CASE STUDY

Visualizing interactions through the 5D World Map: Synergies and Tradeoffs of increasing agricultural productivity (SDG 2.3) with biodiversity, water and climate in tropical countries

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Introduction

This case study present the demonstration of how the 5D World map can be used as a visual tool for addressing interlinkages. Taking advantage of the various areas of research of the students, the interlinkages among these areas were studied by using the 5D world Map. Starting from the aim of doubling agricultural productivity (SDG 2.3), the interlinkages with the inter-linkages with biodiversity and forest cover (SDG 15.1), climate change (SDG 13), Water quality and efficiency (SDG 6.3 and 6.4) are investigated. As a demonstration, tropical countries with large forested areas, Brazil, Indonesia and Malaysia were selected. The investigation of interlinkages were carried out in two stages. Firstly, visualizing the spatiotemporal trends of headline indicators in the mentioned areas using the a in 5D world map demonstrates a possible correlation in terms of general trends were in general, each indicator is at an upward trend. To investigate the causality of these trends, the second stage zoomed in into each issue and location specific data which can be investigated through a search function of the 5D world map. This demonstrated that oil palm may be a critical node in addressing interactions as it interacts with climate change through deforestation and forest fires, reduces water quality near plantations and compete with agriculture for land. As a conclusion, while the 5D World Map may not conclusively infer, it is a useful tool to identify potential inter-linkages. It is recommended that the nexus between Agriculture-Biodiversity-Climate-Water should be researched more in depth and specifically, and that addressing Sustainable Palm Oil could potentially be a critical node that addresses multiple SDGs. Furthermore, either through the 5D database or other means, there is a need to have such databases for researchers as a collaborative platform.

Demonstration on 5D World Map System

A. Deforestation (SDG 15.1)

i. Malaysia case

The Forestry Department Malaysia publishes forested area statistics based on initial topography maps of the Land Survey Department with subsequent deductions and additions whenever a forest area is approved for conversion to non-forest use or development or degazettement of a Permanent Reserved Forest (PRF), or a gazettement for a new Permanent Reserved Forest(PRF) (Hamid 2016).

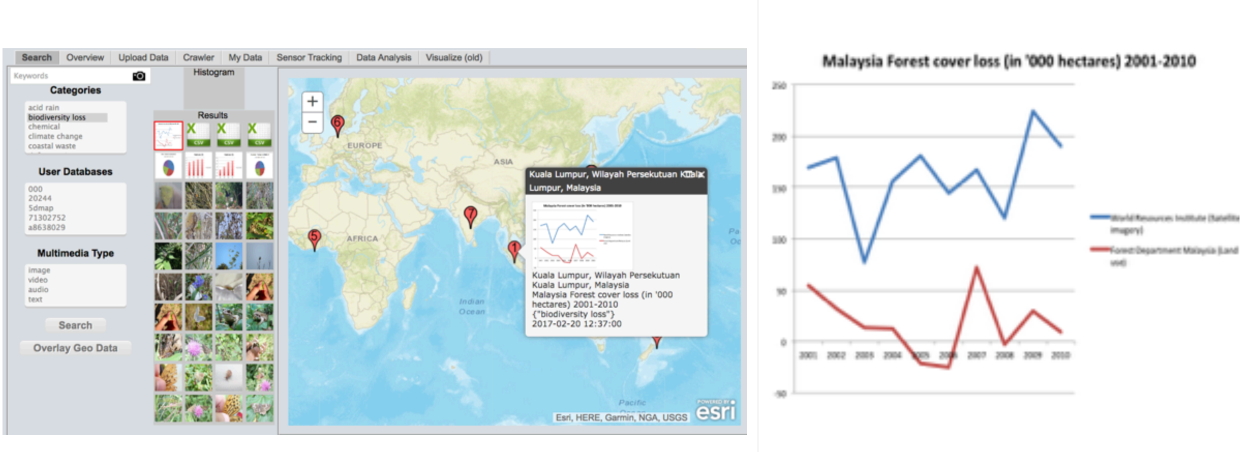

Fig1. Deforestation in Malaysia from 2001-2010

ii. Indonesia case

Today palm oil production is the largest cause of deforestation in Indonesia and other equatorial countries with dwindling expanses of tropical rainforest. Indonesia's endangered orangutan population, which depends upon the rainforest, has dwindled by as much as 50 percent in recent years [1].

