

**US NAVAL WAR COLLEGE**

**Newport, RI**

**Biodiversity, Factor Endowments and National Security**

*The Next Great Game?*

**By**

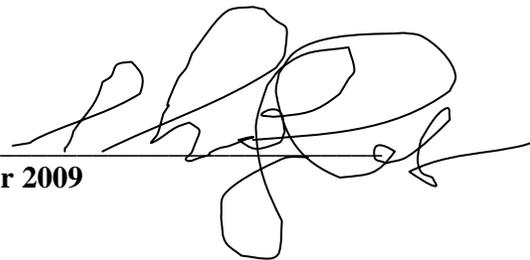
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**The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.**

**Signature:** \_\_\_\_\_  
**08 November 2009**

A handwritten signature in black ink, appearing to read 'T. Grabarz', written over a horizontal line. The signature is stylized and somewhat cursive.

## INTRODUCTION

For years the value of biodiversity has been questioned as to its efficacy and usefulness. Its value as a natural resource has been clouded due to market economics reliance on natural resources immediate productive capacity. However a post industrial convergent technology world is rapidly approaching a point where the national security value of biodiversity will outweigh any other; as genetic engineering and synthetic biology become part of a prevailing technological paradigm that will utilize the genome as the raw material for technological innovation. The lack of control of biodiversity will bring into focus the precarious nature of our current world order, due to the physical location of such biodiversity resting in the Global South where the most pronounced security threats are likely to emanate in the future when coupled with other more traditional peer competitors. In addition, exacerbating this physical location threat will be the threat posed from the emergence of a partnership between the nations that hold this resource and those that hold the technology to transform it. Unfortunately while the US has the technology to transform it, the US lacks the visibility to understand the threat, while others such as India and China likewise increasingly have the ability to transform it and understand the threat much more than the US. This scenario has all the makings of a nascent *Great Game*<sup>1</sup> as originally coined by Arthur Connolly, an intelligence officer of the British East India Company's Sixth Bengal Light Cavalry in describing the strategic enmity between the British Empire and Russian Empire for the conquest of Central Asia and thus its access to its natural resources in the run-up to the original Industrial Revolution which subsequently had repercussions with Middle East oil and the proxy

wars between the US and former Soviet Union. It will be up to us to see that the same challenges in the Middle East today that have resulted in our most recent conflicts, are not transferred onto a metaphorical *Middle East* for future generations, in areas where the most biodiversity exists. Our challenge then as national security advisors is to preclude the *The Next Great Game* from occurring.

As strategy can be thought of as the nexus of national power and policy within the framework of the international security environment<sup>2</sup>, as aspects of that power (such as technology and resource availability) change, then that strategy must change also.<sup>3</sup> The importance of that power is the capability of influencing outcomes desired and altering the behavior of others to enhance or support those outcomes.<sup>4</sup> Disaggregated, at the individual human level it is all about feeling and being safe, to safely enjoy a quality of life that we have grown accustomed to in the US. Within the context of revolutionary changes in technology, the demand for differentiated resources to fuel that technology is changing rapidly, both in type and geographic location relative to the resource supply. Without developing a strategy of securing this resource supply, it will fundamentally affect the security and safety of the US, thus driving it further into the predicted multi-polar world,<sup>5</sup> and possibly changing its power position indefinitely.

The revolutionary technology being advanced and faced by the US is the convergence of a series of historically separate sciences that include nanotechnology, biotechnology,<sup>6</sup> information technology and cognitive science, or NBIC, that promises to bring about significant improvement in human abilities, societal improvements, national productivity and quality of life.<sup>7</sup> These resources or factors of production, the factor endowments

that will “fuel” these new technologies is largely *biomass*, the genetic material of biological systems, that exist largely in the global south<sup>8</sup> in *biodiversity hotspots*.<sup>9</sup> Through the increasing use of commercial applications of biotechnology, (the means through which DNA, the genetic material of plants, animals and microbial systems can be converted or manipulated into useful products and technologies) and recombinant DNA technology<sup>10</sup> and its resource base, biomass; significant changes will occur over the next thirty five years in the wealth-status and power of nation-states relative to these newly recognized factor endowments. However, due to structural economic issues tied to the poor and/or weak governance of many of these least developed country’s,<sup>11</sup> where much of this biomass exists, the traditional trade mechanisms generally engaged in by less developed nation states will continue to be export-led growth.<sup>12</sup> This type of growth has historically led to destabilization on both intra and inter-state levels, resulting in conflict and other security issues.

