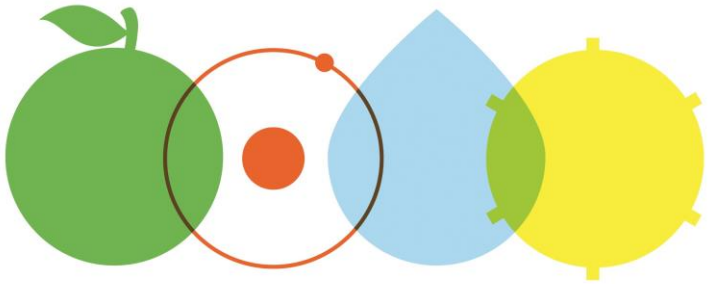

A bottom-up approach to the nexus of energy, food and water security in the Economic Community of West African States (ECOWAS) region

Prof. Subhes Bhattacharyya

Mr. Nicola Bugatti

Mr. Hannes Bauer

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About the Nexus Network think piece series

Funded by the ESRC, the Nexus Network is a collaboration between the University of Sussex, the STEPs Centre, the University of East Anglia, and the Cambridge Institute for Sustainability Leadership. The Nexus Network brings together researchers, policy makers, business leaders and civil society to develop collaborative projects and improve decision making on food, energy, water and the environment. In 2014, the Nexus Network commissioned a series of think pieces with the remit of scoping and defining nexus approaches, and stimulating debate across the linked domains of food, energy, water and the environment.

About the authors

Prof. Subhes Bhattacharyya subhesb@dmu.ac.uk

Professor of Energy Economics and Policy, Institute of Energy and Sustainable Development, De Montfort University. Professor Subhes Bhattacharyya is an internationally renowned energy specialist working on global energy-environment issues with more than 25 years of experience. Subhes specialises in energy, regulatory and environmental studies from a multi-disciplinary perspective taking techno-economic, governance, and management and policy aspects into consideration.

Mr Nicola Bugatti Nbugatti@ecreee.org

Mr Hannes Bauer HBauer@ecreee.org

Abstract

The Economic Community of West African States (ECOWAS) comprises 15 countries from 6 different climatic zones. A review of existing national and regional policies related to water-energy and food security nexus was undertaken for the ECOWAS region and a stock-taking and mapping exercise of field-level activities undertaken by practitioners was conducted. This thought piece presents the results of the above exercises. The purpose of this work is to provide structured information that forms the knowledge baseline for future Nexus initiatives in the region and provides a clear direction for policy initiatives by identifying the gaps, weaknesses and inconsistencies and suggesting any potential for synergies and integration to facilitate policy-making processes.

We find that ECOWAS region has made good progress at the regional level in terms developing an integrated agenda, particularly for water, which has adopted a nexus approach. The member states are also moving in the right direction but a silo mentality still prevails, particularly in terms of project decisions, prioritisations and resource allocation. A decentralised decision making has not deepened in many states and authority has not been appropriately delegated. Various stresses have resulted in the region in the absence of of a nexus approach. Yet, micro-level initiatives are emerging which showcase innovative approaches to deal with the challenges. We suggest rapid replication of such experiences through dissemination and cross-learning, and the provision of enabling conditions can make a major difference.

Keywords: ECOWAS, nexus, top-down, bottom-up

Introduction

It is now recognised that an integrated approach, as opposed to working in independent silos, is essential to ensure our long-term global water, energy and food (WEF) security[1]. Nothing can better capture this challenge than two opposing conditions marking our present situation: on one hand, rapid urbanisation, incredible rise in the middle income group and catch-up with western consumerism through rapid changes in the life-styles have exerted unprecedented pressure on resources such as energy, water and food, with consequent environmental and social implications. On the other hand, approximately 1.2 billion people in the world live with an income below $1.25 per day; approximately 805 million people remain chronically undernourished, approximately 1.3 billion people lack access to electricity, more than 2.5 billion lack access to clean cooking energies in the world and 900 million lack access to safe drinking water. The widespread prevalence of poverty, the consequent deprivation of the basic minimum needs of a population and the unequal distribution of wealth cause long-term impacts.

The Economic Community of West African States (ECOWAS) exemplifies the above contrast: the community of 15 countries with a population of above 300 million faces the prospect of doubling its population by 2030. Almost 58% of the population lives in rural areas and 42% inhabitants of the community lived below the poverty line in 2010. Most of the countries ranked poorly in terms of Human Development Index[2]. 35% of the population lacked access to drinking water in 2010, and 74% did not have access to improved sanitation. It is estimated that approximately 12% of potentially irrigable land is irrigated at present. On the other hand, the region boasts of significant oil and gas resources, a large hydro-electricity potential of 25000 MW and home of major trans-boundary rivers (e.g. Niger, Senegal, and Volta among others). The region is growing fast economically and an integrated approach to development becomes imperative to make best use of the available resources in the community to ensure sustainable development.

The purpose of this think piece is to consider the water-energy-food (WEF) security nexus in the ECOWAS community with an emphasis on policy integration. The feedback from the practice-oriented initiatives already underway in the community countries will also be used to identify possible lessons and the way forward. The paper is organised as follows: Section B introduces the WEF linkages and indicates the implications for ECOWAS community. This is followed by a brief overview of the ECOWAS community. A review of the current status of WEF policy integration in the community is presented in Section D. Section E presents the bottom-up experiences along with the potential policy influences from the field. Finally, some concluding remarks are presented in the last section.

Water-Energy-Food Linkages in the literature

The complex inter-relationships between water, energy and food security has been highlighted by various authors including the Limits to Growth by the Club of Rome[3] which provided a systems view of the interrelated nature of economic growth challenge. In most cases, the linkages are viewed from the perspectives of energy, water or food[4]. For example an early study[5] tried to capture the inter-relationships between water, energy, land, materials and manpower from an energy perspective. However, the policy focus of the nexus came more recently. The WEHAB framework (see Fig. 1) proposed by then UN Secretary General Kofi Annan in 2002 was one of the first international attempts in this area, seen from an energy policy perspective[6]. This qualitatively highlights the unequal access to these resources, the possibility of leveraging one resource to enhance the other (e.g. water for hydropower, energy for irrigation in agriculture, or food for fuel). Harris used a scenario-based approach to explore the likely status of WEF nexus in 2020 considering the inter-linkages[7]. The study used two scenarios – the kick start and destroying forward – capture two alternative options of slowly adopting sustainable development and moving quickly to a revolutionary path of sustainable development.

