Global Resource Ownership Rights: Proposal of a Quantitative System

Ze Zhang, Ph.D.
Department of Science and Mathematics
Coker College, Hartsville
SC 29550, USA

Abstract

This paper proposes a universal quantitative method to determine the ownership rights of natural resources such as territory, islands, mines, and rivers, when disputes and resolutions will have global impact. As opposed to being based on commonly used arguments with a historical, political or certain moral standpoint, this method relies on an assumption of universal ownership of the resource with a depreciation of individual rights proportional to the geographical distance from the point of interests. The distance depreciation follows an inverse distance-squared rule beyond an interest radius R_I, within which however each individual has equal right. The intention of this work is to put forward an initiative to find an objective framework, for computing a quantitative level ownership rights that an individual or a group has regarding a disputed point of interest or resource. It is the author's hope that quantitative calculations of ownership rights, will curtail the number of heated arguments, quarrels, or martial resolutions in resolving issues or conflicts in this more and more crowded world.

Keywords: global resource ownership; mathematical resolution of disputes

1. Introduction

Advancements in science and technology have no doubt led to substantial improvement in the overall quality of life on earth. It has not, however, brought about fundamental changes in the methods of conflict resolution. An issue or conflict is solved by rational debates and calculations only if there is a set of values and rules accepted by all parties involved. When an issue or a dispute is international, unfortunately, there are usually no commonly agreed values and rules for resolution. In that case we tend to apply our local values to wider scopes. If that doesn't favor us, we use a different set of values and rules, which is so-called double standard, to our own benefit. In the worst case we all fall back to the "rule of the jungle", which, more often than not, leads to violence or misery.

A civilized world needs a universal set of rules for resolving conflicts. There should be a value that measures the overall well beings of all parties involved. This value must be mathematically calculable and the set of rules, when applied in resolving a conflict, must lead to a maximization of the value. The reader may immediately raise two questions: First, can such rules be defined? Second, even if they can be defined, is the world willing to adhere to these rules for issue resolution?

The author's answer to the first question is positive. The basic value must be derived from results of scientific research investigating how mankind, as one of the species on earth, can best survive and advance. The second question should be directed to each individual on this planet. As the laws are for citizens to obey, for criminals to break, and lawyers to practice, the universal rules are for good human being to follow, evil human beings to evade, and for future global politicians to play by. The author believes that scientific research and quantitative analysis should ultimately lay the foundations of universal moral standards and political sciences, and therefore this work is an attempt in that direction.

1.1 Distance-Decay Resource Dependence and Relationships

From ancient times until today, almost all conflicts boil down to disputes over natural resources, territory or sovereignty. Land, or more precisely the area on earth, is the most important resource. What entitles a group of humans, a person, or an animal to a piece of land? Commonly, if a tribe comes to live on it first, it can claim it and defend it from the "invaders" who come later. Though this may be dominantly accepted argument, it is not mathematically precise.

Immediately after a child is born somewhere on earth, he needs to breath the air and drink the water in the immediate vicinity. He then needs to take the food grown in fields nearby and live in a house built from local materials. Later when he grows up, he may ride and hunt a few miles away in the forest or if he is a modern man, drive fifty miles to work at his job. He will be very concerned if a river within a hundred miles is contaminated but he cares slightly less about a drought in another state or province. He would be very worried about a hurricane 500 miles away only if he had a sister or brother who lives there; he would feel relieved or perhaps even unaware if there is an earthquake on the other side of the planet. **One needs less and therefore cares less for things that are farther away.** This is also true in the animal world. One can imagine an experiment that measures the probability of a dog barking at a passerby. You would certainly expect a decreasing function with the distance from the house. A dog barks if it thinks a trespasser has entered into its area of interest, or life circle.

1.2 Overlapped life circles and territories

Each living being has a life circle within which it draws resources, seeks collaborators, and receives supports. Overtime, the center of the circle may move and the radius may change (usually increase). The most striking fact is that the **life circles overlap**. Because of overlap, an individual can not claim he owns the circle he lives in. However, a group of people, often biologically related, can claim the land enclosed by the contour which encompasses all of their life circles (Figure 1). As evidenced in history, this type of self claimed homeland may be peacefully settled for some period of time, although not necessarily agreed to by others, and simply because the areas were disjoint (Figure 2). Such an enclosed living area will be analogically referred to as a *country* from now on in the context.