Therefore, whether these newly recognized factor endowments<sup>13</sup> occur within nation-states terrestrially or within the earth’s oceans or other areas outside of sovereign limits, a key to mitigating these potential conflicts will be in common global ownership.

## **DISCUSSION**

### **The Environmental Policy Landscape**

Within the traditional environmental topic descriptors of *biodiversity*,<sup>14</sup> *sustainable development*,<sup>15</sup> *climate change*,<sup>16</sup> or *environmental degradation*<sup>17</sup> (the areas that garner the most attention in the media today), little at first blush seems important to national

security professionals, as on the surface nothing relative to the environment seems vital to national interests for the US.<sup>18</sup> As Clark states ‘people in power’ make decisions every day outside the context of how it affects the health of the planet.<sup>19</sup> Indeed even in the US case, there seems to be immediacy in all decisions discussing vital interest that seldom practically exceed a four year term and typically focus on overt human security.

Environmental security<sup>20 21</sup> literature tends to focus on either resource wars, typically aimed at energy or water;<sup>22</sup> or climate change,<sup>23 24</sup> specific to the littoral environment and sea level changes that have an immediate and clear causal connection to human challenge, and hence the possibility of human conflict. A tangential area of environmental concern that’s effects are far more important to vital national interests, yet has received very little attention is the factor endowments of biomass, or genetic material in its more refined form.

### **Biomass: The Next Technological Driver.**

The importance of biomass as a key to national security begins with an understanding of productivity. Productivity is a function of knowledge and skill, i.e. technology. Growth in productivity depends upon improved technology. Productivity is equal to the efficiency by which the inputs of labor, capital and natural resources (factors of production) are transformed into *output*. Output which is equivalent to GDP, Gross Domestic Product gives a nation the financial capability to exercise its power. Output is a function of Productivity and Input,  $Input = Labor + Capital + Natural Resources$ . Historically the *first industrial revolution* was initiated by the steam engine and electricity. It substituted human labor for mechanical labor. The fundamental building blocks of that revolution

were fossil fuels, as the primary natural resource driver there with substitutions being available including oil, coal and finally nuclear power. Within the *convergent revolution*, the convergence of the technologies mentioned NBIC the primary raw material that will be driving those systems will be genetic material, which has no substitutes. Traditional nation states wealth is built upon factors of production<sup>25</sup> (labor, natural resources and capital) or factor endowments<sup>26</sup> that provide immediate translation into productive ends which then influences its geo-political importance amongst nation-states and thus international relations, through output or GDP as described. As the basis for economic growth and hence international power, natural resource factor endowments,<sup>27</sup> are probably the most important particularly at the foundation of a nations history. Dumont points out that man's economy doesn't produce anything equal to the potential value of natural resources, but only extracts.<sup>28 29</sup> This 'natural capital'<sup>30</sup> then forms the basis for all of the global factor endowments related to natural resources, and like anything of value requires security to protect. The converse is also true, the roots of inequality due to the lack of those same factor endowments<sup>31 32</sup> play as vital a role in preventing a nation from moving forward quickly in economic trajectory and tend to saddle them for many years to come from economic prosperity and thereby international power.