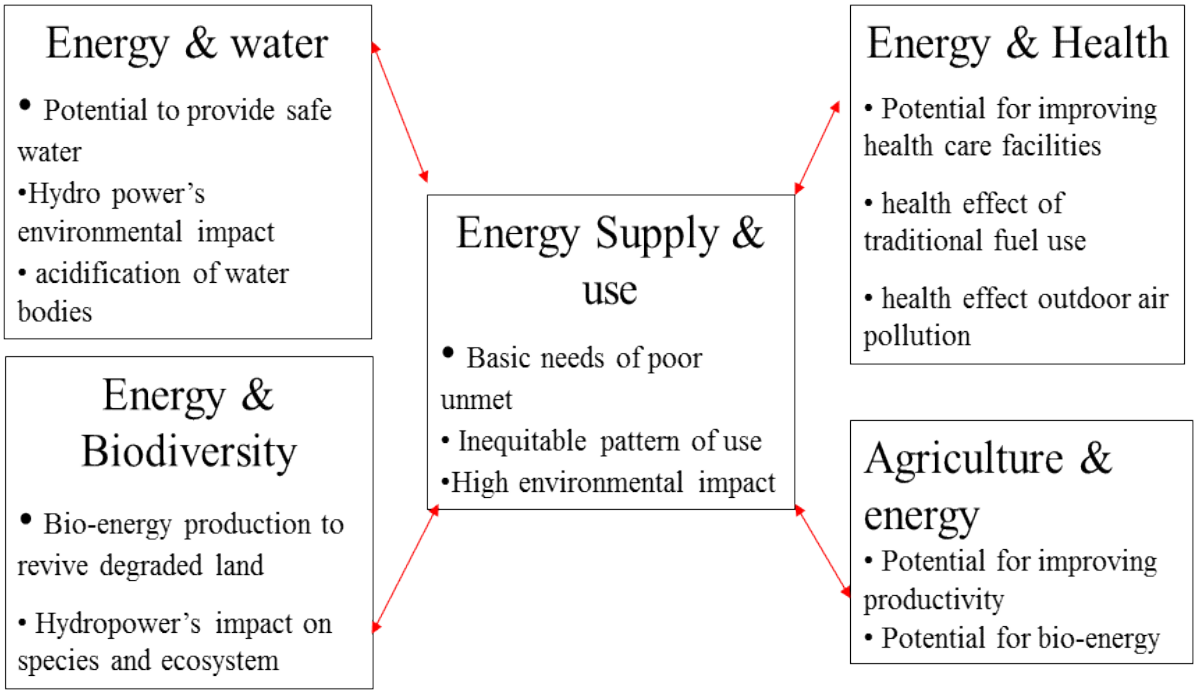

Figure 1. WEHAB framework[8]

More recently, the Bonn Nexus Conference in 2011[9] has approached the problem from a water security perspective (see fig. 2), while the World Economic Forum has emphasised on the risks arising from the security concerns (see fig. 3) and their implications for the businesses and governance[10]. Given their focus on sustainable development, all the above emphasised on the three pillars of sustainable development, with the Bonn Conference adding the governance as the fourth pillar.

The Bonn Conference framework identified urbanisation, population growth and climate change as the main drivers influencing the WEF nexus through its effects on water availability and suggested actions in social, economic and environmental dimensions using finance, governance and innovation as enablers and incentives to achieve universal access, equitable development and a resilient productive system. The World Economic Forum considers population, economic growth and environmental pressures as the main drivers behind resource security concerns. The governance failure and economic disparity exacerbate the risks of conflicts and adoption of unsustainable solutions. It suggests that most opportunities for trade-off between WEF resources exist at the local level but separate administrative structures dealing with each resource makes the management of these trade-offs challenging. [11]

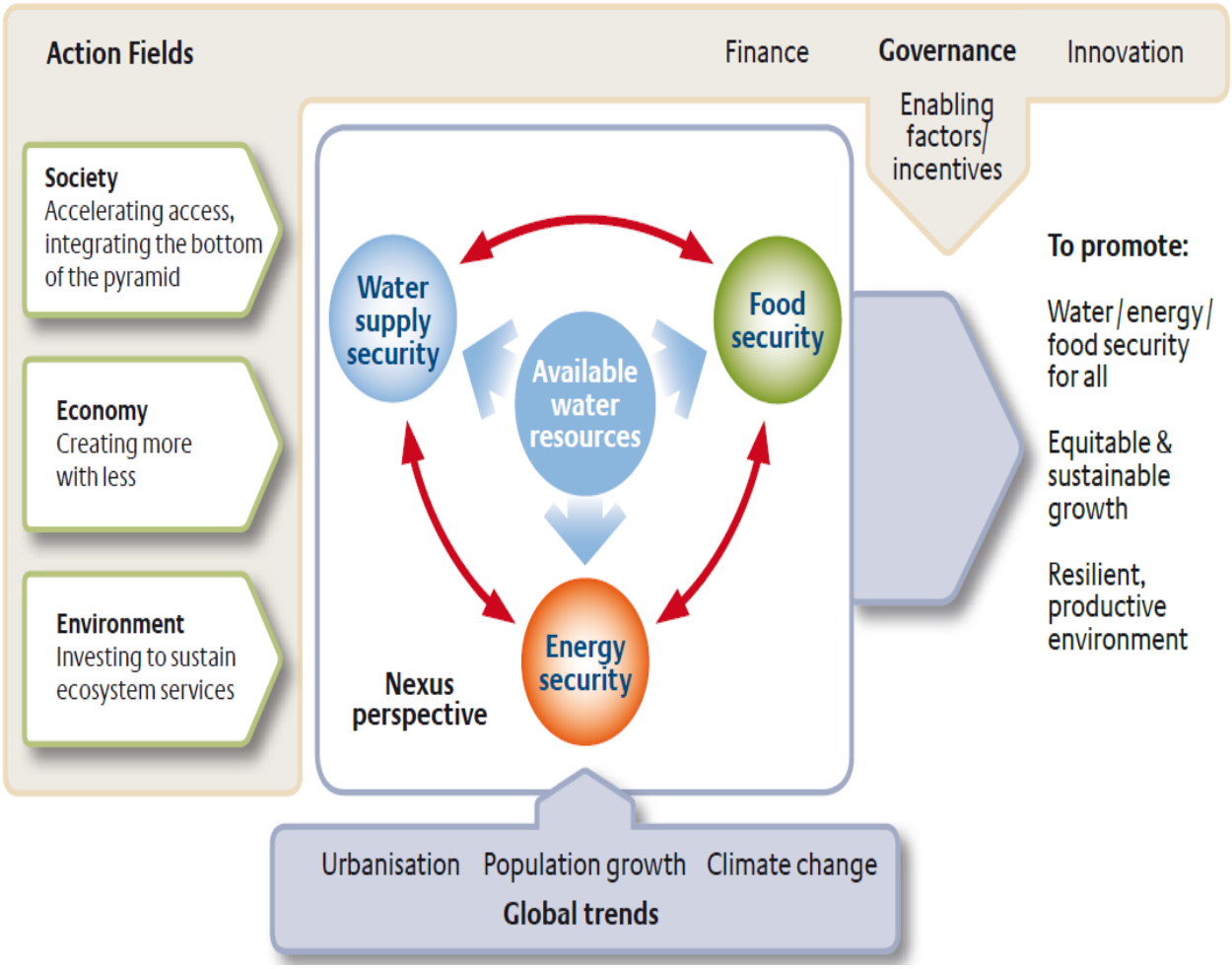

Figure 2. The Bonn Nexus Conference framework – from a water security perspective[12]

With billions of people lacking access to these critical "global goods" at a time when the demand is growing rapidly to compete with a regionally varied and often constrained availability[13], the nexus requires an integrated analytical framework taking possible interactions into consideration. The International Institute of Sustainable Development (IISD) has presented an eco-system-based framework[14] considering the use, access and availability dimensions of food, water and energy and identifying the influences of each on the other in a

holistic framework for a given geo-spatial location (see fig. 4). This implementation-oriented framework captures the interactions between the ecosystem, built-environment and governance dimensions, thereby facilitating identification of various levels of decision-making and policy influences that can affect the WEF nexus.

