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Energy Resources and Environmental Management

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ABSTRACT: World energy resources are the estimated maximum capacity for energy production given all available resources on Earth. They can be divided by type into fossil fuel, nuclear fuel and renewable resources. Environmental management is the management of the interaction and impact of human societies on the environment. It is not, as the phrase might suggest, the management of the environment itself. Environmental resources management aims to ensure that ecosystem services are protected and maintained for future human generations, and also maintain ecosystem integrity through considering ethical, economic, and scientific (ecological) variables. Environmental resource management tries to identify factors affected by conflicts that rise between meeting needs and protecting resources. It is thus linked to environmental protection, sustainability, integrated landscape management, natural resource management, fisheries management, forest management, and wildlife management, and others.

Keywords: energy resources, environmental management, ecosystem, sustainable, wildlife, protection, conservation

I. INTRODUCTION

Reserves of fossil fuel are estimated as:

Fuel	Proven energy reserves in zettajoule (ZJ) as of the end of 2009
Coal	19.8
Gas	36.4
Oil	8.9

These are the proven energy reserves; real reserves may be four or more times larger. These numbers are very uncertain. Estimating the remaining fossil fuels on the planet depends on a detailed understanding of Earth's crust. With modern drilling technology, we can drill wells in up to 3 km of water to verify the exact composition of the geology; but half of the ocean is deeper than 3 km, leaving about a third of the planet beyond the reach of detailed analysis.

There is uncertainty in the total amount of reserves, but also in how much of these can be recovered gainfully, for technological, economic and political reasons, such as the accessibility of fossil deposits, the levels of sulfur and other pollutants in the oil and the coal, transportation costs, and societal instability in producing regions. In general the easiest to reach deposits are the first extracted.

Coal is the most abundant and burned fossil fuel. This was the fuel that launched the industrial revolution and continued to grow in use; China, which already has many of the world's most polluted cities,[2] was in 2007 building about two coal-fired power plants every week.[3][4] Coal's large reserves would make it a popular candidate to meet the energy demand of the global community, short of global warming concerns and other pollutants.[5]

Natural gas is a widely available fossil fuel with estimated 850 000 km³ in recoverable reserves and at least that much more using enhanced methods to release shale gas. Improvements in technology and wide exploration led to a major increase in recoverable natural gas reserves as shale fracking methods were developed. At present usage rates, natural

gas could supply most of the world's energy needs for between 100 and 250 years, depending on increase in consumption over time.

It is estimated that there may be 57 zettajoule (ZJ) of oil reserves on Earth (although estimates vary from a low of 8 ZJ,[8] consisting of currently proven and recoverable reserves, to a maximum of 110 ZJ[9]) consisting of available, but not necessarily recoverable reserves, and including optimistic estimates for unconventional sources such as oil sands and oil shale. Current consensus among the 18 recognized estimates of supply profiles is that the peak of extraction will occur in 2020 at the rate of 93-million barrels per day (mbd). Current oil consumption is at the rate of 0.18 ZJ per year (31.1 billion barrels) or 85 mbd. There is growing concern that peak oil production may be reached in the near future, resulting in severe oil price increases.[10] A 2005 French Economics, Industry and Finance Ministry report suggested a worst-case scenario that could occur as early as 2013.[11] There are also theories that peak of the global oil production may occur in as little as 2–3 years. The ASPO predicts peak year to be in 2010. Some other theories present the view that it has already taken place in 2005. World crude oil production (including lease condensates) according to US EIA data decreased from a peak of 73.720 mbd in 2005 to 73.437 in 2006, 72.981 in 2007, and 73.697 in 2008.[12] According to peak oil theory, increasing production will lead to a more rapid collapse of production in the future, while decreasing production will lead to a slower decrease, as the bell-shaped curve will be spread out over more years. In a stated goal of increasing oil prices to \$75/barrel, which had fallen from a high of \$147 to a low of \$40, OPEC announced decreasing production by 2.2 mbd beginning 1 January 2009.[13]

