GLOBAL SCIENCE AND THE ART OF SETTLEMENT: FOCUS ON WATER, FOOD AND ENERGY SELF SUFFICIENCY

Philip Norton Loheed, AIA, NCARB,
Sarah Howard-McHugh, LEED AP[1] (editor)

In considering sustainable design of human settlements, suitability of land and resource use is a central issue. At the core of learning to live in balance with the earth is learning to consciously inhabit the land and respectfully harvest its finite resources. In Design with Nature*, Ian McHarg illustrated a manual overlay technique for suitability analysis, while others developed remote sensing and GIS for computerized mapping and 'what if' evaluation of data. Despite increased environmental awareness, improved strategies that align human activities with the earth's capabilities remain urgently needed.*

To be truly sustainable, human settlements need to achieve Bioregional Resource Self Sufficiency (BRSS) within a global context. BRSS is attained when bioregions operate within resource budgets that are based on available resources—water, food, energy, land, and biodiversity. Design practitioners need to align their solutions within such budgets; and make periodic adjustments to reflect new technologies or negative feedback from the natural systems.

Section 1 provides an overview of human needs as related to the finite resources of the Earth. Section 2 explores the concept of bioregions and Bioregional Resource Self Sufficiency (BRSS). Section 3 discusses global aspects of budgeting for BRSS. Section 4 explores feedback and metabolic aspects of BRSS. Section 5 looks at the global context of bioregions and BRSS. Finally, Section 6 concludes with thoughts about implementation and design for BRSS.

1 INTRODUCTION: FINITE RESOURCES OF EARTH

1.1 The Finite Nature of the Earth

As everyone will acknowledge, Earth and its component systems are finite. Since the so-called Fuel Revolution of the eighteenth century, human culture has commandeered a disproportionate share of both renewable and fossil resources—resulting in exponential growth of the human population and its cultural systems. It is increasingly clear that supplies of fossil water, fuel, and numerous other critical nutrients and minerals are being rapidly exhausted. As these *non-renewable* resources diminish, complex negative feedback on human cultural operations is occurring and intensifying. Further, disproportionate human consumption and related disruption of natural systems is causing a mass extinction cycle in the entire web of planetary life forms. It is difficult to avoid the conclusion that human culture is in a self-destructive mode that is reducing the habitability of the planet for all the natural systems upon which it depends.

Ultimately, only a small portion of the *renewable* resource base will be available for human use. *Recycled* resources will be available to the extent that they can be used in conformance with "cradle to cradle" no waste principles (McDonough, W., Braungart, M., 2002). For any given resource, global use cannot sustainably exceed the available renewable, or recycled, global total. This leads inescapably to the idea that economic growth cannot be achieved through ongoing increases in consumption, but rather through improved efficiency in beneficial use of natural resources. Such improvement is possible—primarily because of the very low efficiencies achieved with present human technologies.

To be truly sustainable, human settlements need to achieve Bioregional Resource Self Sufficiency (BRSS) within a global context. BRSS is attained when bioregions operate within resource budgets that are based on total globally available resources—for example water, food, energy, land, and biodiversity. Design practitioners need to align their solutions within such budgets; and make periodic adjustments to reflect new technologies or negative feedback from the natural systems.

[1] Earthos Institute, Inc., 1310 Broadway, Suite 103, Somerville, Massachusetts, USA, 02144, www.earthos-institute.us, phil-earthos@ldparch.com, sarah-earthos@ldparch.com

2 BIOREGIONAL SELF SUFFICIENCY (BRSS)

2.1 Bioregional Self Sufficiency Defined

To assess environmental health, ecologists and environmentalists focus on the bioregion, an area defined by topography that can support a critical threshold of interdependent species. Ultimately, the desired outcome is self sustaining bioregions that can produce enough resources to support human settlements and ecosystems into the future. Because these bioregions do not operate in isolation, practitioners must understand consumption and waste rates within a global context using global resource budgets. For example, one region may import water while another exports water, but in the end, the regions must balance each other so that total consumption does not exceed renewable water supplies. Additionally, even with global trade, each region must retain enough water to support critical biodiversity. As a global average, this self-sufficiency will need to be net of imports and exports —to achieve overall global sustainability.