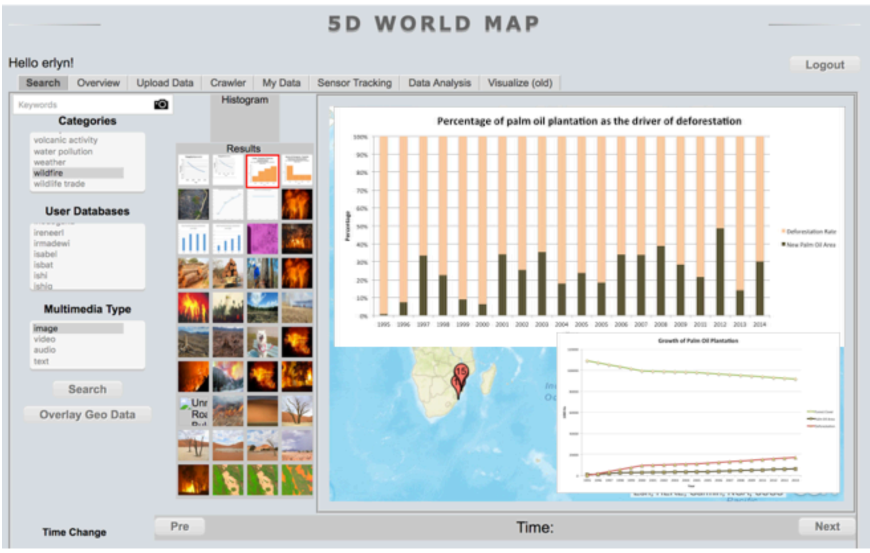

Fig 2. Deforestation in Indonesia from 2001-2010 (Data Source : FAO, Badan Pusat Statistik)

B. Agriculture - Land Use (SDG 15.1)

i. Malaysia case

The agricultural diversification program of the government led to the introduction of oil palm into Malaysian fields (Jaafar, 1994). Oil palm became an important crop because of its high demand at the local and international markets, shorter maturity period and lower labor requirement (Snodgrass, 1980). In Malaysia, oil palm cultivation increased from 641,791 ha in 1975 to 3.9 million ha by the year 2004 under suitable agro –

economic policies and application of science and technology. The structural change in the socio – political economy of the country because of the industrialization in the late 1980's has brought about significant shortages of agricultural manpower in oil palm plantation. [2]