Political considerations over the security of supplies, environmental concerns related to global warming and sustainability are expected to move the world's energy consumption away from fossil fuels. The concept of peak oil shows that about half of the available petroleum resources have been produced, and predicts a decrease of production. A government moving away from fossil fuels would most likely create economic pressure through carbon emissions and green taxation. Some countries are taking action as a result of the Kyoto Protocol, and further steps in this direction are proposed. For example, the European Commission has proposed that the energy policy of the European Union should set a binding target of increasing the level of renewable energy in the EU's overall mix from less than 7% in 2007 to 20% by 2020.[14] The antithesis of sustainability is a disregard for limits, commonly referred to as the Easter Island Effect, which is the concept of being unable to develop sustainability, resulting in the depletion of natural resources.[15] Some estimate that, assuming current consumption rates, current oil reserves could be completely depleted by future.[16] Environmental resource management is an issue of increasing concern, as reflected in its prevalence in several texts influencing global sociopolitical frameworks such as the Brundtland Commission's *Our Common Future*, which highlighted the integrated nature of environment and international development and the Worldwatch Institute's annual *State of the World* reports. The environment determines the nature of people, animals, plants, and places around the Earth, affecting behaviour, religion, culture and economic practices.

Environmental resource management can be viewed from a variety of perspectives. It involves the management of all components of the biophysical environment, both living (biotic) and non-living (abiotic), and the relationships among all living species and their habitats. The environment also involves the relationships of the human environment, such as the social, cultural and economic environment, with the biophysical environment. The essential aspects of environmental resource management are ethical, economical, social, and technological. These underlie principles and help make decisions. The concept of environmental determinism, probabilism and possibilism are significant in the concept of environmental resource management. Environmental resource management covers many areas in science, including geography, biology, social sciences, political sciences, public policy, ecology, physics, chemistry, sociology, psychology, and physiology. Environmental resource management as a practice and discourse (across these areas) is also the object of study in the social sciences.[4][5] Environmental resource management strategies are intrinsically driven by conceptions of human-nature relationships.[6] Ethical aspects involve the cultural and social issues relating to the environment, and dealing with changes to it. "All human activities take place in the context of certain types of relationships between society and the bio-physical world (the rest of nature)," [7] and so, there is a great significance in understanding the ethical values of different groups around the world. Broadly speaking, two schools of thought exist in environmental ethics: Anthropocentrism and Ecocentrism, each influencing a broad spectrum of environmental resource management styles along a continuum.[6] These styles perceive "...different evidence, imperatives, and problems, and prescribe different solutions, strategies, technologies, roles for economic sectors, culture, governments, and ethics, etc." [7]

II. DISCUSSION

The International Atomic Energy Agency estimates the remaining uranium resources to be equal to 2500 ZJ.[17] This assumes the use of breeder reactors, which are able to create more fissile material than they consume. IPCC estimated currently proved economically recoverable uranium deposits for once-through fuel cycles reactors to be only 2 ZJ. The

ultimately recoverable uranium is estimated to be 17 ZJ for once-through reactors and 1000 ZJ with reprocessing and fast breeder reactors.[18]Resources and technology do not constrain the capacity of nuclear power to contribute to meeting the energy demand for the 21st century. However, political and environmental concerns about nuclear safety and radioactive waste started to limit the growth of this energy supply at the end of last century, particularly due to a number of nuclear accidents. Concerns about nuclear proliferation [1,2](especially with plutonium produced by breeder reactors) mean that the development of nuclear power by countries such as Iran and Syria is being actively discouraged by the international community.[19]Although at the beginning of the 21st century uranium is the primary nuclear fuel worldwide, others such as thorium and hydrogen had been under investigation since the middle of the 20th century.Thorium reserves significantly exceed those of uranium, and of course hydrogen is abundant. It is also considered by many to be easier to obtain than uranium.[3,4] While uranium mines are enclosed underground and thus very dangerous for the miners, thorium is taken from open pits, and is estimated to be roughly three times as abundant as uranium in the Earth's crust.[20]Since the 1960s, numerous facilities throughout the world have burned Thorium. Alternatives for energy production through fusion of hydrogen have been under investigation since the 1950s. No materials can withstand the temperatures required to ignite the fuel, so it must be confined by methods which use no materials. Magnetic and inertial confinement are the main alternatives (Cadarache, Inertial confinement fusion) both of which are hot research topics in the early years of the 21st century.Fusion power is the process driving the sun and other stars. It generates large quantities of heat by fusing the nuclei of hydrogen or helium isotopes, which may be derived from seawater.[5,6] The heat can theoretically be harnessed to generate electricity. The temperatures and pressures needed to sustain fusion make it a very difficult process to control. Fusion is theoretically able to supply vast quantities of energy, with relatively little pollution. Although both the United States and the European Union, along with other countries, are supporting fusion research (such as investing in the ITER facility), according to one report, inadequate research has stalled progress in fusion research for the past 20 years. [7,8]