2.2 Bioregions—Basic Functional Units of the Biosphere

"… Bioregions are defined through physical and environmental features, including watershed boundaries, geology, and other ecosystem characteristics. "Bioregionalism" stresses that the determination of a bioregion is also a cultural phenomenon, and emphasizes local populations, knowledge, and existing conditions." (Alexander, 1996)

In the global context, bioregions encompass terrestrial and oceanic systems that cover every part of the biosphere. Thus, analysis of resource requirements and the health of the biosphere becomes comprehensive when all bioregions are included. For analytical purposes, most bioregions also function as relatively autonomous systems—with identifiable boundaries and external resources. This allows a broad range of decisions about the design of human settlements within a particular bioregion to be made in the context of relatively simple budgets and goals related to its "fair share" of global resources. Using locally available resource data, the *"native capacity to tolerate human activity"* of each bioregion can be evaluated with fair precision. To this baseline, favorable trade imports and exports (those that reduce global consumption) can be added. Budget information for "designed water, energy, and food utilization" within the bioregion can then be used to inform the design of human activities and settlement patterns.

2.3 Baseline Resources for Self Sufficiency

The "baseline" resources key to self sufficiency are water, energy and food.

"...it is becoming increasingly important to put fresh water issues in a global context… Knowledge about the virtual-water flows entering and leaving a country can cast a completely new light on the actual water scarcity of a country." (Hoekstra, A.Y., Chapagain, A.K., 2008, pp. 2.)

"Focus on Water, Food and Energy Self Sufficiency," the subtitle of this paper, references the fact that any cultural system must provide for three primary needs. These are: Subsistence, defense, and reproduction. (White, L.A., 1969., pp. 364) Plentiful fresh water and abundant food production, the means of subsistence, have been taken for granted in developed countries since the fuel revolution. However, renewable water and energy supplies are becoming everywhere seriously inadequate—and this will result in significant challenges in generating food. Roughly 80% of human consumption of water resources is for food production. Due to a range of negative feedbacks related to global warming, climate shifts, and other effects, subsistence technologies require serious rethinking and implementation of increases in the efficiency of food production, shipping, and water use. Sustainable energy sources are intimately connected to water use and, especially in biofuel production, can be in direct conflict with food production. Subsistence will become, once again, a priority for global sustainability. Thus water, energy and food resources, and their equitable distribution, come first in self sufficiency.

3 BUDGETING FOR BIOREGIONAL SUSTAINABILITY

3.1 The Budgeted Consumption Economy "BCE"

Sustainability means living in harmony with the natural systems of our planet, while ensuring quality of life for all the Earth's people and other lifeforms. The *Budgeted Consumption Economy* is our proposed concept of the 'new economy,' and is based upon "doing much more" with only those renewable or recycled resources allocated to human cultural use. It achieves "economic growth" through increased efficiency rather than increased physical consumption. The BCE is composed of groups of relatively self-sufficient bioregions encompassing all human settlements on the Earth. For any given global resource [GRhuman], the sum of usage in all bioregions [brU] cannot exceed the total "natural capital" (see Hawkin, P., Lovins, A., Lovins, L.H., 1999) available for human use:

$$brU1 + brU2 + brU3 + \ldots brUn \leq GRhuman$$

There are several types of resources to be considered in this regard:
1) natural capital that is not typically shipped between bioregions, such as water supplied by rainfall; 2) resources that are traded between regions as basic commodities, such as metal ores and minerals; and 3) the "virtual resources"—those necessary to produce manufactured goods and food products. Virtual resources include, notably, major quantities of water and energy used at the point of origin or in processing of trade goods. *At present, "International trade [in virtual water]... reduces global water use in agriculture by 5%."* (Hoekstra and Chapagain, 2008, pp. 43)

3.2 Budgets to Counter the Effects of Global Warming

The most ubiquitous examples of global budget setting efforts to date have been related to changes in the atmosphere: ozone, CO2, and methane limits related to desired moderation of greenhouse warming are hotly debated. Numerous secondary effects of warming are being studied including: melting sea and continental ice; shifting climate patterns; loss of soil moisture; el ninõ cycle changes; storm frequency and intensity; earthquake frequency and intensity; increased volcanic activity; pH changes especially in the oceans; and increased habitat loss with related extinction of life forms. Primary areas of concern in this realm include climate shift, desertification and carbon sequestration in terms of impacts on human agriculture and food production; protection of populations from natural disasters; and preservation of biodiversity.