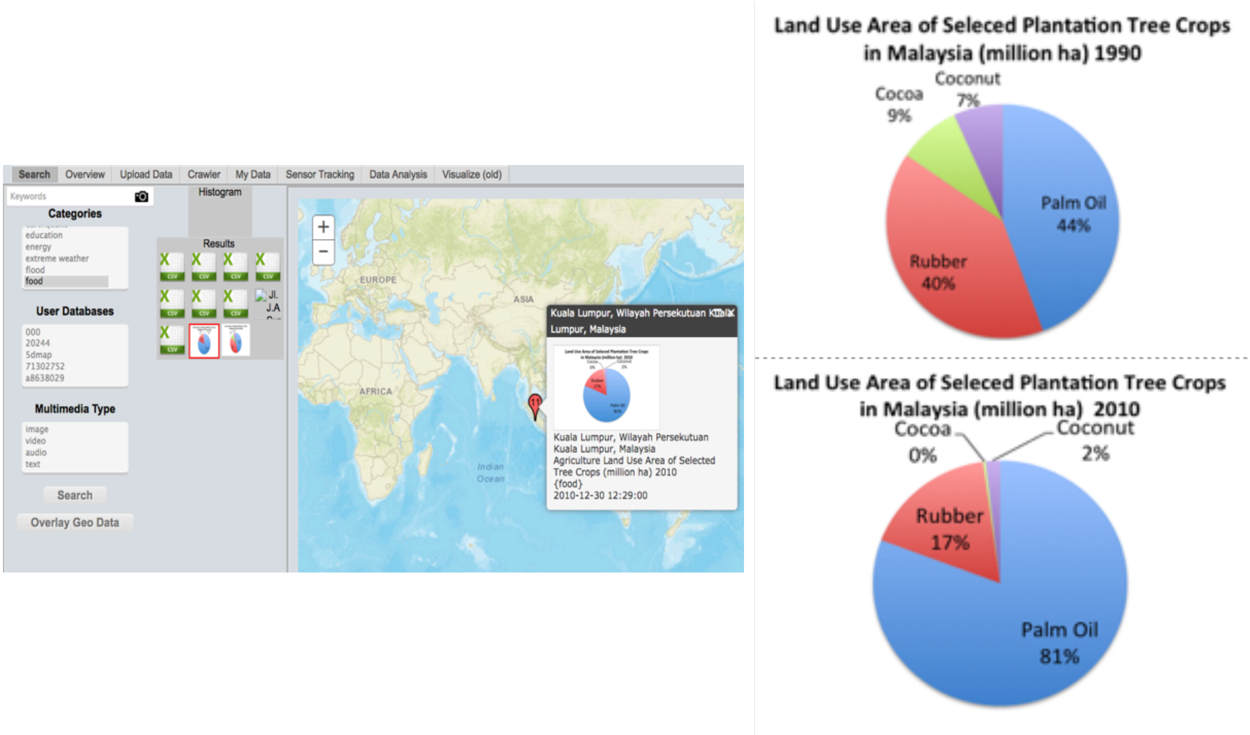

Fig 3. Land use change in Malaysia from 1990-2010

ii. Indonesia case

The large increase of palm oil production over the past 30 years explains in part why land use changes has become a concern for the sustainability of palm oil production. The global land area of mature oil palm increased from 3.5 Mha in 1975 to 13.1 Mha in 2005. Most of this increase is found in Indonesia (increasing from 0.1 to 3.9 Mha) (FAOSTAT, 2008a). Including the area of immature oil palm 1.6 Mha in Indonesia (IPOC, 2005) in 2005), a total land expansion for palm oil production of nearly 9 Mha took place in Malaysia and Indonesia between 1975 and 2005 [3].

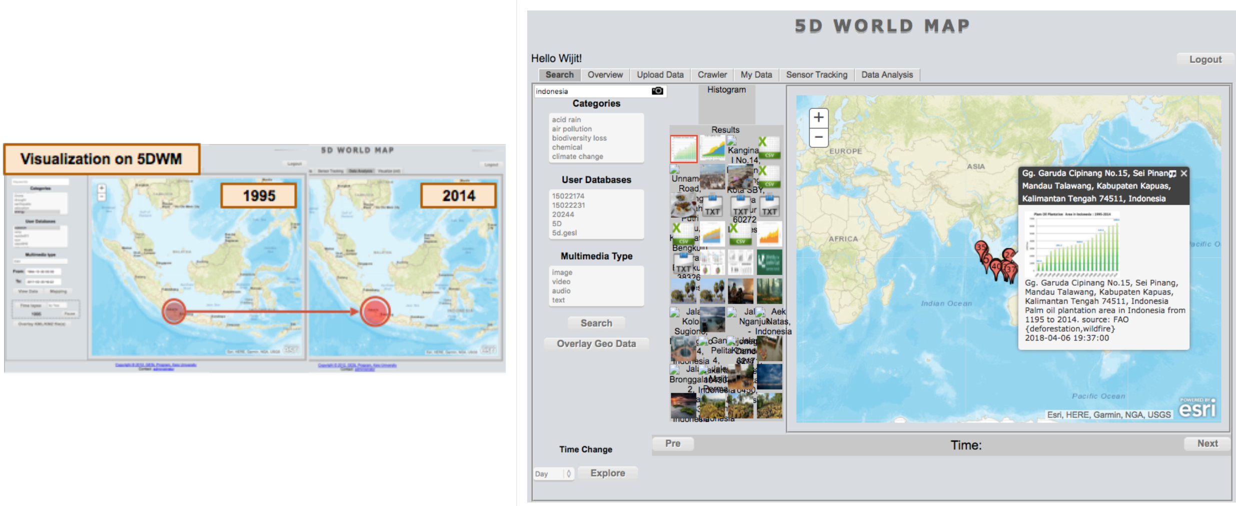

Fig 4. Land use change in Indonesia from 1995-2014
(Data Source : Statistik Perbankan Indonesia, Food and Agriculture Organization of the United Nation)

