Interconnectedness and Geo-Compatibility:
A Paradigm Shift in the Perception of Planet Earth

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Abstract:
Nonlinear Science has witnessed exponential growth in recent years, due to the enhanced ability it offers in understanding intricate patterns of system evolution. The present work purports to the application of such nonlinear analysis tools to obtain an enhanced perspective of the home planet earth. Specifically, nonlinear analyses of latitudinal and longitudinal altitude profiles reveal the presence of underlying chaotic dynamics and patterns. Interpretations of these results lead to the concept of interconnectedness of every location on earth to every other location, through space and time, where man and his evolutions and developments are seen as an integral part of nature's transformation. Taking cue from this, the concept of "Geo-Compatibility" is introduced, given by the covariance of their chaotic signatures. Following this, Geo-Compatibilities of assorted location pairs are computed. From the results, it is seen that geographical similarities across and within continents show low and high Geo-Compatibilities respectively. However, the most interesting results are the high values of Geo-Compatibility obtained for pairings between Holy Sites suggesting that the development of civilizations and cultures, which are a result of man-nature interactions over hundreds of years, too possess intricate patterns. The entire work is thus a testimony to the concept of interconnectedness.

1. Introduction:
The exponential growth and advancement of nonlinear science in the past few decades have enabled the visualization of intricate patterns and long-term trends in evolution of systems, leading to unprecedented levels of understanding of the properties and features of such systems, all possible even with minimal amount of data available [1-3]. Covering among other areas, astronomy, biomedical signals, electronics, mechanics, economics and population dynamics, the tools and techniques of nonlinear analysis have certainly found applications of immense diversity [2-3].

The present work purports to one of the consequences of nonlinear analysis leading to a paradigm shift in our perspective of the world. Specifically, it is seen using standard nonlinear analysis techniques that the altitude profiles of any given latitude or longitude of the planet Earth reveal the presence of chaotic patterns. Drawing inferences and interpretations from such analysis leads to the understanding that every structure, natural or man-made, existing on the earth is the result of intricate interrelations between several neighbouring and non-neighbouring structures, as well as progressive interactions between the said elements over time. This, while adding a new perspective to the concept of space-time continuum and matter-space-time interactions, as proposed in Einstein's Relativity, also brings about a paradigm shift in man's perspective of the world, with the bottom-line being "Everything that's here is here for a reason; Everything that's here is here to stay".

Following this, the concept of “Geo-Compatibility” is introduced, and a novel technique for computing the compatibilities of any two given locations using the ‘Ordinate Correlated Altitude Profiles’ (OCAP) is presented. Example analyses of compatibility for various locations are briefly discussed. It is seen that the interrelations between locations on earth go much deeper than apparent physical similarities, and have deep underpinnings in the understanding of not only geography, but also the way of civilizations through history.

2. Nonlinear Analysis:

As a starting step, the nonlinear analyses of altitude profiles are presented. The base data for the nonlinear analysis is a 2-dimensional grayscale pixel intensity distribution of the world, as shown in Fig. 1. In this image, the brightness or intensity value of each point represents the altitude of the corresponding location, with higher places appearing whiter.

Figure 1 Intensity Distribution of Altitudes around the world

The first hints at the possibility of underlying nonlinearity emerge when computing the entropy of the image. Defined as E = -sum(p.*log2(p)), where p contains the histogram counts, the entropy is a statistical measure of randomness that can be used to characterize the texture of the input image [4]. The entropy of the base image shown in Fig. 1 is obtained as 3.2411 bits/symbol.

The altitude profile can then be obtained for a given latitude or longitude as the cross-section of intensities of Fig. 1, corresponding to the latitude/longitude. To analyse the nonlinearities in the altitude profiles, two standard techniques are used:

1. Phase Portrait: Plotting the derivative of a signal (V’) as a function of the signal (V) itself, the phase portrait is a graphical visualization of the evolution trajectory of the system

corresponding to the signal V. From the phase portrait, one observes properties such as ergodicity (non-repetitive nature) and system complexity, and as a general rule of thumb, an ornate phase portrait with complex patterns, often called “attractor” is a clear indication of the presence of underlying chaotic behaviour, where ‘chaos’ is defined as a system characterized by determinism and an extremely sensitive dependence on certain initial conditions [2].