Warming and its effects are in constant flux, and this introduces trend analysis and continuous observation and feedback into the budget setting task. Information related to water availability and management, used to determine baseline capacity to support a human population and its healthy context, is the most important starting point for budgeting. In all cases, continuous monitoring of rates of change will lead to continuous adjustment of settlement patterns in the various bioregions.

"There are two major factors. The first is the actual displacement of water from where it is sustaining a healthy ecosystem as well as healthy hydrologic cycles. Because humanity has polluted so much surface water on the planet, we are now mining the groundwater far faster than it can be replaced by nature. New Scientist reports of a "little-heralded crisis" all over Asia as a result of the exponential drilling of groundwater. Water is moved from where nature has put it in watershed and aquifers (where we can access it) to other place where it is used for flood irrigation and food production - where much of it lost to evaporation - or to supply the voracious thirst of mega cities, where it is usually dumped as waste into the ocean.

Water is also lost to ecosystems through global trade - water used in the production of crops or manufactured goods that are then exported (known as virtual trade in water). Over 20% of daily water used for human purpose is exported out of watersheds in this way. Water is also piped across long distances for industry leaving behind parched landscapes." (Barlow, M., 2010)

3.3 Budgets to Balance Consumption with Global Renewable Resources

Many different kinds of resources are critical to the creation of settlements. Among these are reasonably stable climate, adequate water, energy sources, and healthy ecological context. Historically, human cultures have often failed to balance their consumption with available resources, resulting in collapse—and often, in extinction of both populations and/or resources.

Consider the primary resource of fresh water: total rainfall on land, combined with some desalinized supplies, constitutes the renewable fresh water supply of Earth. It amounts to roughly

110,000 cubic kilometers annually, but is increasing with global average temperatures. (Rogers, P., 2008., pp. 46-53) The global average consumption of fresh water to support a single human is about 1000 cubic meters. (Rogers, P., 2008., pp. 46-53) One of the primary budget relations for bioregional analysis and design is inherent in these two numbers combined with the space-time distribution of the sustainable resource—in this example fresh water.

3.4 Budgets Related to Trade in Global Virtual Resources

Virtual Water—the quantity required to grow, process, and ship most products—is part of the world's "natural capital" that is usually ignored or undervalued in monetary terms. Yet it is both significant to overall human use of fresh water, and critical to settlements in water-poor environments. Current estimates indicate that trade in virtual water results in a net reduction in global water use by humans of about 5% (see paragraph 1.3), compared to a hypothetical elimination of such trade. However, many trade relationships are disadvantageous—using increased water, energy or other resources to produce a product that could be advantageously made elsewhere. In consideration of business opportunities in the Budgeted Consumption Economy, evaluation of limited renewable resource availability, and advantageous versus disadvantageous virtual trade relationships are important. Bioregional budgets for virtual trade imports and exports thus form a basis for sustainable external use of natural capital.

3.5 Advantageous Global Resources

Trade relationships can result in increases or decreases in global resource use, depending on the relative efficiency of the trading partners. Obviously, we favor those that reduce consumption:

Advantageous Global Resources (AGR) refers to imports to, or exports from, a bioregion that reduce global consumption by humans. For example, this may include recyclables such as minerals and metals.

Advantageous Global Resources—Virtual (AGR-V), as proposed here, are those that result in a net reduction in consumption of globally sustainable resources. Examples include trade in products with virtual water content significantly lower than the same product produced locally. This implies that *disadvantageous* trade in virtual resources should be phased out.

4 FEEDBACK AND THE METABOLISM OF BRSS

4.1 Bioregional Metabolism

In previous sections we have described Bioregional Self Sufficiency (BRSS) as a *process* which balances resources with demand to achieve a healthy lifestyle for its creatures—including humans. As natural and cultural conditions change, continuous adjustments to the metabolism of the region must be made to stay in balance. Such adjustments will effect relationships within the particular region and also its interaction with other parts of the global Budget Consumption Economy (BCE). For example, successes in restoration of biodiversity may alter the harvest rates of plants and animals available to the food chain. Or, products in the BCE that were previously disadvantageous in use of natural capital may become advantageous to help the balance of another bioregion.

