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Debunking Flat Earth: From Geomatics Perspective

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Abstract—With numerous backed research and evidence, the Earth is well-known and established to generally be sphere-shaped, however there are still claims to support that the Earth is flat. Attention should be drawn to these claims because it is spread out to media outlet accessible to the general public which provide the misapprehension of Earth shape. The beliefs of the flat Earth originated from the Western civilization era and made its way to the modern era. By thorough research and rebuttals of pre-millennial literature from the Western civilization era, Islamic literature and geomatics fundamentals; it is found that the Earth is impossible to be flat-shaped.

Keywords; flat earth, Islamic, Western civilization, geomatics, debunking

I. INTRODUCTION

For centuries, with numerous classical and modern research on the Earth shape and its effects to the surrounding, it is generally known that the Earth is spherical in shape. However, there has been ongoing debacle concerning the shape of the Earth spreading in the Malaysian media and community. This issue is highlighted when a public figure makes a statement on social media that the Earth is not spherical in shape but flat [1]. It gained further momentum when this claim is further challenged by Malaysian astronaut claiming that the Earth is not only spherical in shape but to be exact, geospherical with pointed at Poles and bulging at the Equator line. The claim of a flat-shaped Earth is further supported by a researcher from Texas Tech University which published a video on Google's video-sharing site, Youtube, claiming the Earth is a large flat disc [2]. To make things worse, the video gained huge views and shared widely on social media.

Despite numerous evidence and proofs shown to debunk its claim, the flat Earth ideology is still gaining popularity due to lack of exposure and public education on the scientific reasons of why the Earth is spherical shape. Therefore, this paper aims to debunk this claim of a flat-shaped Earth from the view of pre-millennial literature, and Geomatics perspective.

II. PRE-MILLENNIAL LITERATURE

A. Flat Earth Beliefs

The Earth is a disc-shaped which supports the sky shaped like a hemisphere, according to Homer [3]. His view is further supported by other Greek philosophers and literarist such as Stasinus of Cyprus, Mimnermus of Colophon, Aeschylus and Apollonius Rhodius. Apart from Greek, pre-Socratic philosophers also believed the world is flat which is as described by Thales, Leucippes and Democritus. A Muslim scholar described in his tafseer “Jalal al-Din”, which firstly quoted the Quran;

وَأَلَى الْأَرْضِ كَيْفَ سُطِحَتْ

which he interprets to “And at the Earth – how it is laid out flat?” in which he further interprets that

"وقوله «سطحت» ظاهر في أن الأرض سطح، وعليه علماء الشرع، لا كرة كما قاله أهل الهيئة وإن لم ينقض ركناً من أركان الشرع"

From his tafseer, he interpreted that “sutihat” means “laid out flat” which he says that the Earth is flat by the opinion of ulama. However, believing the Earth is a sphere does not nullify any pillar in the Divine Law pillars [4]. This opinion however, is done without consulting the opinion of astronomers and mathematicians. (The authors wish to highlight that the study of Quranic translation and tafseer requires deep understanding of Arabic grammar and must be supervised by a highly-disciplined tafseer scholar).

B. Round Earth Beliefs

It is not until the 6th century BC that the Greeks recorded of the idea of a spherical earth where Pythagoras (582 BC) is of the opinion which is also supported by Aristotle (382 – 322 BC) which affirms that Earth must be spherical in shape based on his observations that the Earth is round-shaped in the occurrence of Lunar eclipse [5][6]. He also observed the changes of ships at sea as they get bigger (or smaller) as they travel further (or closer). Ibn Taymiyyah (661 – 728 AD) supports the above opinion in his publication ar-Risalah al-'Arshiyyah;

“[That] celestial bodies are round (*istidaaratul-aflaak*) - as it is the statement of astronomers and mathematicians (*ahlul-hay'ah wal-hisab*) - it is [likewise] the statement of the scholars of the Muslims; as *Abul-Hasan ibn al-Manaadi*, *Abu Muhammad ibn Hazm*, *Abul-Faraj ibn al-Jawzi* and others have quoted: that the Muslim scholars are in agreement [that all celestial bodies are round]. Indeed Allah - taala - has said: And He (i.e., Allah) it is Who created the night and the day, the sun and the moon. They float, each in a *falak*. *Ibn Abbas* says: *A falak like that of a spinning wheel.*” [7].

Numerous efforts were conducted by astronomers such as Eratosthenes, Posidonius, al-Khawarizmi, Snellius and many more in determining the shape of the Earth. The methodology usually involves the observation of Sun, Moon and the stars movement. These efforts evolve into a new field called astronomy and geodesy which subsequently applied and integrated in land surveying – thus coined a new term called geomatics.