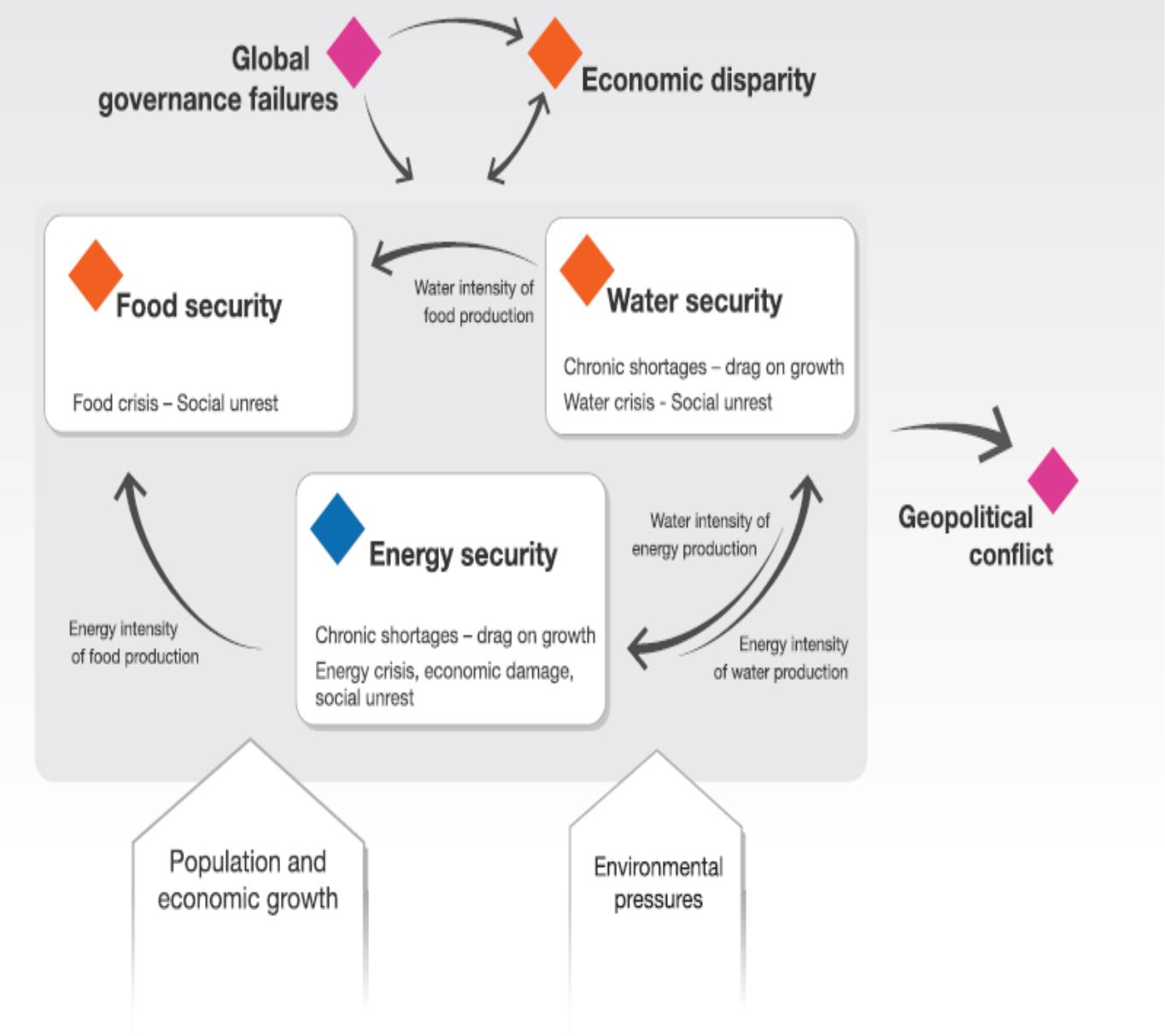

Figure 3. WEF Nexus framework – from a security of water, energy and food perspective[15]

In addition to the above qualitative frameworks, modelling frameworks have also been attempted. An integrated modelling system of LEAP (Long-range Energy Alternatives Planning) and WEAP (Water Evaluation and Planning System) developed and maintained by the Stockholm Environment Institute is one such tool to explore water-energy nexus issues. The framework does not capture the food dimension directly although food can be incorporated through water and energy perspectives. The Climate, Land-use, Energy and Water (CLEW) strategies integrate the relevant perspective to investigate the WEF nexus[16]. This framework combines different reference systems (see Fig. 5 for an example) to produce

insights into specific cases and country studies (e.g. energy system interdependencies in Mauritius have been analysed[17].

Our brief literature review suggests that inter-relations exist throughout the entire chain of each resource or dimension as well as with the rest of the ecosystem and the built environment. The multi-dimensional interaction works through various channels – global, regional and local and can be regarded from a water-centric or energy-centric or food-centric perspective. As water, energy and food derive from the ecosystem services, the nexus cannot be appreciated without embedding it within the natural ecosystem. However, the exact nature of the linkage will depend on specific cases based on the local conditions, the nature of activities and their drivers, institutional and governance arrangements and the like.

For the ECOWAS region, with a diverse range of states with varying resource endowments, living conditions and geo-climatic conditions, the importance of WEF nexus can be considered at the primary and secondary production levels of food and energy; at the use level (with an emphasis on access to these resources) as well as from a globalisation perspective. The policy integration considered in the next section addresses this.

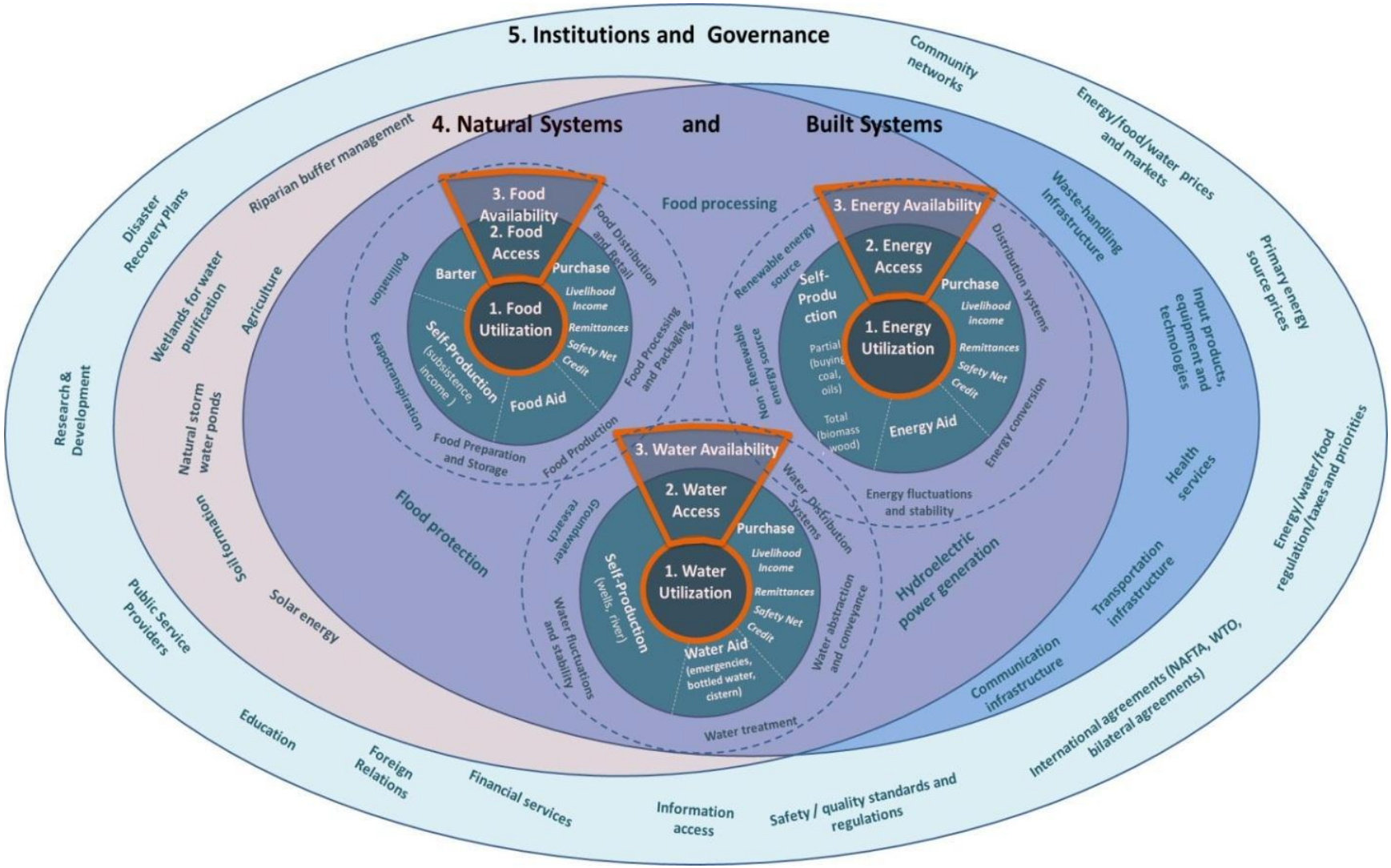

Figure 4. IISD's Nexus framework[18]