Total Renewable Resource (TRR) + Advantageous Global Virtual Trade (AGVT), minus
Shares for Ecosystems & Inorganic Cycles
= Net Budget for Human Uses

To ensure measurable strides towards sustainability, resource budgets for critical resources such as water, food and energy are continuously updated. These are the amounts of available renewable natural resources that can be allocated to human use, after reserving the amounts necessary to support healthy ecosystems. These budgets, as proposed, are based on available resources in each bioregion, combined with advantageous global virtual trade (AGVT).

4.2 Design Innovation and Technology

In terms of efficiency of resource use, we are presently not even close to sustainability—nor do we have the recommended overall targets to get there. This is where design innovation and technological development—informed by global science—come into play. Through constant reference to BRSS goals, as a component of global balance in the BCE, innovators are provided with the "decision support" to fit human culture to Spaceship Earth.

Our Muddle: Economic growth is related to efficiency, not increased resource consumption...
The budgeted consumption economy is not a zero-growth economy...
Economic growth is a technical and design challenge, related to efficiency rather than a consumption...
This is not a utopian concept...
We are at a point of major cultural evolution, which will result in huge changes in the way things are done... We need to do a lot more with a lot less...
Applied technology—that will improve efficiency of raw materials—can generate real economic growth... A critical need of our cultural system is to become more intelligent…
through continuous real-time observation of the:
"total demand is equal to, or less than, the available fair share" realities...

4.3 Settlement Pattern Growth and Modification

Each type of bioregion in the BCE will have different settlement patterns as a function of the nature of its natural systems: linear, radial, vertical, floating, nomadic, static, dynamic forms will all have their appropriate applications. The evolution of the new economy will also sculpt existing cities to accommodate dramatically increased urban agriculture, advantageous business development and related new social classes. Restoration of biodiversity will be carried out by new economy occupations such as our proposed "biorangers" and their nomadic support systems. The productive landscapes managed by the biorangers will displace monocultures and abandoned urban sprawl; forest and grassland soils will be restored; ground water systems will be recharged as intelligent water management systems replace outmoded storm drains and sewage treatment systems...

4.4 Adaptation versus Relocation of Settlements

Unfortunately, many settlements and populations cannot remain where they are at present, due to climate change effects including loss of renewable water, rising seas, and various natural disasters. A further range of cities may be adapted to the changes they face using technologies such as dikes, energy absorptive marsh systems, enclosed agriculture, localized energy production and so on. Agonizing choices involving destabilization of literally billions of people; major ecosystems; historically significant cities of great value; important biological "hot spots"; and thousands of species worldwide will present themselves. We think it obvious that these major shifts in demand patterns for resources must be evaluated and budgetary allocations made—within the available total of natural capital.

5 THE GLOBAL CONTEXT OF BIOREGIONS AND BRSS

5.1 Global Effects of Population Growth on Bioregions

Human population has more than tripled in the last one hundred years, and is projected to peak around 2050 CE in the range of roughly 9 to 12 billion people. This is an average density of 60 to 80 persons per square kilometer of land on Earth. The ratio of city to rural dwellers now exceeds 50% for the first time in history, and will continue to increase. This means that large cities will continue to proliferate in every part of the world, and in an increased range of bioregions. In other cases, existing cities will be relocated due to rising seas, loss of water resources, desertification or other causes. Such major shifts in population will need to be supported with ever more sophisticated technologies for water management and food production. BRSS will require major efforts to preserve biodiversity and natural systems function while eliminating as much agricultural monoculture as possible.

5.2 Human Settlements Versus Bioregional Restoration

"We do live on board an 8,000 mile diameter spherical spaceship speeding around the Sun at 60,000 miles per hour…" (Fuller, R.B., 1981, pp. 55) Repair and maintenance of "Spaceship Earth" now includes dealing with global pollution and habitat destruction by human culture at historically unprecedented scale. The continued growth of the human population, and attendant creation of numerous new cities makes restoration of natural systems both critically important and extremely difficult. The impacts of resource consumption and waste are no longer restricted to local areas, and yet most efforts to assess the impact of design decisions remain local. Virtual and real water, food, natural resources, manufactured goods, waste, and people are transported across the globe. Gas and particle waste such as carbon enters the global atmosphere and indirectly affects bioregions halfway around the planet. Additionally, the earth has a limited ability to digest human solid and gaseous waste. Human settlements now need to abandon global dominance in favor of "partnering with" bioregional restoration, in enlightened self interest.