III. DEBUNKING FLAT EARTH

The following explanation will be based on the main manuscript that has been the core idea of the flat Earth ideology by William Carpenter (1830 – 1896 AD). The manuscript is based on the technique known as Gish Gallop or also called “proof by verbosity” [8]. This technique overwhelms an opponent with numerous arguments with no regards to the truth and structure of the arguments.

A. By Map Projection Proofs

According to Proof #8 and Proof #25 respectively:

“If the Earth were a globe, a small model globe would be the very best – because the truest – thing for the navigator to take to sea with him. But such thing as that is not known: with such a toy as a guide, the mariner would wreck his ship, of a certainty! This is a proof that Earth is not a globe.” [9]

“The surveyor's plans in relation to the laying of the first Atlantic Telegraph cable, show that in 1665 miles - from Valentia, Ireland, to St. John's, Newfoundland - the surface of the Atlantic Ocean is a LEVEL surface - not the astronomers' "level," either! The authoritative drawings, published at the time, are a standing evidence of the fact, and form a practical proof that Earth is not a globe.” [9]

Sea navigators or mariner, in this case, brings a map known as the nautical charts when sailing. Nautical charts show the depths and locations of the sea based on the mean sea level. Maps or charts are examples of projection of the bended surface of the Earth on a flat paper.

A map projection is also additionally a technique for exchanging highlights from a sphere to proper locations on a plane. To generate a projection, the Earth will be represented as a geometrical model known as ellipsoid or simple sphere and further translated into globe before projecting it as flat 2D

surface. Nevertheless, there is no perfect solution to this problem. [10]

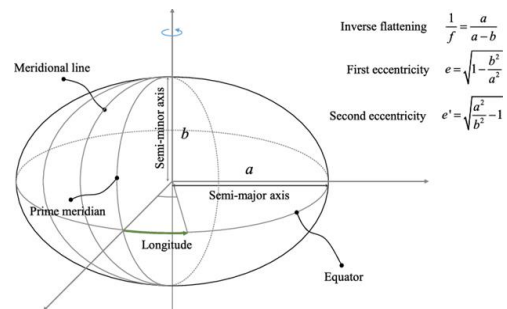


Fig. 1 Ellipsoidal model of the Earth [11].

Latitude and longitude coordinates determine the position on a sphere based on a grid called graticule [12]. Graticules are a network of lines on the sphere representing the meridians and parallels. The actual geographical coordinates are called coordinates that are not processed relative to the coordinates, such as the Universal Transverse Mercator (UTM) system and the State Plane Coordinate System (SPC), which marks the position in the flattened grid. The mathematical equations used to project latitude and longitude coordinates into a plane are called map projections. The inverse prediction formula changes the plane coordinates to geography. The simplest type of projection transforms graticule into rectangular grids where the grid lines are curved yet also straight, intersecting at the right angles in even manner. By different requirements, the projections can be transformed into complex grids where it results in different lengths, shapes or grid lines. The differing results have different types of ‘harassment’ to the geographical nature of the Earth surface. Since there are no projections that can conform to solve all problems, there are three basic map projection created to solve different types of problems, which are planar, conical and cylindrical projection as shown in Fig. 2.



Fig 2. Basic map projection [12].

The first type of projection is from a sphere projected into flat round plane which is called a planar projection. The second type is a cone sitting on packed sphere which is called a conical projection. The third type is alike cylinder wrapped around the sphere called the cylindrical projection. All three projections are shown in their normal aspect with the center point is centered at pole. All three projections have their strengths and weaknesses in the areas of showing accurate shape (conformal), direction (azimuthal), distance (equidistant) and area (equivalent) respective to the applications.

Hence, there are no perfect solution to express the Earth into a plane due to its complexity and the needs of different approach to preserve the desired characteristics of the Earth proves the fact that the Earth is not a flat and it is truly complicated. However, it can be projected from a curved to a plane surface for the people to understand the features of the Earth easily.

B. By Engineering Surveying Proof

According to Proof #3 and Proof #40 respectively,

“Surveyors’ operations in the construction of railroads, tunnels, or canals are conducted without the slightest “allowance” being made for “curvature,” although it is taught that this so-called allowance is absolutely necessary! This is a cutting proof that Earth is not a globe.” [9]

“The Suez Canal, which joins the Red Sea with the Mediterranean, is about one hundred miles long; it forms a straight and level surface of water from one end to the other; and no allowance for any supposed “curvature” was made in its construction. It is a clear proof that the Earth is not a globe.” [9]

The allowance of curvature as mentioned in the above proofs refer to the process of conducting an engineering surveying named levelling. In surveying, the basic components and output that must be undertaken is position (x, y) and height (z). Levelling is one of the methods of determining height by measuring the vertical axis on the surface of Earth using an instrument called ‘level’. This method measures the height difference between bench marks relative to the datum of reference, subsequently obtaining the heights of other points measured.