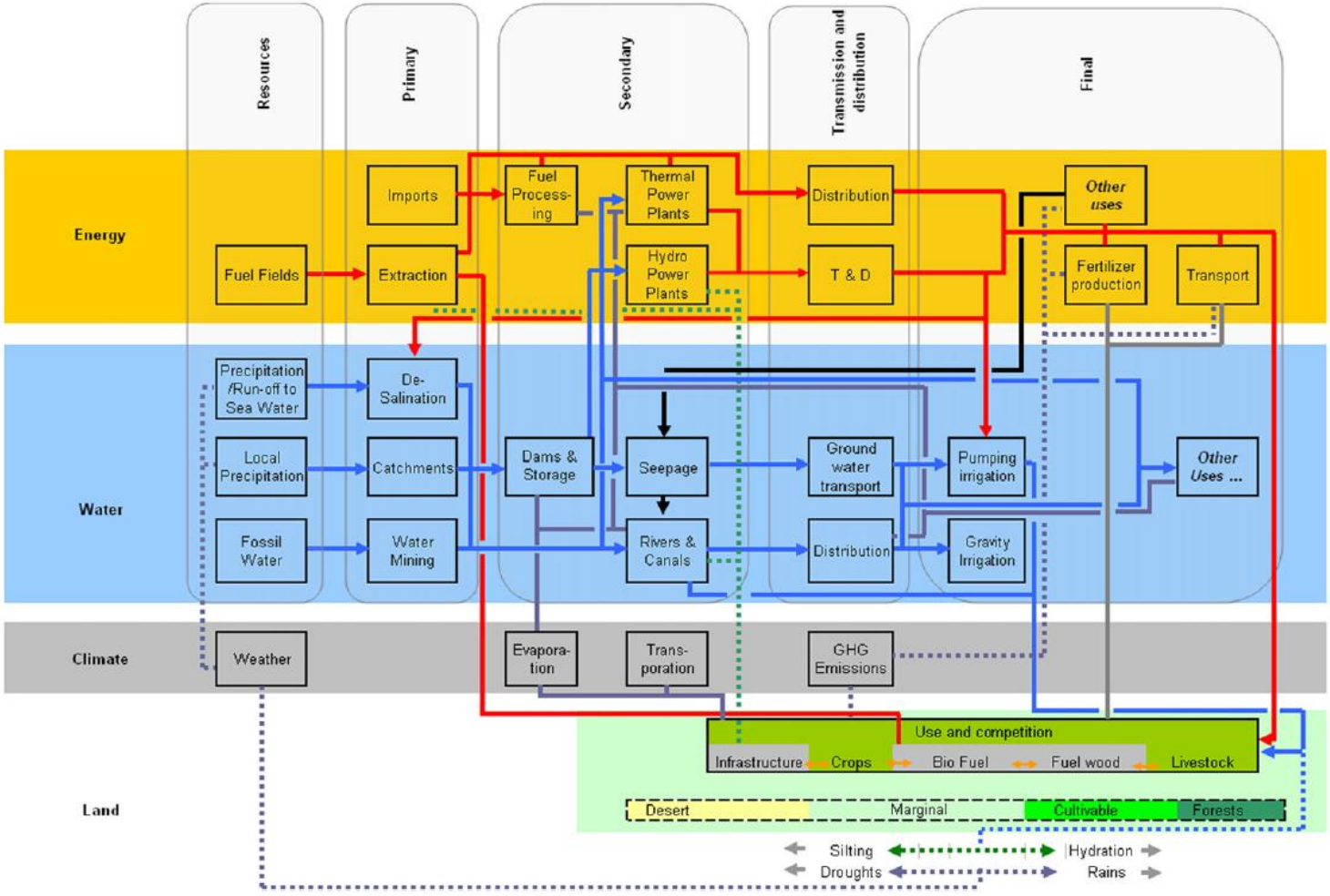

Figure 5. Integrated reference system diagrams for the CLEW framework[19]

Background information on the ECOWAS Community

The Economic Community of West African States (ECOWAS) was established in 1975 by 15 states covering an area of just above 5 million km^2 to promote economic co-operation and integration across all economic activities. The community is composed of members with varying socio-economic conditions (see table 1 for details).

Cape Verde, Gambia and Guinea-Bissau, are very small in terms of size and population, while three other member countries, namely Mali, Niger and Nigeria, account for about 60% of the total land area of the community. Nigeria is the most populous country as well as the largest economy in the region accounting for 53% of the regional population and 81% of the regional gross domestic output. Nigeria had the highest income per person in purchasing power parity terms in 2013, followed by Cape Verde but most of the countries in the community have a relatively low economic output level. A noticeable feature of the region is its widespread poverty – 54% of the population live with less than $1.25 and 80% with less than $2 per day income. This low income and high poverty incidence affects the human development of the region and except Cape Verde, Ghana, and Nigeria, the rest of the member states rank below 160 in HDI ranking in 2013.

The member states exhibit great diversity in natural resource endowments. For example, Nigeria is the most prominent oil and gas producer in the community, Guinea holds 50% of the world's bauxite reserves, Mali is the third largest gold producer in Africa, Niger has large uranium reserves and Sierra Leone is richly endowed with iron, bauxite, diamond, gold and platinum. Agricultural outputs (food and non-food), primary raw materials and energy resources contribute differently to the GDP of the member states. Generally, natural resources contribute a significant share of the GDP in most of the countries but the share falls as a country moves up the income ladder (table 2).

Table 1

Socio-economic conditions of ECOWAS states in 2013[20],[21]

Country	Area (1,000 km2)	Population (M)	GDP PPP (Million USD)	Population density (people/km2)	Per capita GDP PPP (USD)	% of population below $1.25/day	% population below $2 per day	HDI	HDI Rank
Benin	115	10.323	16,653	90	1,613	47.3	75.3	0.476	165
Burkina Faso	274	16.935	27,883	62	1,646	44.6	72.6	0.388	181
Cape Verde	4	0.499	2,074	125	4,156	21.0	40.9	0.636	121
Cote d'Ivoire	322	20.316	42,968	63	2,115	23.8	46.3	0.452	171
The Gambia	11	1.849	3,737	168	2,021	33.6	55.9	0.441	172
Ghana	239	25.905	17,184	108	663	28.6	51.8	0.573	138
Guinea	246	11.745	12,778	48	1,088	43.3	69.6	0.392	178
Guinea-Bissau	36	1.704	2,373	47	1,393	48.9	78.0	0.396	177
Liberia	111	4.294	3,294	39	767	83.8	94.9	0.412	175
Mali	*1240*	*15.302*	*18,330*	*12*	*1,198*	*50.4*	*78.7*	*0.407*	*176*
Niger	1267	17.831	13,881	14	778	43.6	75.2	0.337	186
Nigeria	924	173.615	871,440	188	5,019	68.0	84.5	0.504	153
Senegal	197	14.133	24,467	72	1,731	29.6	55.2	0.485	160
Sierra Lione	72	6.092	9,932	85	1,630	51.7	79.6	0.374	184
Togo	57	6.817	6,680	120	980	28.2	52.7	0.473	167
ECOWAS	5115	327.36	1,073,674	64	3,280	54.3	80.5		