2. Distance Map: In a signal x(t), the distance between any two samples x(i) and x(j) is given by $D(i,j) = \|x(i) - x(j)\|$. The 2D plot of the matrix containing all possible D(i,j) is termed the distance map, and this map depicts, among other properties, regularities, periodicities, recurrences and is thus, the best plot of choice for understanding the chaotic dynamics of a system when limited amount of data is available at hand [5].

Based on the above mentioned techniques, four examples of nonlinear analysis for the following latitudes/longitudes are presented. The first two analyses are latitude analyses, corresponding to the equator with latitude of 0, and the latitude of 27.9881 degrees north, most notably containing Mount Everest plotted in Fig. 2.

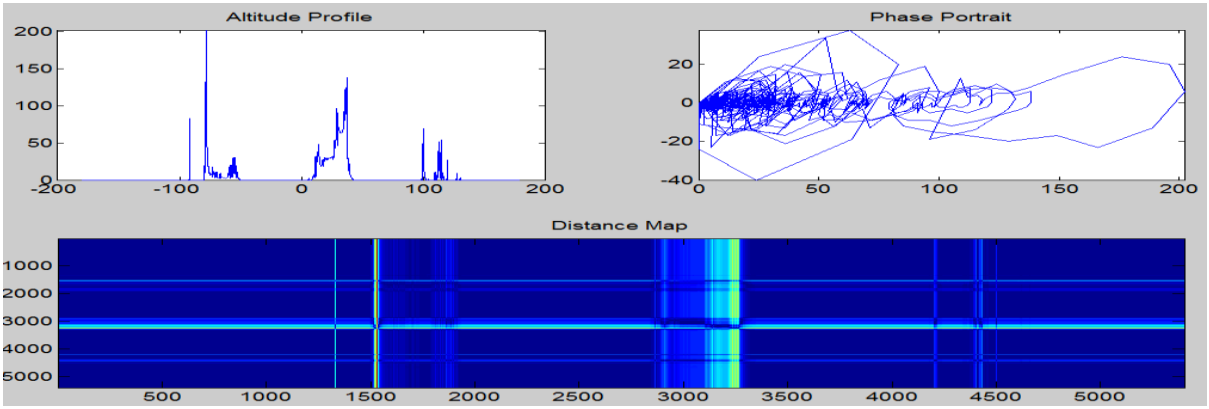

Figure 2 Nonlinear Analysis - The Equator

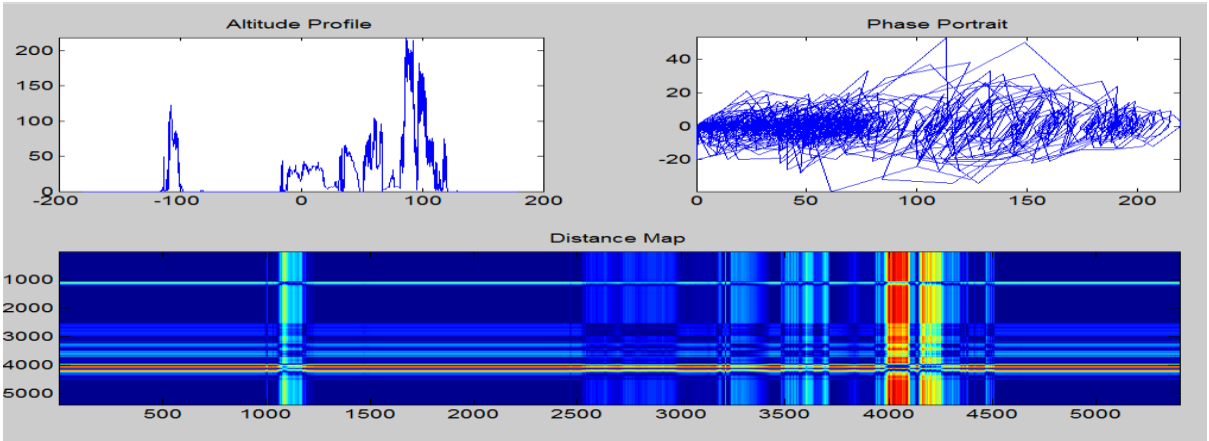

Figure 3 Nonlinear Analysis of 27.9881 degrees north

From the equator altitude profile of Fig. 2, one observes high peaks corresponding to the Andes, mountains in Africa and southeast Asia-Pacific regions.