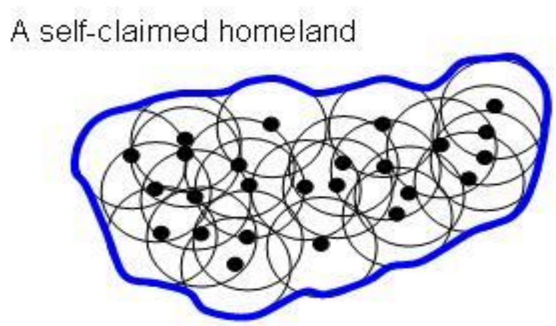

Figure 1: Overlapped life circles and a self-claimed homeland

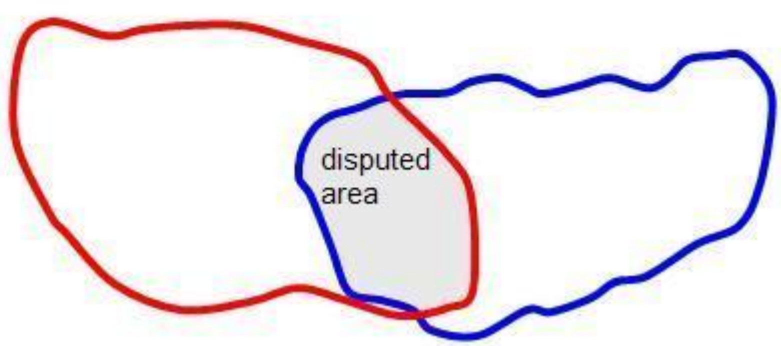

Figure 2: Disputed area between two countries

1.3 Rules and Principles --- where should they come from?

Within the encompassed area, people behave under a set of local rules and customs which they believe would optimize the country's well being. While the well being of a country remains to be more accurately defined, there seems to be two principles that have been popular: 1) all humans are equal, which implies equal sharing all of the resources and has lead to some so-called democratic systems today. 2) Everyone has right to move to and live anywhere within the country. Whether these principles lead to optimization remains to be investigated scientifically. There were other well adopted principles such as the strong-survive (natural selection), strong-help-weak, dictatorship, and various religiously rooted moral standards. Each of these can stir up a heated debate. But none of them seek to deny the ultimate well-being of mankind. In searching for the best way to allocate the resources on earth, this paper adopts a simple assumption: All humans are born equal.

With the passing of time, some resources run out and other resources are discovered. Every single life circle moves and expands. Sheep's need to move to greener pastures and wolves need to follow. The territories of two countries may become overlapped as shown in figure 2. This creates a conflict. Either peacefully or violently, it always settles with two possible situations: the two countries share the overlapped area or they merge into one new country.

Merging into one country is obviously the shortest way toward equal rights. The problem reduces to the internal optimization problem as mentioned above. In general there seem to be more people for unification than for division of countries and some even envision a complete globalization with all countries disappeared. But the reality is not always same as one would wish. As in many mathematical optimization problems, local maxima are not always in the same direction as the global maximum; those who favor natural selection rule over intelligence [1], make all the efforts to maximize their own temporal interests regardless of the global and long term consequences. Peacefully sharing the conflicted areas is another alternative. This article, therefore, suggests yardsticks for measuring the fairness in sharing resources.