5.3 Place Making and Social Justice

A planet at war or filled with injustice is not a sustainable place. It is like a baseball team with injured players, not able to win or even to play reliably. The place-making process assists significantly in advancing global urban culture and the spread of social justice, when it creates harmonious environments welcoming to all. Social justice—as defined in the UN's Millennium Goals to include universal education, empowerment of women, elimination of hunger, and other practical and ethical considerations—becomes an important component of the BRSS process for all bioregions worldwide. In Plan B 4.0 (Brown, L., 2009) these items are considered from a *monetary cost* point of view to show that solutions to such social justice issues are affordable. In this paper, and in our proposed Budgeted Consumption Economy, it is important to note that resource budgets refer to *physical* natural capital *not money*.

5.4 Environmental Bill of Rights

Inherent in the operation of the Budgeted Consumption Economy is the allocation natural resources to maintain the health of all living systems—which are, in turn, critical to the health of human cultures. Determination of "fair shares" of natural capital for human use is therefore net of the resources dedicated to the health and maintenance of "Spaceship Earth" and all of its creatures.

6 CONCLUSION: BRSS IMPLEMENTATION AND DESIGN ALTERNATIVES

6.1 Scientific and Design Protocols—Informed Collaboration

Credible scientific procedure is intended to observe 'reality' and develop verifiable hypotheses to explain its nature and behavior. Such findings and hypotheses are subjected to peer review and verification prior to general acceptance. Design procedure, on the other hand, builds consensus and marshals resources to *modify* observed realities. In the roughly forty years it has taken the scientific and engineering community to develop the communications (internet and www), observation systems (satellite and earth based), data management and analysis (automated mapping and GIS), and systems theory imagined by the design and environmental community to "fit the people to the planet"; the two communities—science and design—have largely ignored each other. Now they must collaborate as never before: the sciences both physical and social, and designers of every stripe can work to bring clarity and just, achievable goals to everyman and to the entire web of life.

6.2 Settlement Patterns

"Settlement Patterns" are patterns of use by human cultures and communities. These may include cities, towns, villages, farming patterns, resource extraction activities, and related infrastructure and transportation systems. The term also implies a spatial relationship between human and non-human natural systems. In the process of achieving BRSS, bioregions become self sufficient, not to insulate themselves from the rest of the world, but to make accurate contributions to global sustainability. As fully empowered players in the BCE, and as successful "biorangers" in restoration of

regional natural systems, the human communities of each bioregion can be fully empowered and competitive in the arenas of social justice, universal education, and highly valued lifestyles.

Communities need to understand their decisions within a globalized context. They also need benchmarks and metrics to understand how their decisions and innovations are affecting consumption and waste rates globally. In determining appropriate relationships between settlement patterns and their natural context, designers will also need to evolve strategies and solutions specific to the unique character of each bioregion.

6.3 Taking Responsibility for The Global Impact of Human Culture

Through the exponential growth of human population, our species has become a force of nature that is threatening all living systems on Earth with pollution, and resource depletion. We have been literally incinerating the fossil fuels and other resources of the planet for about three hundred years. Now we must take responsibility—using our vaunted intelligence—for the problems we have created or exacerbated. This requires a system designed to observe everything, everywhere, as it happens.

Luckily, we have created a sensory apparatus and a nervous system for Spaceship Earth that gives us the required information: remote sensing, the internet, GIS. Unluckily, we are hampered by incompatible political and antiquated financial systems, by regional poverty and inequity, by religions reluctant to coexist with one another, by cultural classism and racism, and by skepticism that any of this is really happening. Nevertheless, millions (out of billions) of people are determined to "save the planet" and are working on it. To be successful, real time decision support based upon accurate information is only part of the problem.