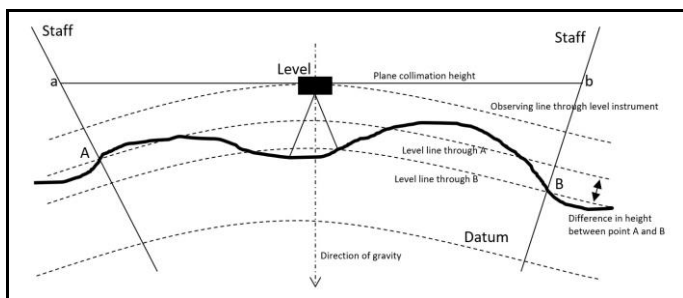


Fig. 3 Concept of levelling.

Conceptually, levelling is based on the horizontal observed line of a level with the level line of a point on Earth. The difference between 2 points is the heights of the point itself. If the height of points A and B can be measured, the height difference can be calculated using the formula:

$$\Delta h = a - b \tag{1}$$

Subsequently, if reduced level (RL) of point A is known, then the RL of point B can be calculated as:

$$RL B = RL A + \Delta h \tag{2}$$

However, in the case of the Proof #3 and Proof #40, it is not entirely true that the allowance of curvature is not considered in the process of levelling. This is because the effect of curvature is considered when the sightings is more than 120 m, together with the effects of refraction. The combined correction for curvature and refraction is given by

$$c + r = -0.0673 \cdot D^2 \text{ m} \tag{3}$$

where c is the value of curvature in meter; r is the value of refraction; and D is the sighting distance in KM [13].

The combined correction value of a sighting distance of 120 m is +/- 0.001 m. Hence, the effect of curvature is considered only if the sighting distance is beyond 120 m. In the case of Suez Canal in Proof #40, this is not true because although sea is level, it does not mean that its surface is flat. It is curved following the shape of the Earth [14].

C. By Geodesic Proof

By Proof #29 and Proof #31 respectively:

“If the Earth were a globe, it would, unquestionably, have the same general characteristics - no matter its size - as a small globe that may be stood upon the table. As the small globe has top, bottom, and sides, so must also the large one - no matter how large it be. But, as the Earth, which is “supposed” to be a large globe, has no sides or bottom as the small globe has, the conclusion is irresistible that it is a proof that the Earth is not a globe.” [9]

“If the Earth were a globe, it would certainly have to be as large as it is said to be - twenty-five thousand miles in circumference. Now, the thing which I have called a “proof” of the Earth’s roundness, and which is presented to children at school, is, that if we stand on the seashore we may see the ships, as they approach us, absolutely “coming up,” and that, as we are able to see the highest parts of these ships first, it is because the lower parts are “behind the earth’s curve.” Now since if this were the case - that is, if the lower parts of these ships were behind a “hill of water” - the size of the Earth, indicated by such a curve as this, would be so small that it would only be big enough to hold the people of a parish, if they could get all round it, instead of the nations of the world, it follows that the idea is preposterous; that the appearance is due to another and to some reasonable cause; and that, instead of being a proof of the globular form of the Earth, it is a proof that at Earth is not a globe.” [9]

The terrestrial surface of the Earth has a complex topography with the surface ranging from the mountains, lands and oceans. Due to this undulating surface, it is difficult to derive mathematical computations. Ergo, several models of the Earth were developed to serve the precision and accuracy

depending on the needs such as cadastre, geodesy or other uses.

The first model is a simplified estimation of the Earth's surface using the mean sea level (MSL) of the ocean which is called geoid as shown in Fig. 4.

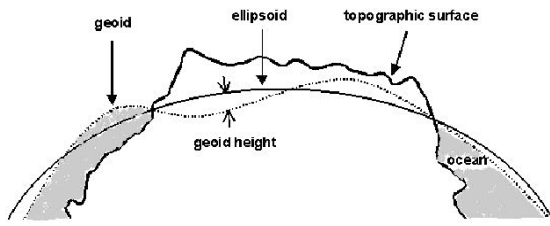


Fig. 4 Graphical representation of geoid [14].

This is because the surface of the sea is universally accepted as the standard of reference for heights on land and depths in sea [15]. The geoid has irregular surface because of the dispersed mass distribution of oceans and land on the surface of the Earth. As suggested by Carl Friedrich Gauss, the surface of geoid is equipotential which means the potential gravity at every point is equal [16].