Quantitative Entitlement of Resources

While distance-decay dependence is generally true, it is becoming less and less of the case for many types of resources on earth. The world has become more cohesive than ever. An individual's right over *a resource* (land, river, island, mineral, etc) can be quantified by a function

$$W(\mathrm{r})$$

The $W(r)$ determines the amount of ownership one has, relative to others who have the same interest for this resource. Obviously $W(r)$ should be some decreasing function of the distance *r* from where the individual lives to the resource. The function is parameterized by a radius of interests (R_I) which is measured from the center of the resource. It characterizes the size or the range of the influence of the resource. For irregularly shaped resource such as an island or an oil field, the center is defined as the geometric center (Figure 3) and the radius R_I is derived from the relation:

$$\pi {R_I}^2 = area$$

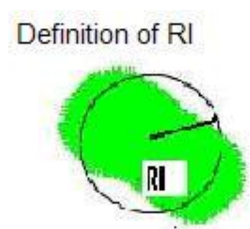

Figure 3: The Radius of Interests is defined as the radius of the circle that is centered at the geometric center of the resource and has the same area as the resource's area.

The exact function form of $W(r)$, however, is not a matter of anyone's choice. Rather it must be an agreement between all the individuals and based on status quo of all the parties involved. In ancient times, at present, or in the future, at one place or another, some of the commonly acceptable rules for sharing resources, may be modeled with the functions shown below:

i) first claimer: $W(r) = \begin{cases} 1 & r < R_I \\ 0 & r \geq R_I \end{cases}$

ii) $\frac{1}{r^p}$ decay: $W(r) = \begin{cases} 1 & r < R_I \\ \frac{R_I{}^p}{r^p} & r \geq R_I \end{cases}$ $0 < p < \infty$

iii) flat: $W(r) = 1$

Figure 4 graphs a few examples of the $W(r)$. The *first claimer* rule is represented by a step function. Its circular symmetry reflects *fairness* in treating random shaped resource areas, as apposed to mathematical simplicity. Throughout history this type of rules was often adopted as the "reasons" for holding a resource; unfortunately it can only be backed up by force and was frequently violated. It is not a rule for sharing. The $\frac{1}{r^p}$ type gives certain amount of right, though reduced, for individuals who live outside of the radius R_I, and therefore is probably easier for everyone to accept. Depending on what value the exponent *p* is set to, the $\frac{1}{r^p}$ function favors the locals to certain degree. The higher the *p*, the larger part of the resource belongs to the local people. When *p* approaches infinity it becomes the first claimer rule (step function). On the other hand when *p=0*, it implies complete globalization (flat function).

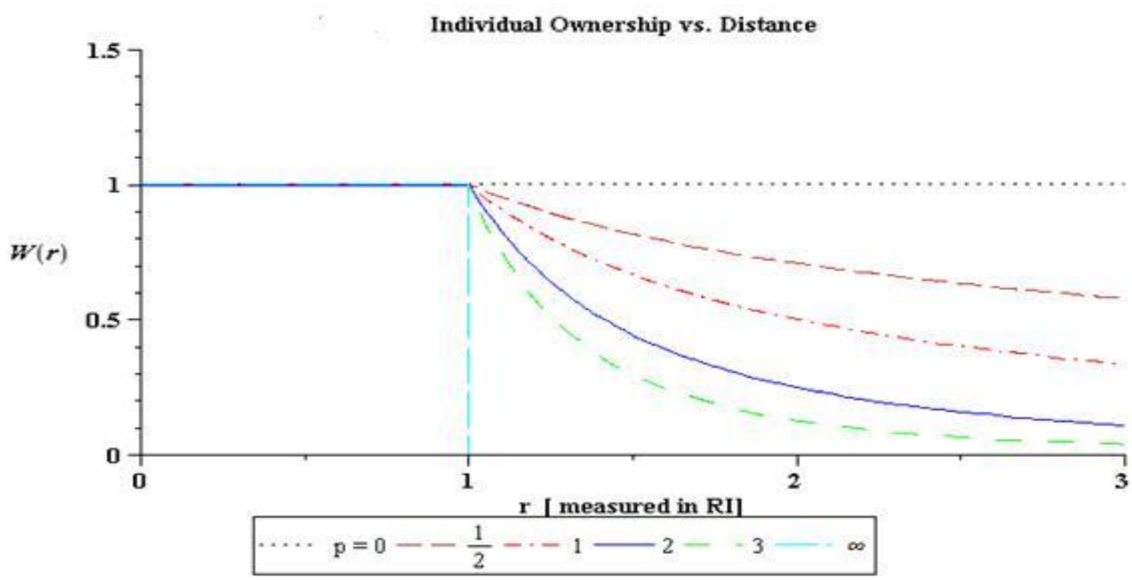

Figure 4: Individual Ownership vs. Distance. The distance *r* is in units of R_I and hence is dimensionless