C. Water Quality near Palm Oil Plantations (SDG 6.4)

i. Malaysia case

For every metric tonne of palm oil produced, 2.5 metric tonnes of effluent are generated from processing the palm oil in mills. Direct release of this effluent can cause freshwater pollution, which can affect downstream biodiversity and people.The average biochemical oxygen demand (BOD) of palm oil processing effluent is 25,000 parts per million. In Malaysia, the BOD level must be below 100 parts per million before effluent can be legally discharged into streams. (Clay, 2004)

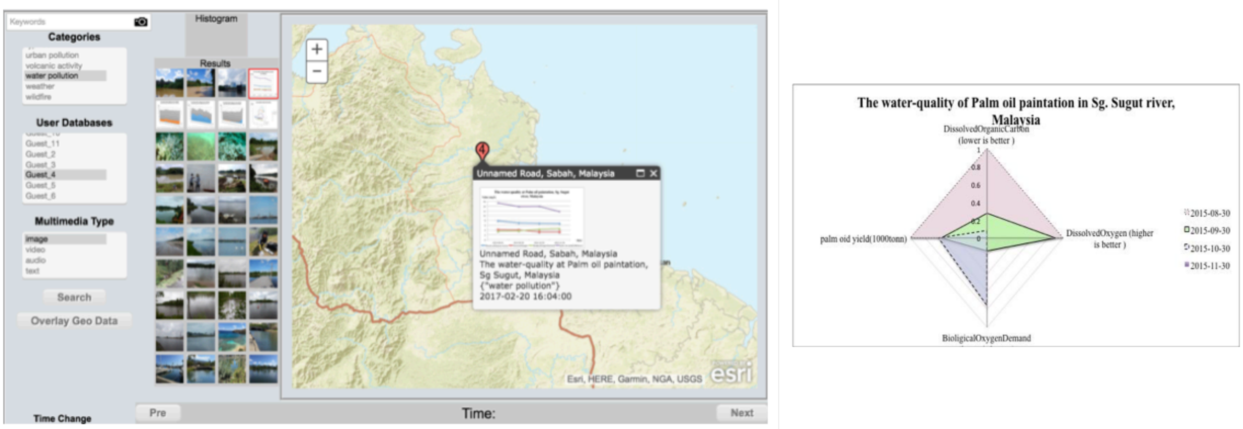

Fig 5. Water Quality near Palm Oil Plantations in Malaysia from 1990-2015 [5,6]

ii. Indonesia case

Indonesia produces almost half of the world's palm oil. Home to the world's third-largest tropical forest, the country is also one of the principal emitters of greenhouse gases, due to the rapid conversion of carbon-rich forests and peatlands to other uses. Significantly eroded water quality now joins the list of risks associated with oil palm cultivation, according to new research co-authored by researchers from Stanford

University and the University of Minnesota said Palm plantations damage freshwater streams that supply drinking water to millions of people in Indonesia. Land clearing, plantation management (including fertilizer and pesticide application) and processing of oil palm fruits to make crude palm oil can all send sediment, nutrients and other harmful substances into streams that run through plantations. Vegetation removal along stream banks destroys plant life that stream organisms depend on for sustenance and shade. [4]