Anthropocentrism, "an inclination to evaluate reality exclusively in terms of human values,"[8] is an ethic reflected in the major interpretations of Western religions and the dominant economic paradigms of the industrialised world.[6] Anthropocentrism looks at nature as existing solely for the benefit of humans, and as a commodity to use for the good of humanity and to improve human quality of life.[9][10][11] Anthropocentric environmental resource management is therefore not the conservation of the environment solely for the environment's sake, but rather the conservation of the environment, and ecosystem structure, for humans' sake. Ecocentrists believe in the intrinsic value of nature while maintaining that human beings must use and even exploit nature to survive and live.[12] It is this fine ethical line that ecocentrists navigate between fair use and abuse.[12] At an extreme of the ethical scale, ecocentrism includes philosophies such as ecofeminism and deep ecology, which evolved as a reaction to dominant anthropocentric paradigms.[6] "In its current form, it is an attempt to synthesize many old and some new philosophical attitudes about the relationship between nature and human activity, with particular emphasis on ethical, social, and spiritual aspects that have been downplayed in the dominant economic worldview." [13] The economy functions within, and is dependent upon goods and services provided by natural ecosystems.[14] The role of the environment is recognized in both classical economics and neoclassical economics theories, yet the environment was a lower priority in economic policies from 1950 to 1980 due to emphasis from policy makers on economic growth.[14] With the prevalence of environmental problems, many economists embraced the notion that, "If environmental sustainability must coexist for economic sustainability, then the overall system must [permit] identification of an equilibrium between the environment and the economy." [15] As such, economic policy makers began to incorporate the functions of the natural environment – or natural capital – particularly as a sink for wastes and for the provision of raw materials and amenities.[16]Debate continues among economists as to how to account for natural capital, specifically whether resources can be replaced through knowledge and technology, or whether the environment is a closed system that cannot be replenished and is finite.[17] Economic models influence environmental resource management, in that management policies reflect beliefs about natural capital scarcity.[9,10] For someone who believes natural capital is infinite and easily substituted, environmental management is irrelevant to the economy.[6] For example, economic paradigms based on neoclassical models of closed economic systems are primarily concerned with resource scarcity, and thus prescribe legalizing the environment as an economic externality for an environmental resource management strategy.[6] This approach has often been termed 'Command-and-control'. [6] Colby has identified trends in the development of economic paradigms, among them, a shift towards more ecological economics since the 1990s.[6]

There are many definitions of the field of science commonly called ecology. A typical one is "the branch of biology dealing with the relations and interactions between organisms and their environment, including other organisms." [18] "The pairing of significant uncertainty about the behaviour and response of ecological systems with urgent calls for near-term action constitutes a difficult reality, and a common lament" for many environmental resource managers.[19]

Scientific analysis of the environment deals with several dimensions of ecological uncertainty.[20] These include: structural uncertainty resulting from the misidentification, or lack of information pertaining to the relationships between ecological variables; parameter uncertainty referring to "uncertainty associated with parameter values that are not known precisely but can be assessed and reported in terms of the likelihood...of experiencing a defined range of outcomes";[21] and stochastic uncertainty stemming from chance or unrelated factors.[20] Adaptive management[22][23] is considered a useful framework for dealing with situations of high levels of uncertainty[24] though it is not without its detractors.[25] A common scientific concept and impetus behind environmental resource management is carrying capacity. Simply put, carrying capacity refers to the maximum number of organisms a particular resource can sustain. The concept of carrying capacity, whilst understood by many cultures over history, has its roots in Malthusian theory. An example is visible in the EU Water Framework Directive. However, "it is argued that Western scientific knowledge ... is often insufficient to deal with the full complexity of the interplay of variables in environmental resource management.[26][27] These concerns have been recently addressed by a shift in environmental resource management approaches to incorporate different knowledge systems including traditional knowledge,[28] reflected in approaches such as adaptive co-management community-based natural resource management and transitions management among others.[28]