The sum of all the individual ownerships of a country, a region, or a group determines its relative amount of entitlement *E*, in computing its percent ownership.

$$E = \sum_{individuals} W(r_i)$$

The percent ownership of each interested party is given by the ratio:

$$\frac{E}{\sum_g E_g}$$

2.1 Computation of ownerships for an imaginary world

Figure 5 shows an imaginary world that has three countries, A, B, and C, which have populations 200, 235, and 150 respectively. Each individual is represented by a color coded asterisk at the location where he or she lives.

Since $W(r)$ is a dimensionless quantity, actual units chosen for the distance is irrelevant. The circle centered on country C, with a radius R_I of 11.02, has the same area as the country. If we use the inverse-square rule (*p=2*) for computing the percent ownerships of this country, a man who lives inside the circle would have a weight 1 contributed to the entitlement for C itself, whereas a man who lives at distance 65 away in country *B* would have a weight of $(11.02)^2/(65)^2$ added to his country's entitlement to C. By adding up all the weights for each country, the percent ownership of country *C* is broken down as:

A : 1.15%, B: 2.97%, C: 95.9%

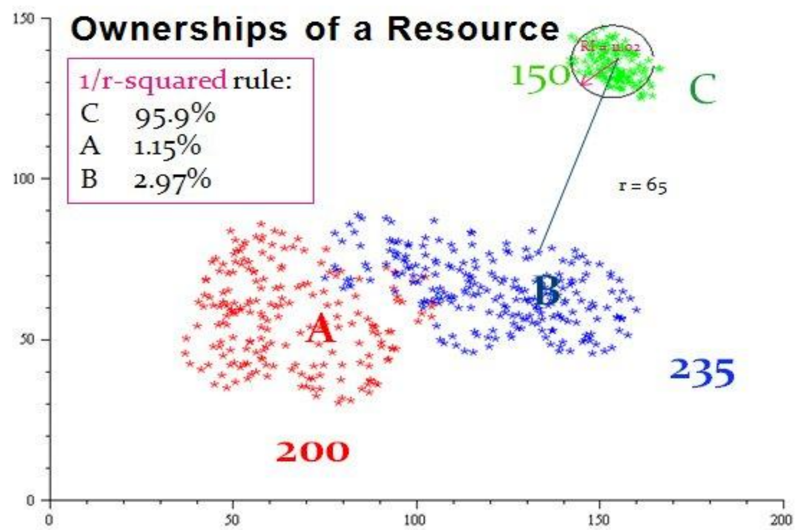

Figure 5: Ownerships of a resource (country C) computed using $\frac{1}{r^2}$ rule.

With the exception of the first-claimer rule, a country is not the sole owner of its land and resources. There will always be some portions that are owned by other countries or groups due to the tail of the $\frac{1}{r^p}$ function. Table 1 shows the ownerships computed for country C, with different exponent (p) values. The same calculations are also performed for countries A and B and the results are presented in Table 2 and Table 3.

Percent Ownerships of Country C in Figure 5						
Country \ W(r) exponent	**p=0**	**p=½**	**p=1**	**p=2**	**p=3**	**p=∞**
A (population: 200)	34.15%	20.50%	9.34 %	**1.14 %**	0.12 %	0
B (population: 235)	40.13%	29.34 %	16.29 %	**2.96 %**	0.44 %	0
C (population: 150)	25.72%	50.16%	74.37 %	**95.9 %**	99.44 %	100%

Table 1: Percent Ownerships of Country "C" in Figure 5

Percent Ownerships of Country A in Figure 5						
Country \ W(r) exponent	**p=0**	**p=½**	**p=1**	**p=2**	**p=3**	**p=∞**
A (population: 200)	34.15%	43.50 %	51.88 %	64.25 %	71.53 %	*83.86%
B (population: 235)	40.13%	39.58 %	37.65 %	32.26 %	27.42 %	16.14%
C (population: 150)	25.72%	16.92 %	10.47 %	3.49 %	1.05 %	0

Table 2: Percent Ownerships of Country A in Figure 5

- Because of an overlap between countries A and B, their self ownerships will not reach 100% even at p=∞.