Table 2
Contribution of primary resources to GDP of ECOWAS states in 2010[22]

Country	Gross resource production per capita (USD nominal 2000)					Resource share
	Hard	Energy	Food	Non-food	Total	(% GDP)
Benin			405	23	428	58%
Burkina Faso	59		243	30	332	62%
Cape Verde				17.8	17.8	5%
Cote d'Ivoire	17	86	487	46	636	55%
The Gambia	8		179		187	31%
Ghana	162	9	494	3	668	51%
Guinea	128		348	12	488	103%
Guinea-Bissau			346	4	350	63%
Liberia			148	32	180	73%
Mali	112		399	14	525	86%
Niger	36	1	426	1	464	133%
Nigeria	0	514	348	5	867	70%
Senegal	27	1	249	2	279	27%
Sierra Lione	20		224	6	250	77%
Togo	19		250	11	280	53%

The ECOWAS region has some other notable facets. Despite improving political situation in the region, there are concerns about political stability, peace and inclusive participation of the population in the political process. The region is characterised by a low level of access to clean energies, and a high dependence on biomass. This also results in a low per capita energy use in the region. Member states use 122 kWh of electricity per person per year on average, one of the lowest usage rates in the world[23]. 45% of the population has access to electricity within the ECOWAS community, although there is wide variability across states (see Table 3). Moreover, the region has an installed electricity generation capacity of 14 GW, which is inadequate to meet the system peak demand and consequently, countries suffer regular prolonged power outages which impose significant economic costs. Privately owned backup systems, mainly in the form of diesel generators, have proliferated as a mitigating measure. For example, it is reported that Nigeria alone has 28 GW of such backup systems[24].

The region uses just 4% of the available 1,000 billion m^3 of renewable water resources at present and 35% of the population lack access to clean water. Only 12% of the potential irrigable land is irrigated and only 16% of the estimated hydropower potential of 25 GW has been used.

Table 3:
Electricity access and per capita electricity use in ECOWAS states[25]

Country	Electricity access %	Electricity consumption per capita, kWh
Benin	26.5	96.1
Burkina Faso	27	47.6
Cape Verde	87	524.7
Cote d'Ivoire	72.9	183.5
The Gambia	15	121.8
Ghana	66.7	225.3
Guinea	20.2	87.3
Guinea-Bissau	15	39.8
Liberia	15	84.5
Mali	27.1	33.2
Niger	9.6	54.5
Nigeria	50.6	126.1
Senegal	54	180.1
Sierra Lione	15	25.7
Togo	22.5	102.6
ECOWAS	45.1	122.9

Agriculture is the main economic activity in the region contributing about 35% of the regional GDP and employing 60-65% of the population[26]. Although land availability in West Africa was 2/3 ha per capita in 1960, population pressure has reduced it to 1/3 ha per capita in 2009[27]. The local crop supply is unable to meet the growing demand, a situation arising from human consumption, animal feed and industrial use. The region is becoming increasingly dependent on protein import from the rest of the world as the local production of meat and milk can supply only 8.7 kg of meat and 7.7 kg of milk per person per year[28]. Interestingly, the region has grown at an average rate of 4.7% per year between 2004 and 2012 and the regional economic growth is likely to accelerate to 7% in 2014 and 2015[29]. With accelerated economic growth in most of the states, water-energy-food nexus will emerge an important issue in the region, to which we turn next.

Water-Energy-Food Policy integration in the ECOWAS Community

Policy integration in the region has been initiated through various regional efforts aimed at improving food security, access to energy and energy efficiency, promote renewable energies, and co-ordinate water resources in the region. Some relevant developments for the WEF nexus are discussed below.

Agricultural policy integration

Agricultural policy integration has been attempted since 2000[30]. The ECOWAS Agricultural Policy (ECOWAP) was adopted in 2005, which is implemented through national investment plans and a regional investment plan that has identified six focal areas including emphasis on improved water management as well as management of other shared natural resources. Member states have committed to allocate 10% or more of national budget to agricultural development and to attain a minimum of 6% of annual agriculture sector growth which will contribute towards the ECOWAS target of a 50% increase in the production of staple food during the plan period (2008-2014). Three categories of food items have been targeted: crops, meat and milk, and fish. An investment of $247 million is planned at the regional level for staple food while $92 million is allocated to improve livestock systems and their industrial networks[31]. Similarly, member states have prepared National Agricultural Investment Plans and have initiated implementation activities. Bold pro-agriculture initiatives and concrete measures are being taken to strengthen the agricultural sector and enhance food security. For example, Niger aims to increase cereal production from 3 million tons to 5 million tons per year; Mali has undertaken the Rice Initiative; and Benin has extended its size of irrigated land. However, a review of the national investment strategies[32] indicates that the plans have not prioritised the investment activities, have not co-ordinated their choices and complementarities with member states, are not adequately supported by appropriate strategies and have chosen to rely on traditional incentives such as input subsidies and funding of land use and small agricultural equipment. Consequently, the progress has remained slow due to political instability, lack of sufficient financial resources, limited capacity and voluntary nature of the participation without any strong compliance arrangement[33]. Moreover, an opportunity has perhaps been missed to integrate water and energy dimensions in these investment plans and policies. Achieving the targets of at least 6% annual growth in the agricultural sector would place additional demand on energy and water. Water demand will grow as the area under cultivation increases, animal rearing is intensified and industrial processing of food and food products is encouraged. Although water management is identified as a thrust area, integration of water and food policies has not happened. The region has one of the lowest use of irrigation (only 3.6% compared to a world average of 18%) while the rainfall follows a predominantly seasonal (i.e. monsoon dependent) and spatially varying pattern (with some parts receiving above 4000 ml per year while the dry areas receiving scanty rainfall of 50 ml per year)[34]. The region also uses 125 g/ha of fertiliser against a world average of 1020g/ha and limited farming equipment such as tractors (13

tractors per 100 km2 against a world average of 200 tractors per 100 km2)[35]. Clearly, food security enhancement cannot be achieved without improving factor inputs for agricultural production. The Food and Agricultural Organisation has estimated that 8.9 million hectares of land can be potentially irrigated and the river basin authorities in the region already have plans for infrastructure development for irrigation and power generation but the potential for technological leapfrogging and holistic decision-making could be missed in the absence of a systemic view.

Similarly, the energy demand for farming and food processing will increase, which could be better managed through an integrated policy regime. Given that a large majority of the population resides in rural areas and tends to be poor, it is imperative that better income generation opportunities need to be supported through use of energy and water for producing value-added local products. This requires an integrated approach.

Energy policy integration

Considering the prevailing energy issues in the region, ECOWAS has devoted its attention to energy policy since 1982 when the ECOWAS Energy Policy was adopted. Further effort has gone into this sector since 2006 when the West African Power Pool was set up, the Energy Generation and Transmission Master Plan was developed, and a White Paper on energy access was approved. The Master Plan was revised in 2011 and aims to add 10.3 GW of regional electricity capacity at a cost of $18 billion. Approximately 7 GW of electricity will be sourced from hydropower projects and another 800 MW from renewable generators[36]. The energy access White Paper has set three targets to be achieved by 2015: (1) 100% of the population should have access to improved cooking fuels and stoves; (2) 100% of urban areas and 36% of rural areas to have access to electricity and (3) 60% of the population living in rural areas to have access to motive power for productive use[37].

