The task of fair division

Division of disputed territories

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***Abstract*—** **In this article we will consider how to divide water territory fairly using simple mathematical models and reports of 9th Moscow international conference on operations research.**

***Keywords—***: territory division; water territory; country interests;

division algorithm

Introduction

The problem of division of disputed territories is very important nowadays. Since ancient times different countries had fought against each other and had argued a lot to decide who would own the desired territory. But today there is no need to fight, so people decided to make some rules that would define who will own the territories. It doesn’t seem hard to divide land, but it is hard to divide water. International law of the sea is one of the oldest parts of international law. But its codification was first carried out only in 1958 in at the UN conference on the law of the sea, which approved four conventions: the territorial sea and the adjacent zone; the high seas; the continental shelf; fisheries and the protection of living resources of the sea. But new days make us to share new territories. Our task is to build a model that will offer several options for the distribution of territories, based on the preferences of countries.

Main part

According to international agreements, water is divided between countries by certain rules:

1. Water territory belongs to the country, if the distance between them is less than 12 miles.
2. There are exclusive economic zones, which are distributed between states according to UN Convention on the law of the sea. This territory can be used by other counties only for cargo transportation.

Due to the fact that global warming has made snow and glacier areas more accessible for resource exploitation, the interest in these areas increased. Some countries can't easily solve the issue of maritime border, because water territory is as close to one country as to another. For example, such a problem had Russia and Norway in 2010. In this case countries must decide how to divide territory themselves. One of the solutions is given in the article "Analysis of territorial interests of the Barents Sea countries" by Alekserov F.T., Demin S.S., Shvydun S. V. [1]. The last 20 years share of oil and gas in the global fuel and energy balance of consumption is more than 70% of all energy sources. That's why we will start from the fact that the most useful resources are gas, oil and fish.

First, we should divide our region into small territories of equal size. The smaller the area of one region, the more accurate our measurements will be. After that we enter some functions:

If the region has neither gas nor oil:

If the region potentially has either gas or oil:

If the region potentially has gas and oil:

If the region has either gas or oil:

If the region has gas and oil:

If is a total number of quarters when there is a fish in region :

Let's assume that resource usefulness of a region for a country is proportional to the distance to the area.

If :

Else:

- the distance after which the country doesn't care about

the region. For example, we take km

- distance from the nearest point of the country to

the region.

So, overall usefulness of each area is:

where characterizes howimportant is a resource.

We assume, that all countries consider the same resources equally important.

To divide to territory fairly, let's enter a function of

satisfaction of the country:

The situation in the world is always changing and some

resources become more important that others. That's why we must think about the choice of the algorithm to maximize the stability of the equilibrium, when we change coefficient .

Now we can go to all three algorithms of distribution of

territories:

1. All regions remain in the possession of their countries.
2. Each region goes to the nearest country
3. Model of the adjusting winner:

At the beginning each country has its own territory. Let's be the least satisfied country and be the most satisfied country. If functions of satisfaction of both countries are equal, then we have fair division. Otherwise, countries change their regions so that the following points are fulfilled:

This algorithm gives us a fair sharing of territories, but it may happen that our functions can't be equal. That’s why we should consider two beginning distribution of the regions:

1. All regions belong to first country
2. All regions belong to second country

The authors of [1] conducted research, during which they received the following statistics:

1. :

|  |  |  |  |
| --- | --- | --- | --- |
| Algorithm number | Norway | Russia | Norway + Russia |
| 1 | 100625 | 46833 | 147458 |
| 2 | 126655 | 23833 | 150488 |
| 3a | 74461 | 74446 | 148907 |
| 3b | 74451 | 74455 | 148906 |

|  |  |  |  |
| --- | --- | --- | --- |
| Algorithm number | Norway | Russia | Norway + Russia |
| 1 | 105691 | 709309 | 815001 |
| 2 | 314519 | 520839 | 835358 |
| 3a | 416719 | 416713 | 833433 |
| 3b | 416703 | 416730 | 833433 |

As we can see, only in third algorithm .

But we must choose the coefficient correctly, because the results are highly dependent on it. The higher is , the greater is Russian function of satisfaction.

Conclusion

We have considered the main solutions to the problem of fair division of territories. In my opinion, the best algorithm is a model of the adjusting winner, which really gives both sides equal satisfaction. Due to such optimizations, people can prevent a lot of world conflicts.

References

[1] Aleskerov F. T., Demin S. S., Shvydun S. V. "Analysis of territorial interests of countries in the Barents Sea." Proceedings of the IX Moscow international conference on operations research (ORM2018) Vol. 2. ОС «Max Press», 2018. p. 443-447

[2] United Nations Convention on the Law of the Sea. 1982.

[3] Brams S.J., Taylor A.D. Fair Division: From Cake-Cutting to Dispute Resolution. Cambridge University Press. 1996.