The patterns in phase portraits of Fig. 2 and 3 indicative of chaos are easily recognizable.

Similar analysis is performed for two longitudes, namely Greenwich Meridian or the 0 Longitude, and the longitude of 79.7 degrees earth, which consists of three sacred and powerful Shiva temples in India – Chidambaram (corresponding to the space element), Kanchipuram (corresponding to the earth element) and SriKalahasti (corresponding to the air element).

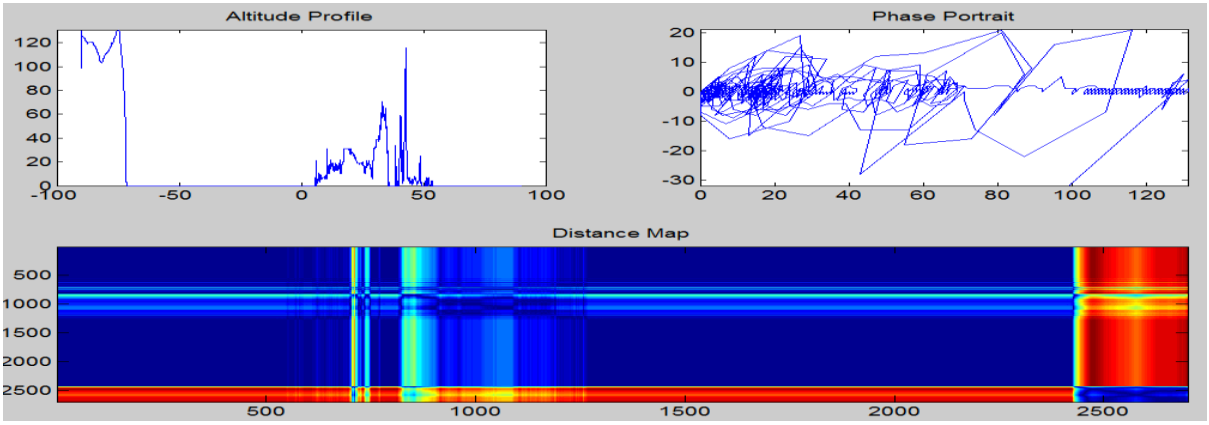

Figure 4 Nonlinear Analysis of the Greenwich meridian

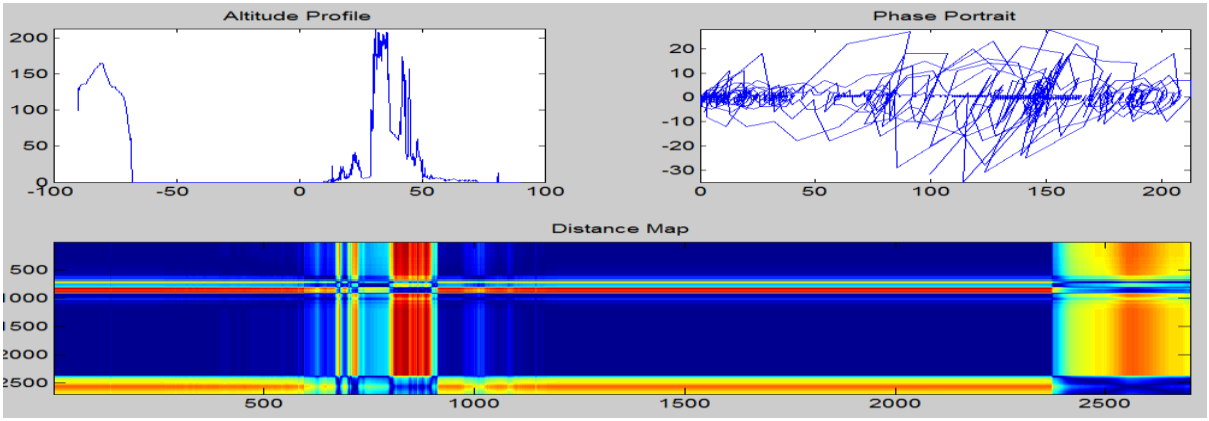

Figure 5 Nonlinear Analysis of 79.7 degrees East

From Fig. 4 and 5, the altitude profiles dominant in the lower positive half (0 to 45 degrees north), are observed, whereas, similar to Fig. 2 and 3, the phase portraits display patterns indicative of underlying chaos. Moreover in all the four cases, the distance maps exhibit dark and bright patches of varying widths indicating variance in periodicities and frequencies of the altitudes.