For exact measurements over long-distance across continents, the second model is mathematically developed known as a spheroid (ellipsoid of revolution). This model means that the Earth is ‘squashed at the poles’, and ‘bulges at the Equator’ because of the force acting upon it as it revolves on its axis. This means that it has a larger equatorial axis as compared to the polar axis. There are four components used to calculate the radii of the ellipsoid as shown in Fig. 1 previously; whereby a is a radius component called the semi-major axis; b is a radius component known as the semi-minor axis, f is an indication of how close the ellipsoid approaches a spherical shape and e is for eccentricity (how much a conic section deviates from being circular). Hence, the 25 000 miles circumference in Proof #31 is not applicable here because mathematically the Earth does not have one exact radius which can be combined to be a circumference, instead it has two radii known as the semi-major axis and semi-minor axis. However, for a simplified approximation of ellipsoid for most applications, a common third model known as the sphere is adopted with the Earth radius from the center is approximated to be 6371 km.

IV. CONCLUSION

The Earth is spherical in shape based on the proofs provided from the rebuttal of Western civilisation-era and pre-Millennium astronomers. The concept of map projection coupled with levelling and geodesy provides further proofs that Earth is spherical. The map projection is also fundamental in

knowing the shape and area of a certain country which varies depending on the map projection. From geomatics perspective, the Earth is impossible to be flat-shaped.

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REFERENCES

- [1] L. A. A. Karim, “Dakwaan bumi rata untuk cari publisiti undang kecaman,” *Berita Harian*. Feb 17, 2019. [Online]. Available: <https://www.bharian.com.my/berita/nasional/2019/02/531985/dakwaan-bumi-rata-untuk-cari-publisiti-undang-kecaman> [Accessed Feb 28, 2019].
- [2] I. Sample, “Study blames YouTube for rise in number of Flat Earthers,” *The Guardian*, Feb 17, 2019. [Online]. Available: <https://www.theguardian.com/science/2019/feb/17/study-blames-youtube-for-rise-in-number-of-flat-earthers> [Accessed Feb 28, 2019].
- [3] R. Merrill, *The Iliad*. Ann Arbor, MI: University of Michigan Press, 2007.
- [4] Al-Suyuti, Jalal al-Din, and Jalal al-Din al-Mahalli, *Tafsir Al-Jalalayn*. Translated by Feras Hamza. Amman: Royal Aal al-Bayt Institute for Islamic Thought, 2007.
- [5] D. Gallop, *Parmenides of Elea: Fragments: A text and translation with an Introduction* (Vol. 18). University of Toronto Press, 1991.
- [6] I. I. H. Ahmad, “Bumi Datar VS Bumi Sfera: Kacamata Astronomi dan Falak,” in *Seminar Ilmu Falak Kebangsaan, PIMPIM UMP 2018*, 4-5 April 2018, Pahang, Malaysia [Online]. Available: UMP Institutional Repository, <http://umpir.ump.edu.my/id/eprint/21499/> [Accessed: June 15, 2019]
- [7] I. Taymiyya, *Majmu al-Fatawa*, Ed. Abd al-Rahman bin Muhammad al-Najdi (Maktabat Ibn Timia, 2nd ed).
- [8] L. Břízová, K. Gerbec, J. Šauer, and J. Šlégr, “Flat Earth theory: an exercise in critical thinking,” *Phys Educ*, Vol. 53(045014), 2018.
- [9] W. Carpenter., *One Hundred Proofs That Earth Is Not a Globe*. Baltimore, MD: William Carpenter, 1885.
- [10] K. Simmers, and D. Wagg, “Coordinates, Coordinate System and LIDAR Data (Part 2)” *GeoCue Group*, Dec 5, 2014. [Online]. Available: http://kb.geocue.com/wp-content/uploads/2014/12/RL_CoordinatePart2.pdf [Accessed June 10, 2019]
- [11] K. Jo, M. Lee, and M. Sunwoo, “Fast GPS-DR Sensor Fusion Framework: Removing the Geodetic Coordinate Conversion Process,” *IEEE Trans. Intell. Transp. Syst.*, Vol. 17(7), pp 2008-13, Sep. 2015.
- [12] S. Joshua, M. S. Jennifer, and A. B. Raechel, *Mapping Our Changing World*, University Park, PA: Department of Geography, The Pennsylvania State University, 2012.
- [13] N. N. Basak, *Surveying & Levelling*. McGraw-Hill Education, 1994.
- [14] Li X, and H. J. Götze, “Ellipsoid, geoid, gravity, geodesy, and geophysics,” *Geophysics*, Vol. 66(6), pp. 1660-1668, 2001.
- [15] J. W. Gregory, “The level of the sea,” *Scottish Geographical Magazine*, Vol. 25(6), 1909.
- [16] R. E. Deakin, “The Geoid what’s it got to do with me?” *Australian Surveyor*, Vol. 41(4), pp. 294-305, 1996.