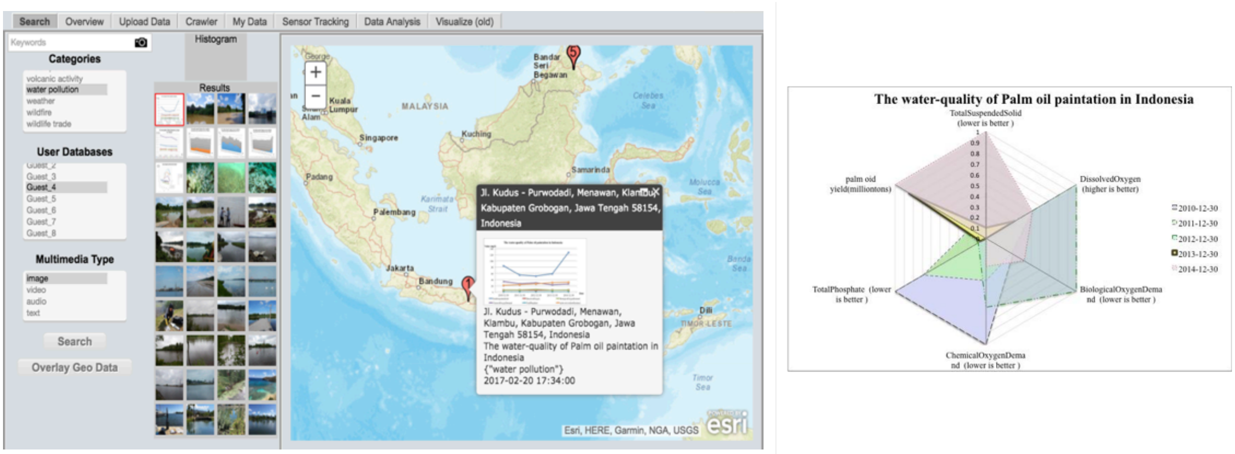

Fig 6. Water Quality near Palm Oil Plantations in Malaysia from 1990-2015 [7,8]

D. Time-series analysis

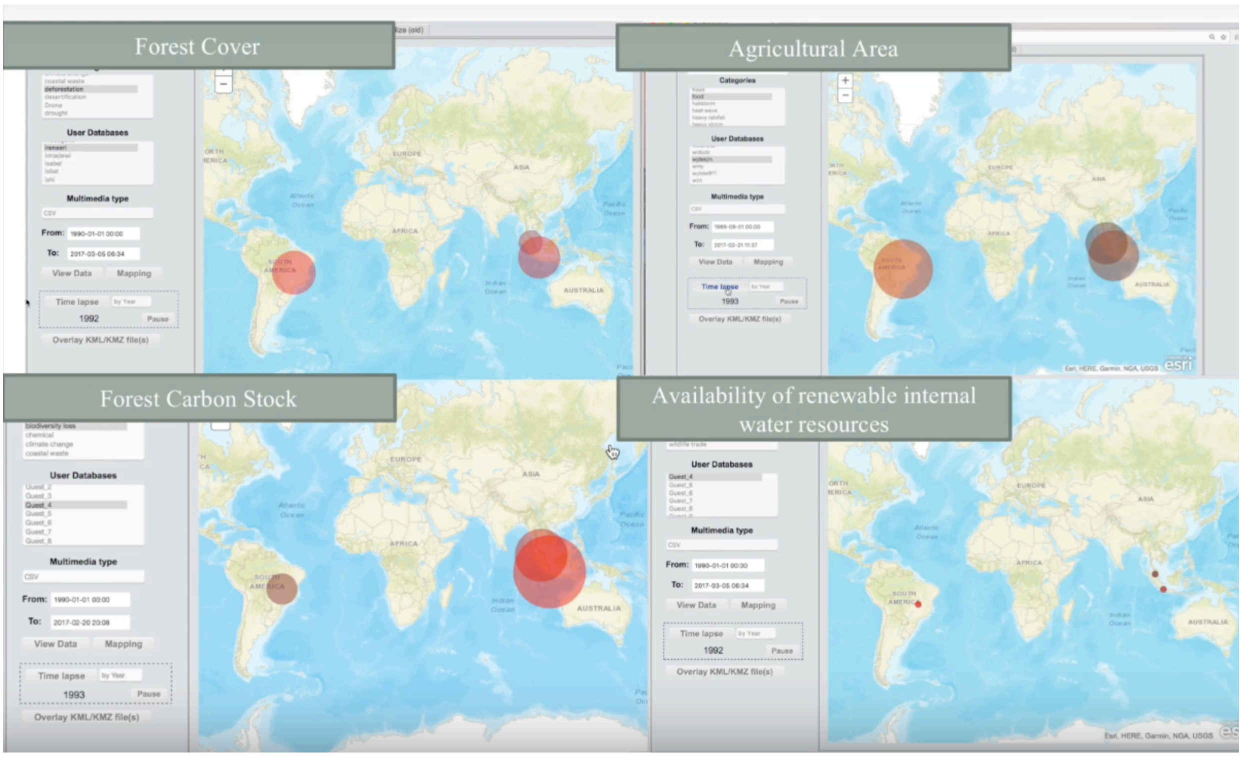

Fig 7. Time series analysis of increasing agricultural productivity (SDG 2.3) with biodiversity, water and climate in tropical countries (Brazil, Indonesia, and Malaysia) between 1992-1993

