau	57.0	16.0	41.0	5.9	5.5	2.2	4.25	3.6	4.1	0.008	0.00	0.023	0.21	0.14	0.11	3.5	3.7

Kenya	365.6	20.7	344.9	7.8	7.2	2.9	5.18	4.8	5.4	0.1	0.52	0.47	7.13	2.17	0.67	2.1	-3.0
Lesotho	23.9	5.2	18.7	1.9	1.8	0.7	1.39	1.2	1.3	0.02	0.02	0.02	0.16	0.01	0.03	1.1	1.1
Liberia	266.3	200.0	66.3	73.4	68.3	27.9	53.13	45.5	50.7	0.02	0.06	0.03	0.42	0.06	0.00	45.4	50.2
Libya	98.5	0.6	97.9	0.2	0.2	0.1	0.14	0.1	0.2	0.132	0.23	0.61	0.82	3.58	5.83	-4.2	-6.7
Madagascar	888.2	337.0	551.2	123.7	115.1	47.0	89.52	76.7	85.4	0.23	0.00	0.42	6.26	14.31	3.44	61.8	75.7
Malawi	140.0	16.1	123.8	5.9	5.5	2.3	4.29	3.7	4.1	0.05	0.06	0.15	1.38	0.81	0.06	2.7	2.6
Mali	349.6	60.0	289.6	22.0	20.5	8.4	15.94	13.7	15.2	0.056	0.04	0.59	1.03	5.90	0.99	7.1	13.1
Mauritania	94.7	0.4	94.3	0.1	0.1	0.1	0.11	0.1	0.1	0.05	0.12	0.15	1.19	1.50	0.88	-1.6	-2.1
Mauritius	4.2	2.8	1.4	1.0	0.9	0.4	0.73	0.6	0.7	0.02	0.17	0.214	0.08	0.49	0.00	-0.1	0.4
Morocco	154.7	29.0	125.7	11.1	10.3	4.2	6.82	6.9	7.7	0.36	1.05	1.23	4.48	11.01	12.10	-5.7	-10.0
Mozambique	827.2	100.3	726.9	36.8	34.3	14.0	26.64	22.8	25.4	0.01	0.02	0.07	1.16	0.55	0.44	22.2	23.8
Namibia	235.3	6.2	229.1	2.3	2.1	0.9	1.64	1.4	1.6	0.014	0.01	0.073	0.35	0.21	0.13	1.1	1.1
Niger	190.8	3.5	187.3	1.3	1.2	0.5	0.93	0.8	0.9	0.01	0.03	0.09	1.76	2.08	0.92	-1.4	-1.8
Nigeria	1062.3	221.0	841.3	81.8	76.0	31.1	57.46	50.7	56.4	0.81	1.72	1.69	26.83	5.51	1.27	42.7	26.6
Reunion	7.5	5.0	2.5	1.8	1.7	0.7	1.33	1.1	1.3					0.00		1.1	1.3
Rwanda	31.9	9.5	22.4	3.5	3.2	1.3	2.52	2.2	2.4	0.012	0.07	0.036	1.07	0.10	0.02	2.0	1.2
Sao Tome and Principe	3.1	2.18	0.9	0.8	0.7	0.3	0.58	0.5	0.6		0.00		0.00	0.00	0.00	0.5	0.6
Senegal	135.0	25.8	109.2	9.5	8.8	3.6	6.85	5.9	6.5	0.058	0.16	0.098	0.76	2.07	0.65	3.7	5.0
Sychelles	0.9	0	0.9	0.0	0.0	0.0	0.00	0.0	0.0					0.00		0.0	0.0
Sierra Leone	181.2	160.0	21.2	58.8	54.6	22.3	42.50	36.4	40.5	0.01	0.04	0.02	0.62	0.35	0.12	36.0	39.7
Somalia	180.1	6.0	174.1	2.2	2.0	0.8	1.59	1.4	1.5	0.002	0.00	0.015	1.04	3.28	2.09	-1.9	-1.6
South Africa	603.9	44.8	559.1	16.5	15.3	6.3	11.87	10.2	11.4	0.756	1.99	3.904	6.38	7.84	10.93	-2.3	-7.9
Sudan	1042.0	30.0	1012.0	11.4	10.6	4.3	7.20	7.1	7.9	0.26	0.92	0.99	6.27	36.07	12.26	-30.3	-11.6
Swaziland	13.7	2.6	11.0	1.0	0.9	0.4	0.70	0.6	0.7	0.012	0.01	0.024	0.09	1.01	0.17	-0.4	0.4
United Republic of Tanzania	1012.2	84	928.2	30.8	28.7	11.7	22.31	19.1	21.3	0.025	0.06	0.527	2.10	4.63	0.64	13.9	18.5