3. Interpretation of Nonlinear Analysis – "Interconnectedness"

While the above results for latitude and longitude based altitude profiles reveal nonlinear and chaotic dynamics from an analysis perspective, it is imperative to understand the implications of such results.

The presence of chaos essentially suggests that the altitude profiles depend heavily on certain 'initial conditions', which may or may not be possible to uncover, but suggests that, had the initial conditions varied even slightly, the altitude profiles, and thus the world, would not appear as it does today.

Since the altitude profiles, and thus the phase portraits are functions of space (latitudinal or longitudinal distance), the results indicate that there is a pattern governing the altitude distributions over any latitude or longitude cross-section. This implies an underlying "interconnectedness" between every location and every other location on the planet.

However, the locations which are interconnected and thus influential to one another, are themselves the results of geological evolutions and transformations through multiple epochs. Thus, the "interconnectedness" is a result of interactions not just in space, but in space-time.

The question that then becomes relevant is: does this principle of interconnectedness hold for man-made structures as well? In the context of interconnectedness, the following cases are considered:

1. Originated naturally, but has been destroyed/transformed by nature: Typical examples of this case are the Bering and Malacca Straits, which were above water level, but have slowly submerged over time. In these, cases, it is seen that while such natural features did exist during a certain period of time, they quickly/gradually disintegrated, since such features were not compatible to certain aspects of nature, such as temperature increase and ocean current flows.
2. Man-made, but has been destroyed/transformed by nature: Three of the Seven Wonders of the Ancient World, namely the Mausoleum at Halicarnassus, Colossus of Rhodes, and the Lighthouse of Alexandria, all three, the victims of earthquakes exemplify this category. While man, as an aspect of intellectual evolution, learnt to appreciate art, aesthetics and spent enormous money and time on various masterpieces, our ancestor's certainly did not have enough foresight to resist such works of art against the vagaries of nature. The destruction of many buildings in the 2015 Nepal Earthquake, and many more warned in Delhi, India and other areas around the world, is a clear indication that man's location and construction settings are not aligned with the flows and trends of earth's features such as floods, volcanoes, seismic waves, and heat waves. Thus, as a part of the "Survival of the Fittest" Principle, what cannot endure nature's vagaries, will eventually be destroyed by nature.
3. Originated naturally, but destroyed/transformed by man: The drying up of the Aral Sea between Kazakhstan and Uzbekistan is a classic example of this. While on the one-hand, it seems logical to think that man has exploited nature for commercial/survival/political needs, such an opinion is superficial and lacks depth, for on a deeper perspective, it becomes clear that man is not outside ecological system of nature but is an integral part of it. Thus, as a part of this world, man's evolution and development has influenced and has been influenced by various natural factors, and the level of physical, intellectual, moral and ethical advancement man has attained (or not attained) leading to his actions (and thus, the destruction of natural features) is nothing but a reflection of yet another aspect of transformation of nature and the world. Thus, these features, such as the Aral Sea, though geographically and geologically accurate in their placements, have fallen victims to man-made destruction as a part of their existence.
4. Man-made, and destroyed/transformed by man: The Temple of Baal, Palmyra, Syria, a remarkable synthesis of Near Eastern and Greco-Roman Architecture, destroyed by the Islamic State of Iraq and Syria (ISIS) in 2015, is a classical example of this category, as is the bombing of the Twin Towers, New York, USA in 2001 by Al-Qaeda. In line with the above discussion of man being a part of nature, this category is taken as yet another aspect of transformation of our planet. While in a human and ethical context, such acts of vandalism and destruction are to be heavily discouraged and condemned, in the bigger scheme of things, such acts stem at least partially in a vain and destructive attempt to show off one's power and might, and thus fall in the category of "Survival of the Fittest".
5. Originated naturally or man-made, and exists today: The Great Pyramid of Khufu, Mount Everest and numerous other tourist sites visited today all fall in this category. Structures in this category are thus the result of natural or man-made structures and locations falling in

alignment with the transformations of the planet, and as a result, have not yet fallen victims to modification, transformation and destruction.