What else is needed? Consensus building through social networking; dissemination of feedback on consumption goals at a personal level; infectious optimism about the future; companionable debate about alternatives… We propose that the Bioregional Self Sufficiency idea, combined with empowerment through a Budgeted Consumption Economy, can provide a reasonable and practical set of goals to balance global resource use with the available renewable quantities. To the extent that the design community is informed by the relevant global science, and works to respond to continuous real-world feedback we can be successful in creative and fruitful operation of Spaceship Earth. All this makes the consideration of design alternatives that enable simple human companionship and the restoration of joy in as many lives as possible the order of the day. Design is not science—but needs to be informed by it. In the web of life, human happiness is to be found in respect for every creature.

"To the children
To all the children
To the children who swim beneath
The waves of the sea, to those who live in
The soils of the Earth, to the children of the flowers
In the meadows and the trees in the forest, to
All those shildren who roam over the land
And the winged ones who fly with the winds,
To the human children too, that all the children
May go together into the future in the full
Diversity of their regional communities."

—Thomas Berry

GLOSSARY (Words in quotes are expressions of the Authors):

"AGVR"— *Advantageous Global Virtual Resources*, as proposed here, are those that result in a net reduction in consumption of globally sustainable resources. Examples include trade in products with virtual water content significantly lower than the same product produced locally. This implies that disadvantageous trade in virtual resources should be phased out.

"**Biorangers"**—are a proposed social class dedicated to preservation and restoration of healthy ecosystems planet-wide. Scientists presently constitute the majority of biorangers, but the class is rapidly evolving into a modern version of naturalized hunter-gatherers.

Bioregions—are defined through physical and environmental features, including watershed boundaries, geology, and other ecosystem characteristics. "Bioregionalism" stresses that the

determination of a bioregion is also a cultural phenomenon, and emphasizes local populations, knowledge, and existing conditions.

"BRSS"—*BioRegional Resource Self-Sufficiency* is the ability of a region to operate within its locally available resources, combined with only *advantageous* global virtual resources (AGVR) from trade relationships.

"BCE"—*Budgeted Consumption Economy* is a proposed concept of the 'new economy' which is based upon 'doing much more with only those renewable resources allocated to human use. It achieves "economic growth" through increased efficiency rather than increased physical consumption. The BCE is composed of groups of self-sufficient bioregions encompassing all human settlements on the Earth.

Place Making and Social Justice—A planet at war or filled with injustice is not a sustainable place. It is like a baseball team with injured players—not able to win or even to play reliably. The place-making process assists significantly in advancing global urban culture and the spread of social justice. We are committed to maintaining and renewing ethnic diversity, with full empowerment, for all people.

Renewable Fresh Water—That amount of water available from annual rainfall, supplemented by desalinization, and in limited cases by aquifer recharge.

Resource Budgets—to ensure measurable strides towards sustainability, resource budgets for critical resources such as water, food and energy are necessary. These are the amounts of available renewable natural resources that can be allocated to human use, after reserving the amounts necessary to support healthy ecosystems. These budgets are based on available resources in each bioregion, combined with advantageous global virtual trade (AGVR):

Total Renewable Resource (TRR) + AGVR, minus
Shares for Ecosystems & Inorganic Cycles
= Budget for Human Uses

Settlement Patterns—are patterns of use by human cultures and communities. These may include cities, towns, villages, farming patterns, resource extraction activities, related infrastructure and transportation systems. The term also implies a spatial relationship between human and non-human natural systems.

Sustainability—means living in harmony with the natural systems of our planet, while ensuring quality of life for all its people.

"SC"—*Symbolic Communicators* are human beings, or other species, with the ability to communicate with spoken or written language—that can interpret non-physical meanings such as 'holy water.' Over time such other species SC's may become candidates for world citizenship. Recently dolphins and other high-functioning marine mammals have been identified for such recognition based upon their work with the U S Navy in the last forty years. In other cases, people may employ bionics to raise additional life forms to such status, using prosthetic technology originally created for impaired humans.

Virtual Energy Content—That amount of energy required to grow, process, manufacture, package and ship a product. This includes both naturally supplied and cultural requirements at the locations of each step in its creation.

Virtual Water Content—That amount of water required—at each step in the creation—to grow, process, manufacture, package and ship a product.

BIBLIOGRAPHY

Alexander, D., 1996. "Bioregionalism: The Need For a Firmer Theoretical Foundation", Trumpeter v13.3.