Sustainability in environmental resource management involves managing economic, social, and ecological systems both within and outside an organizational entity so it can sustain itself and the system it exists in. In context, sustainability implies that rather than competing for endless growth on a finite planet, development improves quality of life without necessarily consuming more resources. Sustainably managing environmental resources requires organizational change that instills sustainability values that portrays these values outwardly from all levels and reinforces them to surrounding stakeholders. The result should be a symbiotic relationship between the sustaining organization, community, and environment.[11,12]

Many drivers compel environmental resource management to take sustainability issues into account. Today's economic paradigms do not protect the natural environment, yet they deepen human dependency on biodiversity and ecosystem services. Ecologically, massive environmental degradation and climate change threaten the stability of ecological systems that humanity depends on. Socially, an increasing gap between rich and poor and the global North-South divide denies many access to basic human needs, rights, and education, leading to further environmental destruction. The planet's unstable condition is caused by many anthropogenic sources. As an exceptionally powerful contributing factor to social and environmental change, the modern organisation has the potential to apply environmental resource management with sustainability principals to achieve highly effective outcomes. To achieve sustainable development with environmental resource management an organisation should work within sustainability principles, including social and environmental accountability, long-term planning; a strong, shared vision; a holistic focus; devolved and consensus decision making; broad stakeholder engagement and justice; transparency measures; trust; and flexibility.[13,14]

III. RESULTS

Renewable resources are available each year, unlike non-renewable resources, which are eventually depleted. A simple comparison is a coal mine and a forest. While the forest could be depleted, if it is managed it represents a continuous supply of energy, vs. the coal mine, which once has been exhausted is gone. Most of earth's available energy resources are renewable resources. Renewable resources account for more than 93 percent of total U.S. energy reserves. Annual renewable resources were multiplied times thirty years for comparison with non-renewable resources. In other words, if all non-renewable resources were uniformly exhausted in 30 years, they would only account for 7 percent of available resources each year, if all available renewable resources were developed.[23] Production of biomass and biofuels are growing industries as interest in sustainable fuel sources is growing. Utilizing waste products avoids a food vs. fuel trade-off, and burning methane gas reduces greenhouse gas emissions, because even though it releases carbon dioxide, carbon dioxide is 23 times less of a greenhouse gas than is methane. Biofuels represent a sustainable partial replacement for fossil fuels, but their net impact on greenhouse gas emissions depends on the agricultural practices used to grow the plants used as feedstock to create the fuels. While it is widely believed that biofuels can be carbon neutral, there is evidence that biofuels produced by current farming methods are substantial net carbon emitters.[24][25][26] Geothermal and biomass are the only two renewable energy sources that require careful management to avoid local depletion.[27] Estimates of exploitable worldwide geothermal energy resources vary considerably, depending on assumed investments in technology and exploration and guesses about geological formations. Renewable energy sources are even larger than the traditional fossil fuels and in theory can easily supply the world's energy needs. 89 PW of solar power falls on the planet's surface. While it is not possible to capture all, or even most, of this energy, capturing less than 0.02% would be enough to meet the current energy needs. Barriers to

further solar generation include the high price of making solar cells and reliance on weather patterns to generate electricity. Also, current solar generation does not produce electricity at night, which is a particular problem in high northern and southern latitude countries; energy demand is highest in winter, while availability of solar energy is lowest. This could be overcome by buying power from countries closer to the equator during winter months, and may also be addressed with technological developments such as the development of inexpensive energy storage. Globally, solar generation is the fastest growing source of energy, seeing an annual average growth of 35% over the past few years. China, Europe, India, Japan, and the United States are the major growing investors in solar energy. Solar power's share of worldwide electricity usage at the end of 2014 was 1%. At the end of 2005, 0.3 GW of electricity was produced by tidal power. Due to the tidal forces created by the Moon (68%) and the Sun (32%), and Earth's relative rotation with respect to Moon and Sun, there are fluctuating tides. These tidal fluctuations result in dissipation at an average rate of about 3.7 TW.[15,16]