Percent Ownerships of Country "B" in Figure 5						
Country \ W(r) exponent	**p=0**	**p=½**	**p=1**	**p=2**	**p=3**	**p=∞**
A (population: 200)	34.15%	31.66 %	**28.79 %**	**23.15 %**	18.69 %	9.80%
B (population: 235)	40.13%	48.73 %	**56.81 %**	**69.87%**	78.24%	90.20%
C (population: 150)	25.72%	19.61 %	**14.39 %**	**6.98%**	3.06%	0

Table 3: Percent Ownerships of Country "B" in Figure 5

As seen in table 1, the self ownership of an isolated area like C can change from 25.64% to 100%, with the exponent p varying between 0 and ∞. If there exists a point between these two extremes, where all countries would agree, then this area's ownership can be temporarily resolved. The mutual recognition of two countries may be interpreted as an agreement to exchange ownership rights on each others' territories and resources or to have the rights indefinitely reserved. Though not explicitly expressed, the sense of such rights is put into effect when humans engage in activities such as migration, immigration, declaration of independence, interfering with each others' internal affairs, or invasion.

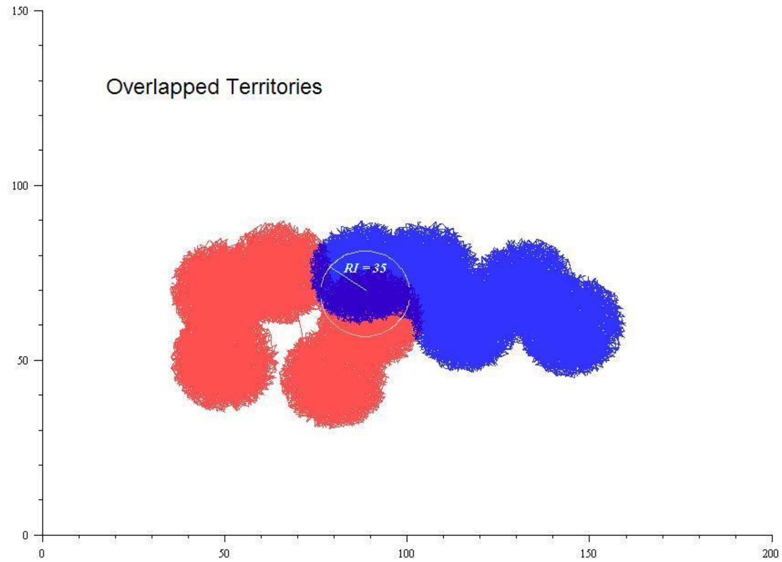

Figure 6: Overlapped territories of countries A and B

2.2 The overlapped area

Figure 6 depicts the self-claimed territories of countries A and B and an overlapped area which nurtures both red (A) and blue (B) humans. It has a R_I of 35. The result of the ownership computation is summarized in Table 4. The percent ownerships for the region where A and B overlap are A:41.81%, B:56.06%, and C:2.13% with $\frac{1}{r^2}$ rule and A:41.48%, B:49.50%, and C:9.01% with $\frac{1}{r}$ rule. If only A and B were interested parties, the similar calculation shows the shares between A and B to be 42.7% and 57.3%. Assuming the two sides can agree on the $\frac{1}{r^2}$ rule (justifications given in the next section), the ownership ratio could serve as basis for various negotiations pertaining to the conflict over this area. They could, as one can imagine, plan their fishing schedules, set up water irrigation quotas or oil drilling portfolios, or in the worst case, build a wall to divide this area.