In July 2013, two energy policies were approved by the Heads of States and Governments: the ECOWAS Renewable Energy Policy and the ECOWAS Energy Efficiency Policy. The Renewable Energy Policy aims to achieve[38] 35% of overall regional share of renewable energy in installed electricity capacity by 2020 and to reach 48% renewable energy penetration in electricity capacity by 2030. An off-grid electrification target of 25% by 2030 (the remaining 75% to be covered by grid extension, thereby complying with the Sustainable Energy for All targets). First generation bio-ethanol target of 5% of gasoline consumption by 2020 and 15% by 2030 and a biodiesel share of 5% of diesel and fuel oil consumption by 2020 and 10% by 2030. 100% improved cook stove penetration in the region by 2020. 36% and 41% penetration of modern cooking fuels by 2020 and 2030 respectively. 7% of renewable energy equipment installed by 2020, in value terms, to be regionally manufactured and to increase this share to 20% by 2030. The member states develop national Renewable Energy Plans and Action Plans to implement regional policy. States are expected to develop their investment plans by 2014. However, the progress has not been uniform. Only Cape Verde has established an ambitious target of 50% RE penetration in electricity mix by 2020

and has prepared an action plan. Its government has enacted a renewable energy law in 2011 to facilitate this process. Senegal, Ghana, Mali, Liberia, Guinea and Nigeria are making an effort to implement a RE policy while for other member states, the renewable energy policy is yet a policy focus. The level of renewable energy policy integration in ECOWAS states is shown in table 4. ECREEE is currently supporting all the 15 ECOWAS member states in the elaboration and adoption of National Renewable Energy and Energy Efficiency Action Plans and SE4ALL Action Agenda: the process will be completed before the end of 2014.

Table 4
Renewable energy policy integration in ECOWAS member States[39]

Status	BJ	BF	CV	GH	GN	GW	CI	LR	ML	NE	NG	SN	SL	GM	TG
RE/ Energy Policy	P	P	Y	Y	Y	P			Y	P	Y		Y	Y	
RE/ Electricity Bill				Y					Y			Y		Y	
Specific RE Policy			Y	Y				Y			Y	Y			
Specific RE Law			Y									Y			

Note: Y – yes, P – partial.

Country codes: BJ – Benin, BF – Burkina Faso, CV – Cape Vedre, GH – Ghana, GN – Guinea, GW- Guinea-Bissau, CI – Cote d'Ivoire, LR – Liberia, ML – Mali, NE – Niger, NG – Nigeria, SN – Senegal, SL – Sierra Leone, GM – The Gambia, TG – Togo.

The promotion of small hydropower (up to 30MW) by ECREEE at the regional level and the efforts to improve use of biomass through improved cook stoves and other technologies for energy production (e.g. biogas) are part of the investment initiatives for renewable energy development. While the regional policy and action plans are targeting rural and peri-urban population, and focusing on energy access issues, energy policies do not appear to be embedded in the overall rural development agenda where agricultural policies, water resource management policies and income generation issues are considered in tandem. For example, the 5% and 15% bio-ethanol targets for 2020 and 2030 and 5% and 10% biodiesel targets for the same period would require a careful coordination with food security issues due to potential risk of land use change, encroachment in forest land and potential implications for water and nutrient use. An example from Ghana is considered in the next section which highlights the possible implications and interdependencies.

On the other hand, the Energy Efficiency Policy[40] aims by 2020 to double annual energy efficiency improvements, thereby reducing each year the energy required to produce a given quantity of goods and services by 4%. The strategy includes the phasing out of incandescent lamps, reducing transmission and distribution losses to 10%, adopting region-wide standards and labels for major equipment, initiating one priority initiative in each member country and taking measures to free up 2000 MW of power capacity. However, the member states have

not made significant progress so far (see table 5). ECREEE is currently supporting all the 15 ECOWAS member states in the elaboration and adoption of National Renewable Energy and Energy Efficiency Action Plans and SE4ALL Action Agenda: the process will be completed before the end of 2014.

Table 5
Energy efficiency policy integration in ECOWAS region[41]

Status	BJ	BF	CV	GH	GN	GW	CI	LR	ML	NE	NG	SN	SL	GM	TG
Efficient lighting promotion		Y		Y					Y		Y	Y			Y
Efficient cook stove promotion	Y	Y		Y	Y				Y	Y		Y			
Policies, strategies, projects	Y		Y	Y			Y		Y						

Note: Y – yes,

Country codes: BJ – Benin, BF – Burkina Faso, CV – Cape Vedre, GH – Ghana, GN – Guinea, GW- Guinea-Bissau, CI – Cote d'Ivoire, LR – Liberia, ML – Mali, NE – Niger, NG – Nigeria, SN – Senegal, SL – Sierra Leone, GM – The Gambia, TG – Togo.

Water policy integration

West Africa is the home of 25 trans-boundary river basins and each member state, except Cape Verde, shares at least one basin with another state. The region has realised the need for integrated water resource management quite early and adopted a regional action plan in December 2000. A specialised entity, the Water Resources Coordination Centre (WRCC), was established in 2004 to implement an integrated water resource management in West Africa and to ensure regional coordination of water resource related policies and activities. The Centre has prepared a strategic plan for 2007-2015 and adopted two themes for intervention in cross-border water resource management through support for cross-border basin management and advancement towards regional integration in the water sector. To facilitate the integration objective, the centre developed a regional policy framework for the water sector, adopted in 2008. The centre supports managing and sharing of information and facilitates dialogue on large-scale water infrastructure projects. The regional policy aims, inter alia, to support poverty reduction and socio-economic development of the region through the development of water infrastructure development. The water policy recognises the water-energy-agriculture nexus and suggests a concerted effort in managing the water resources for the overall development of the region.

The regional policy and plans are supplemented by action plans of member states. The region has made significant progress in this respect and states have either adopted national a plan or are implementing road maps to develop an integrated plan. Although the region has no

significant on-going water disputes at the time of writing, there are inherent conflicts of interest. For example, the Volta Basin is predominantly shared by Ghana and Burkina Faso with minor parts passing through Togo, Cote d'Iviore, Mali and Benin. Upstream, Burkina Faso's interest is in irrigation development as they do not profit from hydropower generation while downstream, Ghana is more interested in electricity production, as evidenced by its hydropower stations. On one hand, food security can be under threat in the entire basis due to low water availability and soil degradation, on the other an intensive irrigation system development can have adverse consequences on hydropower systems. Thus a nexus approach surely becomes relevant.

Bottom-up experiences from the ECOWAS region

The following bottom-up experiences from the region may provide some insights into the policy integration issue and initiatives being taken at the grassroots level.

Local Development in Boucle du Mouhoun region of Burkina Faso

Burkina Faso has experienced significant changes in its climate in recent times. Rainfall has declined exponentially and the frequency and amplitude of extreme meteorological events have increased. 74% of the arid and semi-arid land has been degraded due to desertification. The country meets 85% of the energy needs from biomass, which is the main cause of deforestation, but currently the growing demand for firewood is partially satisfied. 90% of the labour force works in agriculture but poor harvests due to adverse climatic conditions cause recurrent food crises in the country, exacerbating poverty.