Another physical limitation is the energy available in the tidal fluctuations of the oceans, which is about 0.6 EJ (exajoule). Note this is only a tiny fraction of the total rotational energy of Earth. Without forcing, this energy would be dissipated (at a dissipation rate of 3.7 TW) in about four semi-diurnal tide periods. So, dissipation plays a significant role in the tidal dynamics of the oceans. Therefore, this limits the available tidal energy to around 0.8 TW (20% of the dissipation rate) in order not to disturb the tidal dynamics too much. Waves are derived from wind, which is in turn derived from solar energy, and at each conversion there is a drop of about two orders of magnitude in available energy. The total power of waves that wash against Earth's shores adds up to 3 TW. The available wind energy estimates range from 300 TW to 870 TW. Using the lower estimate, just 5% of the available wind energy would supply the current worldwide energy needs. Most of this wind energy is available over the open ocean. The oceans cover 71% of the planet and wind tends to blow more strongly over open water because there are fewer obstructions.[17,18]

The public sector comprises the general government sector plus all public corporations including the central bank. In environmental resource management the public sector is responsible for administering natural resource management and implementing environmental protection legislation. The traditional role of the public sector in environmental resource management is to provide professional judgement through skilled technicians on behalf of the public. With the increase of intractable environmental problems, the public sector has been led to examine alternative paradigms for managing environmental resources. This has resulted in the public sector working collaboratively with other sectors (including other governments, private and civil) to encourage sustainable natural resource management behaviours. The private sector comprises private corporations and non-profit institutions serving households. The private sector's traditional role in environmental resource management is that of the recovery of natural resources. Such private sector recovery groups include mining (minerals and petroleum), forestry and fishery organisations. Environmental resource management undertaken by the private sectors varies dependent upon the resource type, that being renewable or non-renewable and private and common resources. Environmental managers from the private sector also need skills to manage collaboration within a dynamic social and political environment. Civil society comprises associations in which societies voluntarily organise themselves into and which represent a wide range of interests and ties. These can include community-based organisations, indigenous peoples' organisations and non-government organisations (NGOs). Functioning through strong public pressure, civil society can exercise their legal rights against the implementation of resource management plans, particularly land management plans. The aim of civil society in environmental resource management is to be included in the decision-making process by means of public participation. Public participation can be an effective strategy to invoke a sense of social responsibility of natural resources. [19,20]

IV. CONCLUSIONS

As with all management functions, effective management tools, standards and systems are required. An environmental management standard or system or protocol attempts to reduce environmental impact as measured by some objective criteria. The ISO 14001 standard is the most widely used standard for environmental risk management and is closely aligned to the European Eco-Management and Audit Scheme (EMAS). As a common auditing standard, the ISO 19011 standard explains how to combine this with quality [21,22] management. Other environmental management systems (EMS) tend to be based on the ISO 14001 standard and many extend it in various ways:

- The Green Dragon Environmental Management Standard is a five-level EMS designed for smaller organisations for whom ISO 14001 may be too onerous and for larger organisations who wish to implement ISO 14001 in a more manageable step-by-step approach,
- BS 8555 is a phased standard that can help smaller companies move to ISO 14001 in six manageable steps,



- The Natural Step focuses on basic sustainability criteria and helps focus engineering on reducing use of materials or energy use that is unsustainable in the long term,
- Natural Capitalism advises using accounting reform and a general biomimicry and industrial ecology approach to do the same thing,
- US Environmental Protection Agency has many further terms and standards that it defines as appropriate to large-scale EMS,
- The UN and World Bank has encouraged adopting a "natural capital" measurement and management framework.[23,24]

Other strategies exist that rely on making simple distinctions rather than building top-down management "systems" using performance audits and full cost accounting. For instance, Ecological Intelligent Design divides products into consumables, service products or durables and unsaleables – toxic products that no one should buy, or in many cases, do not realize they are buying. By eliminating the unsaleables from the comprehensive outcome of any purchase, better environmental resource management is achieved without systems. Another example that diverges from top-down management is the implementation of community based co-management systems of governance.[25,26] An example of this is community based subsistence fishing areas, such as is implemented in Ha'ena, Hawaii. Community based systems of governance allow for the communities who most directly interact with the resource and who are most deeply impacted by the overexploitation of said resource to make the decisions regarding its management, thus empowering local communities and more effectively managing resources. Recent successful cases have put forward the notion of integrated management. It shares a wider approach and stresses out the importance of interdisciplinary assessment. It is an interesting notion that might not be adaptable to all CASES.[27,28]

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