Togo	66.3	11.5	54.8	4.2	3.9	1.6	3.05	2.6	2.9	0.004	0.04	0.089	0.97	0.08	0.03	2.4	1.9
Tunisia	33.9	4.2	29.7	1.6	1.5	0.6	1.05	1.0	1.1	0.11	0.25	0.365	1.04	2.17	3.39	-1.7	-3.6
Uganda	284.5	39.0	245.5	14.3	13.3	5.4	10.40	8.9	9.9	0.05	0.16	0.13	3.45	0.12	0.16	8.6	6.1
Zambia	767.4	80.2	687.2	29.4	27.4	11.2	21.30	18.3	20.3	0.13	0.12	0.29	1.00	1.32	0.23	16.5	19.0
Zimbabwe	256.7	256.7	0.0	94.3	87.7	35.8	68.19	58.4	65.0	0.298	0.20	0.589	1.95	3.32	0.72	54.2	62.2
Latin America	**30127.4**	**13154.0**	**16973.4**	**4552.6**	**4233.9**	**1730.0**	**4048.8**	**2822.6**	**3141.3**	**23.2**	**107.7**	**36.9**	**98.1**	**127.0**	**67.4**	**2635.5**	**2868.1**
Antigua and Barbuda	0.5	0.1	0.4	0.0	0.0	0.0	0.016	0.0	0.0	0.001	0.00	0.003	0.00	0.00	0.00	0.0	0.0
Argentina	1642.1	276.0	1366.1	93.3	86.8	35.4	89.42	57.8	64.4	2.76	23.97	4.91	6.34	21.52	12.20	28.6	21.9
Bahamas	17.9	0.02	17.9	0.0	0.0	0.0	0.01	0.0	0.0		0.98		0.03	0.00	0.00	0.0	-1.0
Barbados	0.6	0.1	0.5	0.0	0.0	0.0	0.02	0.0	0.0	0.04	0.04	0.03	0.02	0.02	0.00	-0.1	0.0
Belize	39.1	16.0	23.1	5.5	5.1	2.1	4.94	3.4	3.8	0.11	0.00	0.01	0.02	0.03	0.01	3.3	3.8
Bermuda	0.0	0	0.0	0.0	0.0	0.0	0.00	0.0	0.0					0.00		0.0	0.0
Bolivia	1258.9	303.5	955.3	104.9	97.6	39.9	93.66	65.1	72.4	0.099	1.40	0.18	5.32	1.16	0.98	63.6	64.7
Brazil	15235.7	5418.0	9817.7	1861.5	1731.2	707.4	1695.06	1154.1	1284.4	10.65	30.15	12.02	35.00	36.63	9.88	1094.8	1209.4
Chile	1151.6	884.0	267.6	318.2	296.0	120.9	247.52	197.3	219.6	3.16	28.96	1.42	3.33	7.97	25.14	184.8	162.2
Colombia	2974.6	2112.0	862.6	718.1	667.8	272.9	675.84	445.2	495.5	0.4	2.12	5.39	8.34	4.92	1.93	434.5	483.1
Costa rica	149.5	112.4	37.1	38.9	36.1	14.8	34.68	24.1	26.8	0.46	0.60	0.79	0.56	1.43	0.19	21.4	25.5
Cuba	148.0	38.1	109.8	13.7	12.8	5.2	10.6736	8.5	9.5	1	0.74	1.56	7.67	5.64	2.11	0.3	-1.1
Dominica	1.6	0.0	1.6	0.0	0.0	0.0	0.00	0.0	0.0		0.00		0.00	0.00	0.00	0.0	0.0
Dominican Republic	68.7	21.0	47.7	7.3	6.8	2.8	6.48	4.5	5.0	0.06	1.66	1.09	1.28	2.24	0.84	1.1	1.2
Ecuador	591.8	432.0	159.8	149.3	138.9	56.8	133.30	92.6	103.1	0.9	0.62	2.12	2.47	13.96	1.41	75.6	98.6
El Salvador	36.3	17.75	18.5	6.1	5.7	2.3	5.48	3.8	4.2	0.2	0.28	0.32	0.97	0.76	0.07	2.5	2.9
French Guiana	260.6	134	126.6	46.3	43.1	17.6	41.35	28.7	32.0		0.01		0.01	0.00	0.00	28.7	31.9