Percent Ownerships of Overlapped Area between Country "A" and "B" in Figure 6						
Country \ W(r) exponent	**p=0**	**p=½**	**p=1**	**p=2**	**p=3**	**p=∞**
A (population: 200)	34.15%	38.80 %	**41.48 %**	**41.81 %**	39.42 %	32.96%
B (population: 235)	40.13%	45.15 %	**49.50 %**	**56.06%**	60.18%	67.04%
C (population: 150)	25.72%	16.05 %	**9.01 %**	**2.13%**	0.40%	0

Table 4: Percent Ownerships of Overlapped Area between Country "A" and "B" in Figure

Justifications

How could all the interested parties agree on a common rule? The answer is only if all of them think it is *fair* or fair enough. The fairness here is the degree to which this rule reflects the equality of all the human beings. At different stages in mankind evolution on earth this equality may be honored in different ways:

3.1 The Radius of Interests (R_I)

If everyone agrees to a *disputed resource area* shape as in Figure 3, the area's geometric center is obviously the point from which we should measure *how far* a person lives from the resource. In general, the farther away from a resource one is, the less one might need it. However for those who live inside the area, the comparison of closeness to the center is unnecessary because the native population is an inhabitant of the resource; and therefore should have equal rights to it. In order to be fair to people in all directions the rule must also be isotropic, which leads to the choice of the circularly symmetric function $W(r)$. The *inside* area should, therefore, be redefined as the area within the circle of R_I, beyond which distance-decay may start.

3.2 Inverse distance squared rule ($\frac{1}{r^2}$)

Humans started living on earth like other animals who consume resources from around where they live and reproduce. The $\frac{1}{r^2}$ rule is a good rule, if the following two assumptions can be accepted:

- The consumable resources are uniformly distributed, i.e., probability for finding consumable resources is proportional to the area on earth.
- The ideal or best solution for the survival of an entire species is when each individual consumes an equal amount of resources.

Imagine two rabbits living in two burrows that are r_A and r_B away from a newly found area of grass. Since the rabbits are both interested in this area of grass, we can reasonably conclude that they are searching and consuming food within circles of radii of at least r_A and r_B. Because they each need to eat the same amount of grass, *K*, the rates (C_A and C_B) at which they eat grass must be *inversely* proportional to the areas of the circles, i.e.,

$$K = C_A \times \pi {r_A}^2 = C_B \times \pi {r_B}^2$$

$$\Rightarrow \quad \frac{C_A}{C_B} = \frac{{r_B}^2}{{r_A}^2}$$

For this new area the same rates must be kept. Otherwise, the rabbits will not consume equal amounts overall. Therefore to sustain the rates until the grass is all gone; the shares S_A and S_B must be proportional to the rates C_A and C_B, i.e.,

$$\frac{S_A}{S_B} = \frac{C_A}{C_B} \quad \text{or} \quad S_A \propto \frac{1}{{r_A}^2} \quad \text{and} \quad S_B \propto \frac{1}{{r_B}^2}.$$

3.3 The inverse distance rule ($\frac{1}{r}$)

A human society may reject the above two assumptions depending on its level of advancement or type of resources under consideration, but it may still accept the distance-decay nature of resource dependence. Being one of the simplest decaying mathematical functions, the $\frac{1}{r}$ relation may be the choice for a *general* rule. Though this is intuitive, its rigorous justification seems to be impossible.

3.4 Resource Specific Rules ($\frac{1}{r^p}$ or other distance-decaying functions)

With different type of resources or resource related issues, the exponent (*p*) value can be set differently. Or some other forms of functions can be proposed. Attempts must be made, however, to scientifically justify these choices, before letting them fall into the set of negotiation parameters.

3.5 Globalization ($p \to 0$ or $R_I \to \infty$)

In today's world, people's interests for many types of resources are becoming less and less location dependent. For resources that related to energy or water this can be depicted by p approaching zero. When dealing with issues such as pollution and global warming, letting $R_I \to \infty$ would mean everyone owns an equal share of a single resource – the earth.