The discussion of all the above categories as interpretations to the interconnectedness principle, can be summarized in the following statement:

“Everything that’s here is here for a reason; Everything that’s here is here to stay”.

4. Geo-Compatibility

The immediate implication of the above discussions pertaining to interconnectedness is that an enhanced understanding of the nature of our planet can be obtained by considering not just geographical locations, but also the interconnections and interrelations between pairs of locations, however far they may be physically separated. In line with this thought, a parameter, termed “Geo-Compatibility” is introduced, where for a pair of locations X and Y, Geo-Compatibility represents the covariance of not just X and Y, but of both the latitudinal and longitudinal altitude profiles of X and Y.

The procedure to compute Geo-Compatibility is as follows:

a. With LaX and LoX representing the latitudinal and longitudinal altitude profiles of X, the “Ordinate Correlated Altitude Profile” (OCAP) of X is given as the Cross-Correlation OCAPX = CrossCorr(LaX,LoX). Since the latitude and longitude of X have exactly one unique intersecting point, at X itself, this correlation represented by OCAPX is a unique signature of the location X, and in face-value represents the net result of all the underlying chaotic processes influencing and influenced by X.
b. Similar to the above step, OCAP of Y is given by OCAPY = CrossCorr(LaY,LoY), with LaY and LoY representing the latitudinal and longitudinal altitude profiles of Y.
c. The Geo-Compatibility GC is then given as the covariance of OCAPX and OCAPY. Thus, Geo-Compatibility GC is obtained from the off-diagonal elements P12 and P21 of the 2x2 matrix given by P = Cov(OCAPX,OCAPY)/STDDEV(OCAPX)STDDEV(OCAPY).

Thus, the Geo-Compatibility of two locations X and Y is thus a measure of the similarity between OCAPX and OCAPY which are the signatures of the two locations. While theoretically, the standard deviation normalized covariance GC exhibits the range [-1,1], only positive GC values are seen, owing to the fact that the OCAP of any location possesses a trend of an increasing followed by a decreasing altitude [6]. Thus, higher the value of GC, more the places are correlated, which implies that the locations are compatible to each other, owing to the similarity in their underlying chaotic signatures.

As an example, the Geo-Compatibility of Mount Everest in Nepal and Mount Shasta in California, USA is shown in Fig. 6 and Fig. 7.