Grenada	0.8	0.0	0.8	0.0	0.0	0.0	0.00	0.0	0.0		0.00		0.00	0.00	0.00	0.0	0.0
Guadaloupe	0.0	0	0.0	0.0	0.0	0.0	0.00	0.0	0.0		0.00		0.00	0.00	0.00	0.0	0.0
Guatemala	217.3	109.2	108.1	37.8	35.1	14.3	33.70	23.4	26.0	0.27	1.62	0.13	1.24	1.61	0.10	21.4	23.1
Guyana	513.1	241.0	272.1	83.3	77.5	31.7	74.37	51.7	57.5	0.01	0.00	0.03	0.25	1.60	0.35	50.0	56.9
Haiti	40.0	13.0	27.0	4.5	4.2	1.7	4.01	2.8	3.1	0.01	0.34	0.05	1.49	0.93	0.31	1.8	1.0
Honduras	221.4	95.9	125.5	33.2	30.8	12.6	29.60	20.6	22.9	0.1	0.48	0.07	0.45	0.69	0.28	19.7	21.7
Jamaica	22.5	9.4	13.1	3.3	3.0	1.2	2.90	2.0	2.2	0.07	0.24	0.14	0.39	0.20	0.02	1.6	1.6
Martinique	0.0	0	0.0	0.0	0.0	0.0	0.00	0.0	0.0		0.00		0.00	0.00	0.00	0.0	0.0
Netherlands Antilles	0.0	0	0.0	0.0	0.0	0.0	0.00	0.0	0.0		0.00		0.00	0.00	0.00	0.0	0.0
Nicaragua	310.9	189.7	121.1	65.6	61.0	24.9	58.55	40.7	45.3	0.03	0.94	0.19	2.64	1.08	0.34	39.4	41.3
Panama	203.3	147.4	55.9	51.0	47.4	19.4	45.49	31.6	35.2	0.04	0.60	0.55	0.79	0.23	0.04	30.8	33.7
Paruguay	459.5	94.0	365.5	32.5	30.2	12.3	29.01	20.1	22.4	0.04	0.08	0.1	1.19	0.35	0.25	19.7	20.9
Peru	2233.7	1616.0	617.7	576.4	536.0	219.0	463.25	357.4	397.7	2.03	5.23	1.68	10.82	16.42	7.79	337.2	373.9
St. Kitts and Nevis	0.5	0.02	0.5	0.0	0.0	0.0	0.01	0.0	0.0		0.00		0.00	0.00	0.00	0.0	0.0
Saint Lucia	1.4	0	1.4	0.0	0.0	0.0	0.00	0.0	0.0		0.00		0.00	0.00	0.00	0.0	0.0
St. Vincent and Grenadines	0.6	0	0.6	0.0	0.0	0.0	0.00	0.0	0.0		0.00		0.00	0.00	0.00	0.0	0.0
Surinam	380.6	88.0	292.6	30.4	28.3	11.6	27.15	18.9	21.0	0.02	0.05	0.03	0.04	0.62	0.18	18.2	20.7
Trinidad and Tobago	11.3	3.8	7.4	1.3	1.2	0.5	1.18	0.8	0.9	0.08	1.25	0.21	0.52	0.02	0.01	0.5	-0.9
Uruguay	222.9	59.0	163.9	20.4	19.0	7.8	18.21	12.6	14.1	0.04	0.12	0.08	0.83	3.03	1.35	9.5	11.8
Venezuela	1710.1	722.5	987.6	249.8	232.3	94.9	222.93	154.9	172.3	0.59	5.18	3.81	6.12	3.97	1.59	146.5	159.4
World total (sum of regions)	**103972.6**	**42593.2**	**61379.4**	**14607.7**	**13585.1**	**5550.9**	**13377.8**	**9056.8**	**10079.3**	**782.9**	**980.6**	**380.5**	**1190.6**	**2687.6**	**2367.9**	**5205.8**	**5540.3**

Source notes:
1) preciptation, IRWR and 2005 withdrawal data obtained from AQUASTAT (FAO, 2008c)
2) Environmental flows based on Smakhtin, Revenga & Döll (2004)
3) runoff partitioning based on Postel et al. (1996)
4) 2030 withdrawal data based on Alcamo et al. (2003)