### **Factor Endowments and National Power**

The origin of such international power relations through factor endowments started with the *mercantilist* view that national power was tied to national economic wellbeing<sup>33</sup> through international trade, their motto being to *always export more than one imported*,

international trade was in their view a zero-sum condition, one wins-one loses, which can act as a catalyst for conflict to return the losers to their original position. Wealth for the mercantilists was measured as a stock of precious metals, allowing them to form and equip major armies, thus consolidating power at home, and enlarging colonial ambitions.<sup>34</sup> In response to this early isolationist view, was Adam Smith's view through his *Wealth of Nations*<sup>35</sup> in what became the basis of classical economics. Smith theorized that international trade, contrary to the mercantilists view, would allow all resources to be utilized most effectively thereby *maximizing international welfare*;<sup>36</sup> a kind of a rising tide lifts all ships early globalization view. This theory of *free* trade parallels the current view, defining the wealth of a nation by its stock of human, man-made, and natural resources allowing production of goods and services,<sup>37</sup> to flow to the nation it can best serve economically. These values are called factors of production,<sup>38</sup> or more currently, factor endowments.<sup>39</sup> This theory was further refined in the *law of comparative advantage* by David Ricardo in 1817,<sup>40</sup> where it was found that it was advantageous to specialize in specific factors of production, even if a nation had an "absolute advantage" in multiple products or resources, as that absolute advantage was never to be completely equal. It is through this process that resources are utilized in the most efficient manner.<sup>41</sup> The efficacy and resiliency of this law has had, and continues to have far reaching effects upon the interplay amongst nations both in terms of economies as well as security relative to international free trade.

### **Hechsher Ohlin Theorem and International Trade**

The mutual or multiple benefit to nations utilizing the law of comparative advantage<sup>42</sup> was then further refined through the Hechsher Ohlin Theorem,<sup>43</sup> using the K/L *capital labor ratio* that said that the complexity of an economy would not only define to what *extent* it traded, but *what* it traded as well. While one could make the argument that the US, due to its substantial *in-situ* factor endowments, could well survive without international trade; examining the interdependence of nations by comparing their imports/exports in GDP % terms, one sees that the US has become significantly dependent on international trade within the last 50 years,<sup>44</sup> a result of globalization. As nations continue to industrialize, thus becoming more complex technologically, the Hechsher-Ohlin Theorem recognizes that specialization will broadly change from being labor intensive L, to being capital intensive K. The HO theorem suggests that the difference of supply of the various factors of production result in a change in factor prices, ultimately affecting overall national income.<sup>45</sup> This change in factor prices is what drives economic prosperity and that separate developed country's from developing countries. Growth effects for smaller countries at the margin with equal factor endowments will be larger than for larger countries economy's<sup>46</sup> due to economies of scale. This suggests that country's with smaller GDP's will benefit proportionately more with such specialization, such as the global south, which typically host much smaller economies.

### **Outside the Bounds, the Search for Resources**

A result of the US post-industrial economy caused by the increase in the K/L ratio, the US has become more of an information or high technology economy,<sup>47</sup> <sup>48</sup>capital

intensive, relying upon very complex and technologically advanced R & D, processes and equipment. In the last ten years this *convergent revolution* has increasingly tied the US economy (unlike in its previous history) to *remote* resources, outside the bounds of the US as well as developed nation states which despite the concept of factor mobility,<sup>49</sup> (where factors of production when not restrained will move to where the highest marginal return is obtained) is concerning as it means that the need to obtain such factors outside the local area is no longer an option, but increasingly a requirement. While this has been partly true of the natural resource of oil, it will be largely true for genetic material. While to date factor mobility for genetic material residing in the global south has remained,<sup>50 51</sup> there are trade barriers being erected which may change this outlook.

### **The Biotechnology Revolution**

This NBIR convergent revolution is characterized by the use of efficient and economical capital which has facilitated the development of an information revolution utilizing the biodiversity of living systems to perform engineering functions. Essentially natural organism's genetic codes contain the "recipes" for chemical compounds that may have significant value for pharmaceutical as well as nano-technology, cognitive science, information technology and biotechnology companies. Obtaining this "breeding stock" for commercial exploitation of promising molecules can speed up a research effort that can otherwise continue on for years.<sup>52</sup> As nature creates efficient compounds in the crucible of evolution that scientists could never dream, this provides an increasing "OODA, Observe Orient Decide Act" loop<sup>53</sup> that can be very cost effective, especially when one considers that between 1981 and 1993 on average *only* 23.4 new drugs were

approved by the FDA Food and Drug Administration per year.<sup>54</sup> From an innovation perspective this is resulting in a number of other new technologies including pharmaceutical bio-prospecting, ethno-botanical bio-prospecting, botanical medicines, nano-technology, biological control and crop protection, biomimetics, bio-monitoring horticulture and agricultural seeds including genetically modified organisms<sup>55</sup>, bioremediation and ecological restoration.<sup>56</sup>