Barlow, M., "An International Rescue Plan for Water", http://www.stwr.org/land-energy-water/an-international-rescue-plan-for-water.html, On the Commons, January 2010

Berry, T., 1999. The Great Work, Our Way into the Future, Three Rivers Press, New York.

Brown, L.R., 2008. Plan B 4.0, Mobilizing to Save Civilization, W. W. Norton, New York, London.

Capra, F., 2004. The Hidden Connections, a Science for Sustainable Living, Anchor Books.

Capra, F., 1996. The Web of Life, A New Scientific Understanding of Living Systems, Anchor Books, New York.

Fuller, R.B., 1981. Critical Path, Saint Martins Press, New York

Gleick, P.H., 2009. The World's Water: 2008-2009, The Biennial Report on Freshwater Resources, Island Press.

Hawkin, P., Lovins, A., Lovins, L.H., 1999. Natural Capitalism, Little Brown.

Hoekstra, A.Y., Chapagain, A.K., 2008. Globalization of Water: Sharing the Planet's Freshwater Resources, Blackwell Publishing.

Ludwig, F., Kabat, P., van Schaik, H., van der Valk, M., 2009. Climate Change adaptation in the Water Sector, Earthscan.

McDonough, W., Braungart, M., 2002. Cradle to Cradle, Remaking the Way We Make Things, North Point Press, New York.

Rogers, P., 2008. Facing the Fresh Water Crisis, Scientific American, 8:46-53.

Sen, A., 1999. Development as Freedom, Anchor Books.

White, L.A., 1969. The Science of Culture: A Study of Man and Civilization, Second Edition, reprinted by Percheron Press, New York, 2005.

Yunus, M., 2007. Creating a World Without Poverty: Social Business and the Future of Capitalism, PublicAffairs™.

Will energy sufficiency guarantee development ? Well to achieve energy self-sufficient, a country should be very well developed. If a country becomes energy self-sufficient then following things can happen which will directly impact its development. 1. More job opportunities 2. Energy lending 3. Stronger economy. Data Sources: OPEC and BBC. 2.5K views Â·. View 1 Upvoter. Related Questions. In your own idea, explain how the status of alternative energy resources in the world today? What would it take/need to happen for the entire world to completely switch away from unsustainable energy sources Food self-sufficiency is related to, but not the same as, measures of net food importing and net food exporting countries, which indicate whether countries import more than they export or vice versa. However, most net food exporting countries are self-sufficient by the SSR and DEP measures, and most net food importing countries are not considered self-sufficient by those measures.3 Using the SSR and/or DEP measures of food self-sufficiency, a country can be considered self-sufficient while still engaging in food trade.Â The percentage of the global population living in countries that had under 95 percent self-sufficiency was 19 percent and the percentage living in countries with over 105 percent self-sufficiency was also 19 percent (Oâ€™Hagan 1975, p. 358).4. RESEARCH ARTICLE. Food security and food self-sufficiency around. the world: A typology of countries. Agnieszka Baer-NawrockaID*. â˜. , Arkadiusz SadowskiID. â˜. Department of Economics and Economic Policy in Agribusiness, Faculty of Economics and Social SciencesÂ to food security focused on food stocks which allowed to survive famine. As the level of overall. human development was rising, another reason for food insecurity was found to be the insuffi-. cient purchasing power of poorer population segments. Finally, health qualities and nutrient. content of food became a matter of concern for food security. These three aspects, i.e. physical. and economic availability and food safety and quality, as well as the stability of all these dimen The paper discloses trends in food self-sufficiency of the northern region in 1980-2013 and reveals reasons for the decrease in its level in the period of market reforms. It considers possible scenarios to develop the agrarian sector and food self-sufficiency. To predict the agriculture development the author identifies strong and weak sides, opportunities and threats by means of SWOT-analysis.Â In crop production agrochemical and water-physical properties of soil are aggravated and the area of marshy and bushy land expanded due to the destruction of drainage systems and almost the cessation of reclamation work. The application of mineral fertilizers in recalculation on 100% of nutrients per 1 ha of sowing fell from 135 in 1990 to 20 kg in 2014, organic - from 18 to 4.2 tons.