A recent review[42] shows that multi-sector political frameworks are in place and the Integrated Water Resources Management Action Plan has created stable institutions but the linkage with energy-related issues is weak, although water and food linkages are better captured. The Strategy for Accelerated Growth and Sustainable Development provides the general direction for country's development and covers water-food, water-climate change, energy –food and energy access linkages. But each of these dimensions has not been sufficiently articulated with one another and pure sectoral approach still prevails in the decision-making process. The decentralisation process is deepening in the country and the general code of authority allows the local administrations to manage their activities independently.

The sustainable regional development programme in the Boucle du Mouhoun region of Burkina Faso, supported by the Austrian Development Agency, contains indicators that a nexus approach has been embedded. The current Indicative Programme of Cooperation covering the period 2008-2013 (extended to 2016) was designed to improve the quality of life through self-reliance where local communities ensure full ownership of their development. At the moment the programme is operating in five urban districts and eight rural districts. The

strategy clearly is to promote an integrated action programme that covers food security, access to clean drinking water and energy and adding value to biomass use.

The review mentioned above[43] indicates that the environmental consideration is present. An example of application of the nexus approach is the initiative to protect the banks of the rivers Mouhoun and Sourou that contribute to the security of food and water supply as well as energy.

Ghana biofuel and land grab experience

With its Bioenergy Policy, Ghana seeks to ensure energy security, reduce dependence on imports, create jobs and contribute to climate change mitigation through the integration of 20% biofuels into transport fuels by 2030. Biofuel production from agricultural feedstock is dependent on land, water, and other resources. Two alternative cases could evolve. If the biofuel is produced from crop feedstock (e.g. corn and cassava), competition for land may be less prominent but diversion of food grains for fuel may lead to price competition that can have a damaging impact (higher social cost) on society if not properly managed using a comprehensive regulatory framework.

On the other hand, where non-crop (e.g. Jatropha) feedstock is selected, food-fuel price competition would be eliminated but food and fuel would now compete over limited land. Thus land becomes a critical factor. Also, overall, land is often a limiting factor to biofuel development in that even where it exists, local agro-ecological factors such as soil fertility, and climate could limit feedstock output. Ghana has a total land area (TLA) of 23.9 million hectares of which 57% constitutes the agricultural land area (ALA). 58% of ALA is under cultivation with only about 0.4% under irrigation Ghana has a total land area (TLA) of 23.9 million hectares of which 57% constitutes the agricultural land area (ALA). 58% of ALA is under cultivation with only about 0.4% under irrigation as shown in Fig. 6. A scenario analysis[44] shows that Ghana is likely to meet its 20% biofuel target both in 2020 and 2030, and cassava and palm oil are likely to be the main feedstocks for the biofuel production. The area cultivated stands out as the main influencing factor to the quantity of biofuel output. Under a business as usual scenario the biofuel feedstock will use 54 to 61% of the agricultural land area by 2030, more than doubling their land coverage compared to 2010.

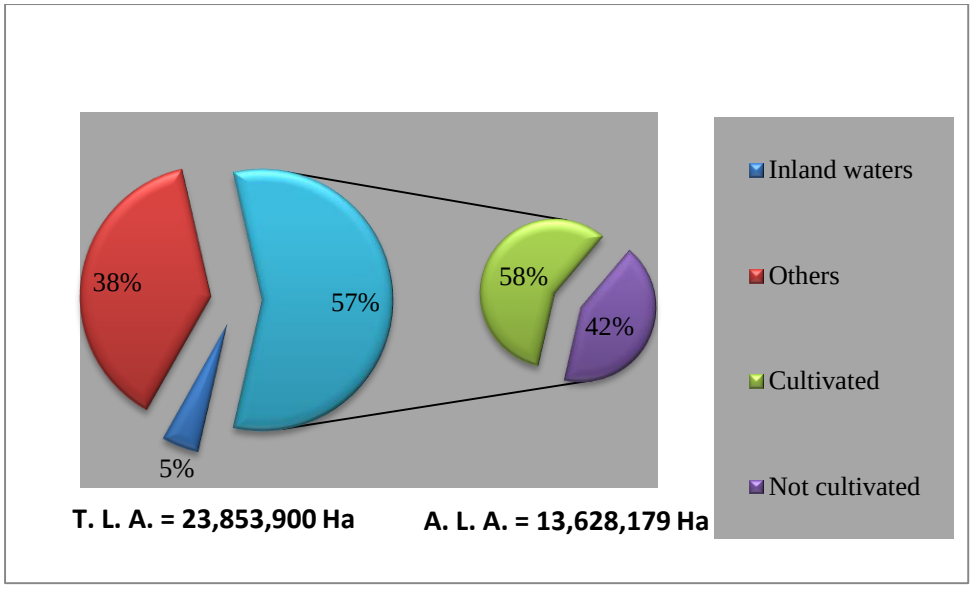

Figure 6. Ghana land use status in 2010[45]. Note: TLA – total land area, ALA – Agricultural land area.

A global assessment of biofuels[46] indicates that jatropha was cultivated on 5,700 hectares in Northern Ghana but by 2015, this could increase to 600,000 hectares. An issue that has arisen in this respect is the so-called land-grab phenomenon. It has been reported that biofuel projects are acquiring land to develop biofuel using first generation technologies with feedstock such as jatropha, cassava and palm oil[47],[48]. Clearly, the land use change for biofuel plantation affects food security and water use patterns.

Firewood substitution and improved cook stove promotion in traditional beer breweries in Burkina Faso

As mentioned above, 85% of energy needs in Burkina Faso are met with biomass. The average biomass consumption is 0.69 kg per person per day[49]. The traditional beer-brewing (called "dolo" locally) is a cottage industry, mostly run by women as a small-scale home-based business. There are thousands of such breweries in the country of which approximately 4,000 breweries exist in the peri-urban area of Ouagadougou itself[50]. The brewing follows a traditional process where sorghum is crushed and ground to a paste which is then boiled for more than a day. This requires considerable energy and the industry has generally relied upon firewood from nearby forests as the source of energy. Traditional cook stoves are inefficient and consequently consume more fuel and take longer to brew the beer. Beer-brewing contributes to about 15%-20% of national demand for firewood and is contributing to deforestation and land degradation in the country. Moreover, given these factories are located in the densely populated suburbs of Ouagadougou, the smoke causes health hazards for the local population as well as for the employees of the factories. The price at which firewood is procured has increased significantly, affecting the businesses economically. Realising that fuel substitution and use of improved cook stoves can address environmental, health, social and economic issues, a number of initiatives have been undertaken by the government in

association with private partners, local businesses, and international agencies. GIZ implemented FAFASO (Foyer Amélioré au Burkina Faso) beginning in 2005 through a Dutch-German energy partnership which supported development and dissemination of improved cook stoves in the country. In 2012, UNIDO initiated a project with the Global Environment Facility funding to promote improved cook stoves in the beer breweries. An improved cook stove can save 60 to 70% of firewood needed but the efficiency declines if the stove is not properly maintained. A fuel substitution demonstration project has also been initiated in 2012 to displace firewood by LPG under the ECOWAS Renewable Energy Facility (EREF). An LPG burner is more efficient than an improved cook stove and the flame can be controlled. However, due to traditional practices being used for brewing, LPG has not penetrated in the fuel mix. Accordingly, pilot and demonstration projects in association with the private entities are being undertaken to address an important issue in the country.

An evaluation of the FAFASO activities between 2010 and 2012 found that 2,348 dolo stoves have been installed and breweries had saved 42kg of firewood saved per brewing process[51]. Gaul[52] however points out that Burkina Faso has seen many projects in this area in the past and has developed a project mentality where grants are taken for granted, and failure is considered normal.

ECOWAS Renewable Energy Facility funded projects[53]

Under the ECOWAS Renewable Energy Facility, a number of projects are being supported in various ECOWAS countries. Many of these initiatives are being undertaken by public-private partnerships or private parties. A few such initiatives are discussed below to indicate the diversity of energy-driven application of the nexus approach.