### **Wealth and Conflict in the South**

Between 5 million and 30 million species of organisms exist on the earth, each with thousands of genes, and less than 2 million have been taxonomically described at the most basic level.<sup>57</sup> As less than 1% have been utilized in some type of technology or medication thus far, it's expected that with the application of new and as of yet undeveloped knowledge base of technology, that significant outcomes are yet to be yielded,<sup>58</sup> which will result in a higher K-capital ratio for the US. These numbers include only the terrestrial environment and not even the world's oceans, where significant progress has been made to converting many ocean organisms to everything from cancer related medications to engineered polymers.<sup>59</sup> The current technological landscape extant in the developed world or global north, these high K or capital intensive economies, combined with the factor endowments of less developed areas of the world have already formed business partnerships between the north and the south.<sup>60</sup> However, it remains to be seen as to how viable this partnership will remain. The demand for genetic resources for biotechnological production mainly focuses on material that is extracted from areas where biological diversity is highest, i.e. genetic material from

developing countries in tropical climate zones.<sup>61 62</sup> Thus where much of the biomass exists, is also where much of world conflict occurs<sup>63</sup> or as Barnett calls it the “core” versus the “gap”, the global south being the “gap”.<sup>64</sup> It is estimated that 50%<sup>65</sup> of the biomass used to manufacture drugs today originate in these so-called biodiversity hot spots<sup>66</sup> totaling 34 locations and covering 5 continents and 111 countries. This includes 70% of the plants used to develop treatment for cancer.<sup>67</sup> To qualify as a hotspot, a region must meet two basic criteria: it must have at least 1,500 species of vascular plants (> 0.5 percent of the world’s total) as endemics, and must have lost at least 70 percent of its original habitat.<sup>68</sup> Of particular concern are the endemic species or those that exist in only one location<sup>69</sup> which are currently 150,000 plant species and 11,823 animal species<sup>70</sup> Up to 44% of all species of vascular plants and 35% of all species of vertebrate groups are confined to 25 hotspots, comprising only 1.4% of the land surface of the Earth.<sup>71</sup> The debate to date on the environment has focused on preserving biodiversity or the biomass of living systems, based at best on its value as an industrial resource subject to issues of environmental stability and resilience relative to the risk of extinction<sup>72</sup> from an ecological standpoint rather than with the possibility of genetic material as a strategic resource.

### **Probable Short Term Scenario**

Unfortunately what has already occurred are many of the developed country’s colonializing extraction campaigns have resulted in multi-national enterprises (through their extractive processes) having already worn out their welcome.<sup>73</sup> Less developed nations in many cases are closing their doors to further development and extraction by

other country's, labeling it as bio-piracy.<sup>74</sup> From an economic perspective, this has resulted in the *sub-optimizing* of resources<sup>75</sup> within LDC's that lack the technology to transform it, i.e. high L, low K. As the history of economic development has started with factors of production followed by absolute and then comparative advantage it's likely that the global south will in the short term manage some form of trade with the north despite the problems and inefficiencies despite perceiving the global north once again to having hegemonic interests of previous colonial powers. The capital poor country, attempting to gain that new found power from increasing factor endowments, is likely to face setbacks as it tries to move away from an autarkic (absence of trade) model for growth.<sup>76</sup> It has been suggested that in international trade with the global north,<sup>77</sup> the global south would face a comparative advantage ironically due to restricted or weakened property rights whereas the north following a regime of private property ownership and following the marginal rate of return and the south the average rate of return,<sup>78</sup> thus in the short term being an advantage to the south.