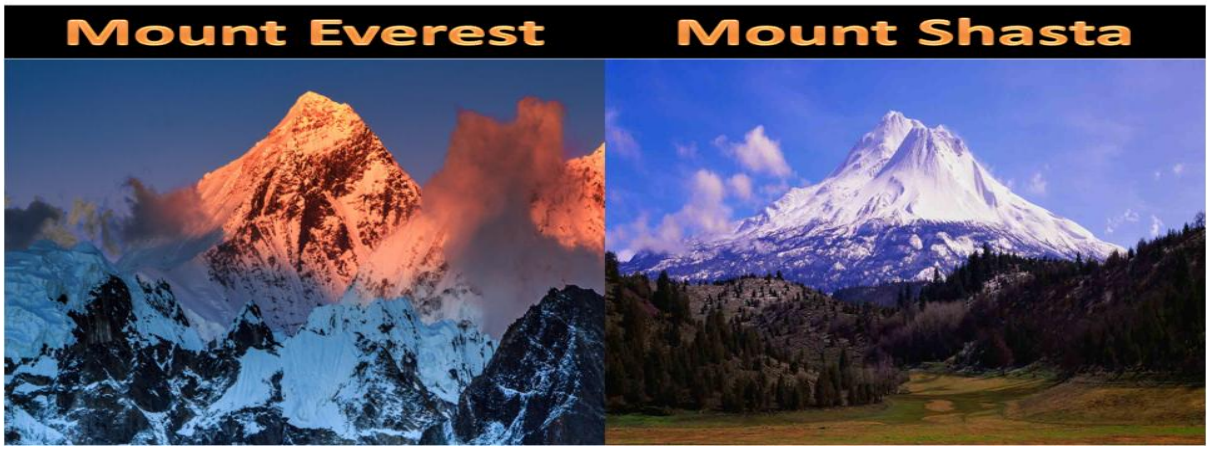

Figure 6 Mount Everest and Mount Shasta

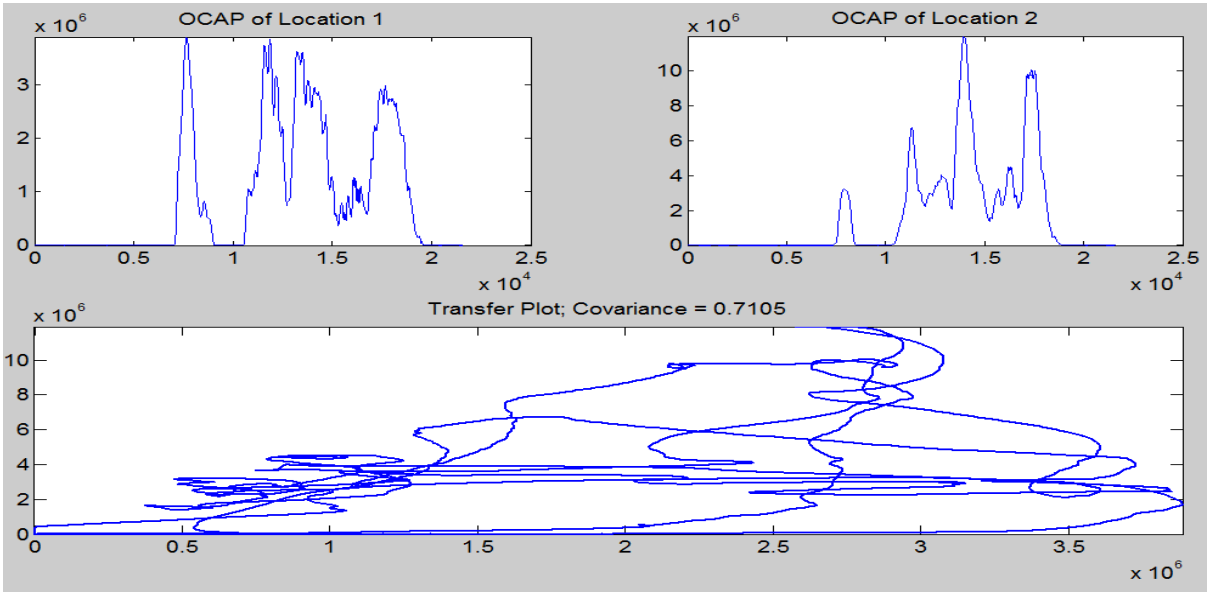

Figure 7 Geo-Compatibility of Mount Everest and Mount Shasta

Mount Everest, also known as Sagarmatha and Chomolungma, and with its peak at 8488 metres above sea level, is the highest mountain on the planet, and thus has been an avid fascination for photographers, mountain climbers and statistics aficionados. Mount Shasta, in California, is a potentially active volcano with a 4321.8 metre high peak, and has been a subject of various lores and theories such as the Klamath Abode of the Spirit of the Above-World, a Hidden Village of the submerged Lemuria, and a strong Catholic presence in the area.

Apart from a possible apparent similarity of the mountainous peaks, and the fact that both the locations are mountainous peaks, one wouldn't suspect of any correlation. However, the analysis does reveal a hitherto unseen significant Geo-Compatibility value of 0.7105.

The Geo-Compatibility values for assorted pairs of locations are tabulated in Table 1.

Table 1 Geo-Compatibility Covariances of Assorted Location Pairs

Sl. No	Location 1	Location 2	Covariance
1	Mount Everest, Nepal	Mt. Kilimanjaro, Tanzania	0.4152
2	Mount Everest, Nepal	Mt. Shasta, California, USA	0.7105
3	Valley of Geysers, Russia	Yellowstone, Wyoming, USA	0.4638
4	Pyramid of Khufu, Egypt	Chichen Itza, Mexico	0.4466
5	Prayag, Allahabad, India	Bhavani Sangamam, India	0.6448
6	Senegambia Stone Circles	Stonehenge, England, UK	0.1987
7	Varanasi (Kashi), India	Vatican City (Holy See)	0.6472
8	Varanasi (Kashi), India	Mecca, Saudi Arabia	0.8669
9	Mecca, Saudi Arabia	Vatican City (Holy See)	0.7174
10	Mecca, Saudi Arabia	Taj Mahal (Agra), India	0.8014
11	Thirumala, AP, India	Acasta Gneiss, Canada	0.3350
12	Thirumala, AP, India	Mount Kailash, Tibet	0.2052
13	Lake Titicaca, Bolivia	Lake Manasarovar, Tibet	0.4376
14	Thirumala, AP, India	Uluru (Ayer's Rock), Australia	0.6335
15	Angkor Wat, Cambodia	Jerusalem, Israel	0.3824
16	Mount Ararat, Turkey	Mount Fuji, Japan	0.7745
17	Thirumala, AP, India	Dwaraka, Gujarat, India	0.7094
18	Easter Island, Chile	North Sentinel Island, India	0.5946