Applications

4.1 Definability of the disputed area and the negotiation parameters

The main application would be resolving issues of a disputed area or territory. For example, if two countries A and B each draw out their own acceptable borders, the overlapped area (Figure 7) is the disputed area. Note that pushing one's border unlimitedly outward will not result in more ownership from the computations, because it only makes the area closer to the other side and likely to enclose more people of the other country. Therefore the *disputed area* can always be well-defined – both agree to the disagreement.

The two sides first attempt justify scientifically a proper value for p and a $W(r)$ and then, if consensus cannot be reached, they negotiate on a p value and a $W(r)$. Computations can then proceed. The computed ownerships are the essential facts to be presented at negotiation tables.

Once the percent ownerships are obtained, options to share this area can be discussed. In case the countries decide to geographically divide the area, figure 7 illustrates a mathematical method: dividing it with a straight line that is perpendicular to the line connecting the centers and dividing it into the portions as the computed ownerships.

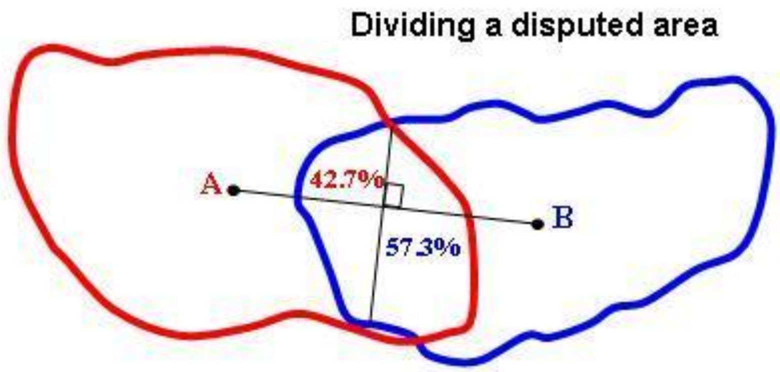

Figure 7: dividing a disputed area by the computed percentages

4.2 Global issue resolution

Within this formalism every country is entitled to a fraction of every other country. But the author does not suggest that the world balances these rights by dividing existing countries. This formalism can be used as a basis for resolving crisis when conflicts occur and escalate. In addition to resolving the issue of resource distribution between two areas, the system can also pose solutions for a dispute within one area. Issues within an area can be resolved by a voting scheme where the voters' rights depend on their distance from the center. One can call this the *distance-weighted-vote*. Interestingly the "R_I" can also be the *radius of influence*. When an issue warrants an R_I of infinity, there can be a *world wide vote* – the ultimate democracy.

4.3 An Example – Liancourt Rocks

As an example of possible applications, the author estimated the ownership proportions for the "Liancourt Rocks", which is a tiny island between South Korea and Japan [2] (Figure 8). It is not populated by any race or country so every individual has certain right to it depending on his or her distance from the resource. Assuming only Japan and South Korea are interested in the sharing, ownership proportions for the $\frac{1}{r^2}$ rule are estimated as:

Japan:	49%
South Korea:	51%

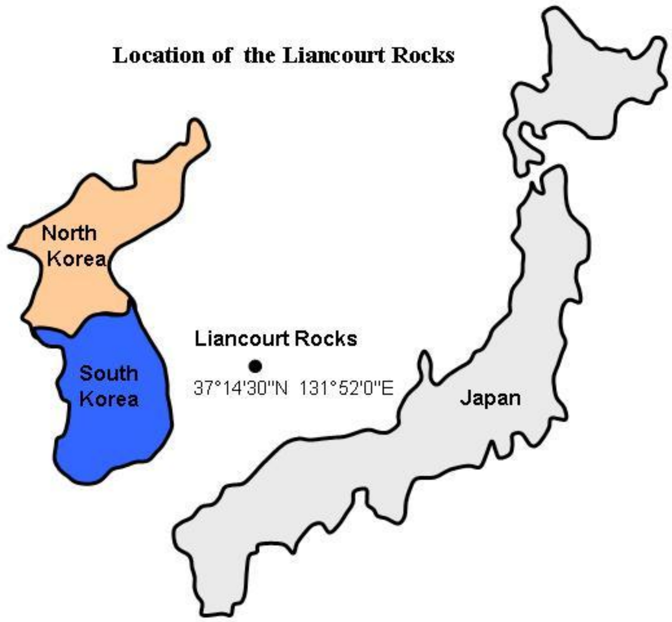

Figure 8: Location of Liancourt Rocks[5]