1. Installation of solar powered water pumping and efficient lighting in a shelter in Bolobi (Cote d'Ivoire).

An NGO in Bolobi (Cote d'Ivoire) is engaged in providing shelter for destitute girls. The NGO works for the betterment of the impoverished girls by providing support. The shelter is located in a palm oil field and it has been working on vegetable gardening but without electricity they cannot produce value added products. Access to water was also difficult as water had to be collected from communal wells at a faraway place. Through the EREP funding the shelter installed solar-powered efficient lighting and a water pumping system that will enable efficient lighting using LED, pumping water from a borehole for shelter's needs and for possible irrigational use for vegetable gardening. A solar power plant of capacity 2.1 kW and a water pump of 20m^3 of water capacity per day have been installed in April 2014.

2. Rope wind farm to pump ground water for farming in Accra (Ghana)

The Energy Foundation, an NGO, is designing a wind energy propelled water pumping system to irrigate vegetable farms in urban and peri-urban areas so that farmers can reduce

diesel fuel use and avoid sewage water usage for irrigation purposes. It is believed that Accra alone has 1,000 vegetable farmers and about 100 hectares of vegetable farms undergo irrigation using tap dug outs, boreholes and drains. The conventional diesel-operated pumps face increasing diesel prices and the use of dirty water makes poses obvious health risks. As a low cost renewable energy-driven alternative, the rope wind pumping system can offer benefits not only to vegetable farmers but can have potential use in aqua culture, rural water distribution and lift irrigation in irrigation canals. The wind pump is being designed using light-weight materials (with an overall weight of 150kg), is easy to erect and dismantle and transport from one site to another. As many farmers use lands rented over a short period of time (1-2 years) due to difficult land tenure systems, portability is an important local design consideration. To cater to the periods of low or no wind, a manual rope winding system is integrated into the wind pump to enable farmers pump water manually. The design of the system has been completed by 2013 and its fabrication is underway.

3. Biomass powered off-grid electricity system in Liberia

Access to electricity in Liberia is extremely limited due to decades of war. Only 10% of urban residents and 2% of rural population have access to electricity. Winrock International in partnership with Ecopower Liberia has installed a 10kW biomass gasifier at Brooker Washington Institute campus in Liberia as a pilot project demonstrating an isolated electricity supply system. The gasifier and generator were manufactured and assembled at All Power Laboratories in California and shipped to Liberia. The unit has been tested and operated using rubber wood chips, coconut shells and palm kernel shells. USAID has supported installation of three 20kW units at the same location, thereby taking the capacity to 70kW. In addition to creation of direct employment opportunities, these off-grid electrification systems will create indirect and downstream opportunities through the value-added to resources and wealth-creating activities. Farmers will have new opportunities for growing, preparing and assembling biomass fuel for these plants. Power generated through these plants will also support local natural resource industries to add value to their products before exporting them.

4. Solar powered refrigeration in Tchambanga village in Niger

Tchambanga village in Dosso district of Niger is an unelectrified village where the local hospital cannot preserve medicine and local women engaged in horticulture and dairy farming are unable to store their products, thereby losing opportunities to market their outputs. In addition, the local school does not have electricity. An NGO (Ecole Instrument de Paix, Niger) has carried out a project to install solar powered refrigeration in the village hospital, provide electricity to school and add a solar refrigeration system for horticultural and dairy products. A 1.65 kW plant has been installed in the hospital while the school was fitted with a 1.8 kW plant.

5. Off-grid electrification for electricity access and water supply in Uniarho Community in Edo State, Nigeria

Like many communities in Southern Nigeria, Uniarho in Edo state does not have access to electricity. The community of 1500 people rely on kerosene and firewood for lighting and cooking purposes. An NGO, Community Research and Development Centre, has developed a 2.4kW solar-powered mini-grid to provide electricity to 19 households, and a water pumping facility. The project facilitates access to electricity and safe drinking water. The system begun operating in February 2014.

6. Establishment of a solar-hydro hybrid power system for fish processing and eco-tourism in Sierra Leone

Many areas of Sierra Leone do not have reliable electricity supply and the electrification rate is very low. River number 2 community in Western Peninsula, bordering the capital Freetown, does not have access to electricity. The community of 1,000 inhabitants relies on costly diesel generators and firewood for fish smoking. This is a local activity undertaken mainly by women and the high volume of wood used by the community poses a threat to the Western Area Peninsula Forest Reserve (declared a National Park). A shift to an alternative processing using a clean power source will reduce health impacts, deforestation, value addition and better livelihood for the local population. The tourism resort in River number 2 is another focus area as it receives 7-10,000 visitors per year.

The mountainous area however benefits from rivers, with year-long water flows which can used for hydropower generation. Availability of electricity can transform the community by providing fish-processing opportunities and through the development of eco-tourism. German NGO German Agro Action in association with a local partner Energy for Opportunity has undertaken a hybrid solar-hydropower project. Initially a 10 to 20kW hydropower plant was considered but the site investigations revealed that enough water is not available to support the needs of the community. Accordingly, a solar-hydropower combination was selected. A 4.5 (3x1.5kW) hydro and a 4.6 kW solar power plant are being installed.

Although these are pilot or demonstration projects, they reflect a tendency to go beyond a single dimensional approach and capture energy-water, energy-food or energy-water-food linkages. Driven by NGOs and private organisations, they are driving innovative initiatives of promoting new business initiatives in peri-urban areas. Successful implementation of these project-level initiatives show that the nexus approach can be used as good business opportunities if a supporting environment exists and if the activities are designed keeping the stakeholders' requirements in mind. The above initiatives have benefited from active stakeholder participation and a win-win situation ensures project sustainability in the long-run.

Closing remarks

The need for policy integration of water-energy-food security concerns is becoming increasingly clear but in practice the existence of multiple organisations for policy and decision-making and the compartmental approach to policy implementation creates barriers. The West African states are in an advantageous position due to the overall integration agenda of the ECOWAS Commission. The regional integration objective alongside the desire to overcome the economic, social and environmental challenges through efficient use of resources, efficient governance and market integration has been supported through various regional initiatives which have advanced a the nexus approach. While the regional focus on nexus has inspired the member states and some initiatives at the national level are evident, the degree of success varies. The sector-based approach to policy-making still continues and the implementation of an integrated approach is rare. Moreover, the centralised top-down approach of decision making and governance prevails and decentralised bottom-up mobilisation of initiatives are lacking. Even when the decentralisation has been promoted, the delegation of appropriate authorities has not taken place.

The states within ECOWAS Community have experienced the consequences of inappropriate or weak policy integration at the national and local levels. The promotion of biofuels and the consequent land-and water-grabbing phenomena have caused adverse effects in a number of countries. Conflicts of interest exist amongst beneficiaries of trans-boundary water basins in respect of prioritisation of water use for agriculture and hydropower development. Against the background of top-down approach towards policy implementation, micro-level experiences are emerging with the support of NGOs, private entrepreneurs and private-public partnerships who are experimenting with innovative opportunities to address the challenges. These participatory processes confirm that local resources can be appropriately managed at the decentralised level through adequate capacity building, stakeholder involvement, and an appropriate supporting environment. By promoting such initiatives at a large scale, the sustainable development agenda can be taken forward and a fairer, equitable and prosperous living condition can be established.

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The Nexus Network

www.thenexusnetwork.org


@uk_nexus

For general enquiries

E info@thenexusnetwork.org

T 01273 678350

The Nexus Network

SPRU

University of Sussex

Jubilee Building

Brighton BN1 9SL

UK

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