The following can be observed from the table:

1. Unlike the high Everest-Shasta GC value, a lower value of 0.4152 is seen for the pair of Everest and Kilimanjaro, the highest point in Africa. As results of an exercise in comparing similar geographic features across continents, moderate GC values of 0.4638 and 0.4376 are seen for Valley of Geysers-Yellowstone and Titicaca-Manasarovar lake pairings respectively.
2. However, geographical similarities within the same continent, such as the Prayag-Bhavani Sangamams show reasonably high GC values.
3. Monuments of Civilizations continents apart, such as the Khufu-Chichen Itza pyramid pairings and Senegambia-Stonehenge pairings reveal varying GC values of 0.4466 and 0.1987.
4. Perhaps the most interesting result in this study is the one obtained by pairing each of the Hindu, Islam and Christian Holy sites, namely Varanasi, Vatican City and Mecca with each other, and the fact that all the three GC values 0.6472, 0.7174 and 0.8669 are in the high range is no happy coincidence. This trend suggests an intricate pattern and dynamics underlying years of development of civilization, religion and spirituality, with holy sites such as these being the centres of accumulation of spiritual energy. It also reinforces the notion that man and his development over centuries are an integral part of nature's transformation, leading to such holy sites that have stayed on without destruction this long, and are bound to stay for centuries to come.
5. With the interesting result of the previous point, and the beliefs/notions that the Taj Mahal and the Kaaba in Mecca were once Shaivite Hindu Temples, a GC is done pairing the sites. A high value of 0.8014 does suggest the possibility of an underlying relation.
6. As the most sacred site of Sri Venkateshwara, Thirumala in Andhra Pradesh, India, known for very old geological formations, is paired with various sites such as Lord Krishna's Kingdom of Dwaraka, the Ayer's Rock or Uluru in Australia, the abode of Lord Shiva, Mount Kailash in Tibet, and the oldest geological finding in Acasta Gneiss, Canada. Of these, the highest GC's are obtained with Dwaraka and Acasta Gneiss.

7. Mount Ararat, believed to be the site of Noah's Ark, is paired with Mount Fuji in Japan, an active stratovolcano and an icon of its country. A high GC of 0.7745 is remarkable.

5. Conclusion

The present work starts with an application of nonlinear analysis techniques to latitudinal and longitudinal altitude profiles of the planet earth, and the presence of chaotic dynamics with intricate patterns underlying the earth's geography is asserted. Interpretations of these results lead to the concept of interconnectedness of every location on earth to every other location, through space and time, where man and his evolutions and developments are seen as an integral part of nature's transformation. Taking cue from this, the concept of "Geo-Compatibility" is introduced, where the "chaotic signature" of any given location is obtained as the cross correlation of the latitudinal and longitudinal altitude profiles, and the Geo-Compatibility between a pair of locations is given by the covariance of their chaotic signatures. By including the chaotic signatures, much more information than apparent similarities is accessible through the Geo-Compatibility values, and to explore the possibilities, Geo-Compatibilities of assorted location pairs are computed. From the results, it is seen that geographical similarities across and within continents show low and high Geo-Compatibilities respectively, whereas certain mountain pairings such as Everest-Shasta and Ararat-Fuji show high Geo-Compatibilities. However, the most interesting results are the high values of Geo-Compatibility obtained for each of the pairings between the Holy Sites Varanasi, Vatican City and Mecca. These results suggest that, while geographically, similarities in landscape patterns between distant locations exist, the development of civilizations and cultures, which are a result of man-nature interactions over hundreds of years, too possess intricate patterns, assertively proving the fact that man is indeed an integral part of nature's transformation process. The entire work is thus a testimony to the concept of interconnectedness, which is beautifully summarized in the single statement "Everything that's here is here for a reason; Everything that's here is here to stay".

References

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