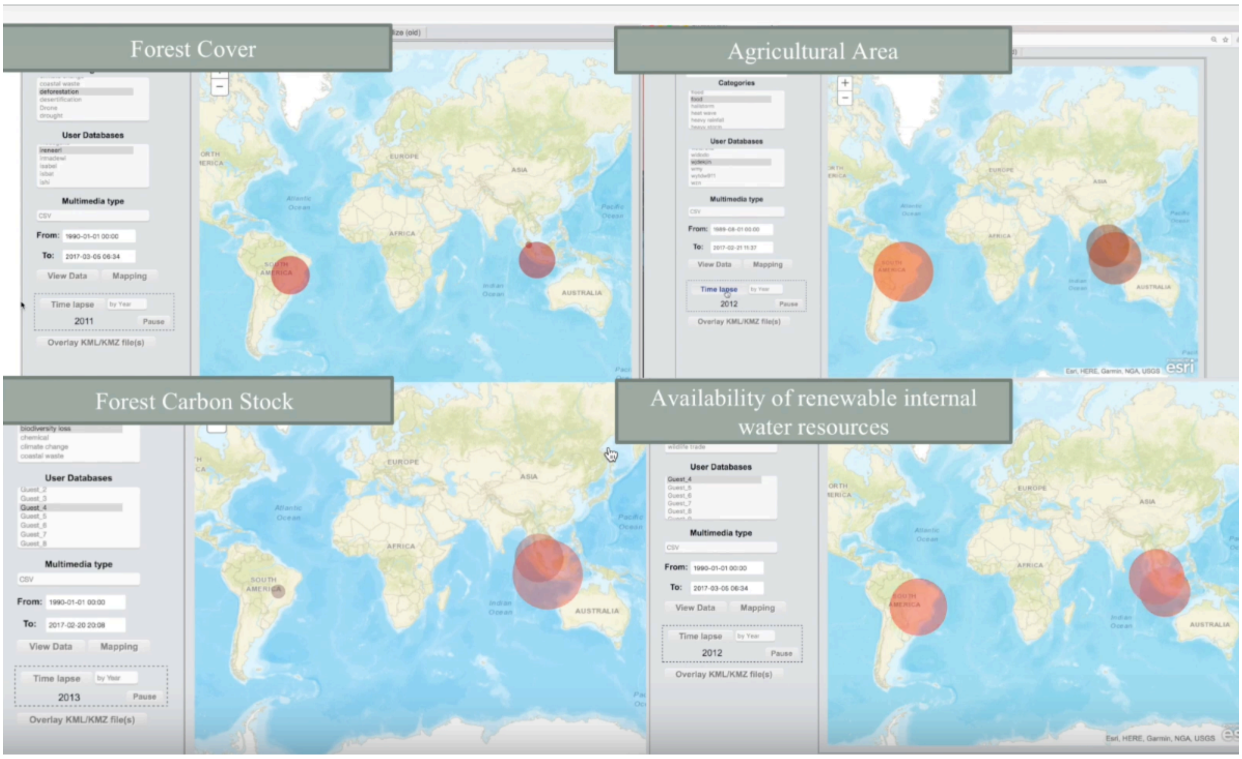

Fig 8. Time series analysis of increasing agricultural productivity (SDG 2.3) with biodiversity, water and climate in tropical countries (Brazil, Indonesia, and Malaysia) between 2011-2013

Conclusion

The case study highlighted that in the context of achieving SDG 2.3 (doubling agriculture productivity) in Malaysia and Indonesia, Palm Oil may be a critical node with high levels of interaction with other targets, including deforestation (15.1), climate change (SDG 13), Water quality and efficiency (SDG 6.3 and 6.4). It is proposed that further research is undertaken on Sustainable Land Use for Palm Oil in the context of addressing multiple SDGs targets and the nexus between Agriculture-Biodiversity-Water-Climate (Goals 2,15,6,13)

- **Identification of inter-linkages**

Wider trends of different goals and targets can be identified using the 5D World Map via the time-lapse function which provides a spatiotemporal visualization.

- **Inferring causality**

Visualizing trends does not, however, infer causality, as further research and data needs to be investigated.

- **Context matters**

Investigation of possible causalities and inter-linkages will require data at specific spatial and temporal scales on various issue-areas to enable more in-depth analysis.

・Database

Knowledge database such as the 5D World Map can help identify interactions as well as its causes if utilized more widely by researchers.

References

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