If the three main surrounding countries are considered, however, the proportions become:

Japan: 44%
South Korea: 46%
North Korea: 10%

Table 5 shows the data used in these estimations. The distances were approximately calculated from Liancourts Rocks to geometric center of the countries. The weights (W) are obtained by multiplying the center distances with the respective populations, instead of by summing up the individual weights[1]. For serious discussions or negotiations, the ownership weights must be replaced by the exact calculations as described in Section 2, and must be based on the up-to-date population distribution data.

Country	Distance(miles)	Population	W	Ownership(%) $1/R^2$
Japan	350	127,580,000	550891.143	44
South Korea	226	48,224,000	322204.602	46
North Korea	339	23,790,000	105967.257	10

Table 5: Ownerships of Liancourt Rocks for Japan, North Korea and South Korea. The population data is based on the References [3] and [4].

If more countries are included in the sharing of Liancourt Rocks, the ownership divides as in Table 6. Although in principle every country is entitled to a non-zero fraction of this resource, most countries should not need to claim it, unless they must take positions in resolving issues about it.

[1] The results are accurate only when the dimensions of the countries are much smaller than the distance to the point of the resource.

Estimated Ownerships for Liancourt Rocks for 21 Selected Countries ($\frac{1}{r^2}$ rule)				
Country	**Distances(miles)**	**Population**	**Weight**	**Ownership (%)**
South Korea	226	48,333,000	2157.65	32.97
Japan	376	127,580,000	2057.6	31.44
North Korea	339	24,051,706	477.2	7.29
China	1546	1,331,690,000	1270.4	19.41
India	3327	1,166,050,000	240.2	3.67
United States	6228	306,853,000	18.04	0.28
Russian	2453	141,829,000	53.75	0.83
Philippines	1788	92,226,600	65.78	1.01
Malaysia	2258	27,468,000	12.29	0.19
Indonesia	3032	230,512,000	57.18	0.88
Laos	2106	6,320,000	3.25	0.05
Thailand	2351	63,389,730	26.15	0.4
Mongolia	1550	2,671,000	2.54	0.04
Pakistan	3571	166,851,500	29.84	0.46
Afghanistan	3691	28,150,000	4.72	0.08
Australia	4323	21,839,000	2.67	0.05
Canada	5070	33,706,000	2.99	0.05
Ukraine	3127	46,143,700	10.76	0.17
Tajikistan	3230	6,952,000	1.52	0.03
Vietnam	2090	88,069,000	45.98	0.71
Cambodia	2332	13,388,910	5.62	0.09

Table 6: Estimated ownerships of the Liancourt Rocks for 21 selected countries. The distances to the resource are estimated using the Google Earth facility [5].

Conclusions and Remarks

The paper puts forward formalism for quantitatively evaluating entitlements to natural resources. Its application to real world problems is a moderately challenging task with the help of modern technologies such as satellite survey, global positioning systems, and scientific computing. Though the earth is a sphere, the measurement of distances can be generalized to that of the shortest paths along its surface.

There is no doubt that there will be objections to this formalism. Resource-related issues are typically historically, culturally, or even emotionally charged. These are exactly what this article targets. Because these factors are multidimensional and contain a certain degree of bias, they only aid in complicating the problem and/or intensifying the conflict. If the statement "all human beings are equal" can be accepted by all countries concerned with an issue, then there is a mathematical solution to the issue. If the statement can not be accepted, and one country believes they to be somehow superior to another, and thus required more resources; then there is still a mathematical solution to the issue. Assuming that said superior country claimed that their one Dalmatian was equal to two Chihuahuas, this would at least make their assertions mathematically clear and the computations for a solution can still occur.

Gentlemen, isn’t it time to shelve swords and expand equations?

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