### **Possible Long Term Scenario**

In the long term, what may result in the global south are such country's forming an OPEC like cartel, a PTA Preferential Trading Agreement<sup>79</sup> or trading block similar to the EU to enhance their trading power, potentially leading to additional resource conflict.<sup>80</sup> With few if any substitutes, this will result in inelastic (monopolistic) pricing behavior similar to the oil embargo days, engendering significant control by these nations over a major source of future wealth and security, a strategic resource. This then could be the beginning of the resurgence and realization of the potential for the global south at the

expense of the global north<sup>81</sup> thereby changing the dynamic over time where historically 15% of the world's population has produced 54% of the global GDP with less than 10% of the global land mass.<sup>82</sup>

As an example Hugo Chavez of Venezuela has made significant inroads in changing the power status in his region.<sup>83</sup> For him to originate such a cartel or PTA in concert with outside influence such as the Chinese and or Indian (who are well versed in bio-technological issues),<sup>84</sup> could provide the influence that he would need to get other areas of the worlds with such biological natural resource wealth working in unison with him, thus concentrating power in ways that may not be advantageous for other global players. However, either scenario is likely to result in further conflict as the south lacks the social institutions to transfer that wealth to their populations and additionally will lack the ability to maintain order when needed. As the history of economic activity in these regions has followed export led growth<sup>85</sup> with little land ownership rights, *secure* growth will be difficult to maintain.

### **-The Security Issue**

From a security standpoint though this enhanced recognition of factor endowments in genetic materials in the global south will garner potentially enormous power that the US and other western powers will be abrogated from. Following the “rentier” hypothesis this will lead to an enormous increase in unearned income due to natural resource revenues within the LDC's without the attendant benefit to their populations, thus increasing the “haves and have-nots.”<sup>86</sup> This will increase the tendency towards

domestic conflict as exports of the contested resource increase with increasing unearned, undistributed income.<sup>87</sup>

### **-The Economic Issue**

From the economic standpoint, it will leave these newly transformed resources in the hands of one's unable to transform it. This is the logical outcome from a public/private goods policy perspective,<sup>88</sup> in that when a public good lacks the ability to be controlled through use or taxation, it is ultimately exhausted. However, much of what is considered within a national border is in fact completely transparent to it, making the enforceability of this "border" impossible to manage.

## **RECOMMENDATIONS**

In contrast to The Convention of Biological Diversity<sup>89</sup> which presupposes that such assets will remain in sovereign hands, is that these resources should become part of a 'global commons'<sup>90 91</sup> which will facilitate a global sharing of value thus limiting further inequality thereby negating the possibility of a potential genetic resource war. An estimate of the global cost to set aside all land globally to protect biodiversity would be \$143.8 B in 1990 dollars where the US share would represent 15%.<sup>92</sup> More importantly, based upon the other economic options that might occur, to stem further the decline of these same nations if they attempted to deal with that enhanced level of trade, for which they are ill equipped to secure, transform, or equitably treat its constituents to the proceeds from such extraction.

There is widespread support for an alternative to the option of the UNEP United Nations Environmental Programme, perhaps more in keeping with the WTO World Trade Organization, as a WETO World Environment and Trade Organization, that would subsume the UNEP.<sup>93</sup> From a political philosophical perspective this deals more with the constructivist philosophy in which “norms based behavior” plays an increasingly important role, where areas of CHM the Common Heritage of Mankind are exploited according to the precepts of international distributional equity.<sup>94</sup>

## **CONCLUSIONS**

That said, with the advent of the mapping of the genome, each living species can now be looked at as a virtual spatial frontier, akin to the New World 500 years ago, with all of the promise of resource value and conflict for them. We see a world with our eyes and seemingly sense its entirety within which all human acts take place. However the world being described at the atomic and subatomic levels is infinitely larger, and equally or more rich. That is the future battlespace that will define ours and our national existence, one that we cannot yet truly perceive.

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