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ARTICLE

The Size of the Ecumene of the Mediterranean in Ancient Times

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ABSTRACT

For the purpose of this manuscript, we used the old maps of Europe and of the ecumene, as it was known at the time, in order to establish the ecumene properties, as well as the size of the Mediterranean in the time of Ptolemy. We obtained the coordinates (geographic longitude and latitude) from Ptolemy's map of ecumene of ancient Mediterranean settlements. According to the historical data the coordinates of the Mediterranean ecumene were studied in the 7th century, since the Mediterranean was the centre connecting the civilizations of Europe, Asia and Africa. Although longitudinal and latitudinal errors are large, these coordinates are of great importance for the studies of the past settlements. Today, these settlements are the symbol of civilisation and of human existence. Using the data from 501 settlements overall, we obtained two principal maps of the Mediterranean ecumene with the average density of settlements on the area of 2000 km2. All Ptolemy's maps, which were used, were of great significance from the scientific point of view, since they made the description of 2000 years old civilization possible. Historically, part of these civilizations, and those formed afterwards, belonged to the Mediterranean.

1. Introduction

Ptolemy (*Claudius Ptolemy*) is considered to be one of the founders of geography, which was formed in 100 AD in Alexandria, today's Egypt. According to historical resources, Ptolemy lived in the first century AD. Together with Eratosthenes (Eratosthenes), Ptolemy is regarded as the best father of geography because he was the first to introduce the concept of geographic coordinates (*longitude and latitude*) and the idea of creating some maps using geographical projections. Most of the coordinates of the ecumene, set at that time can be found in the epochal book of Almagest. Ptolemy was the first to present the relation between the geographic longitude and gnomonic projection of the solar declination throughout the year. The complexity of the equinox lines, in the further context of parallels, begins from the equator. These lines extend in durations of the diurnal light reckoning from the summer solstice. The durations increase by a quarter from 12 to 18 equinox hours by the geographic latitude of (58°φ), i. e. by 24 equinox hours on the Arctic Circle (66° 8′ 40″ φ). The major problem in establishing the total area of the ancient ecumene is the northernmost point situated at the place of Thule (coordinates: 30° 30′ λ, 63° 00′φ). The most probable position of that point has still not been completely confirmed, but most scientists think that this settlement belongs either to Iceland or Greenland. The southernmost point according to Ptolemy's ecumene map had the following coordinates: 60° 00′λ, -20°00′ φ, near Cartum (*in present time Assuan*) (Orbis Ptolemai, the map

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of ecumene). The majority of coordinates we used for the present purpose are from Ptolemy's Geography (III, IV). In order to georeference this old map successfully, we compared it to modern, as for construction and deformations, the most similar projections. The ecumene back then, as well as the whole world, was divided into three continents. To the east, it reached Asia Major, India today, to the south, Ethiopia, south of Libya (part of Ethiopia presented on Ptolemy's ecumene map was called Agisymba), to the west, the bay bordering the Ethiopian Bay in the Western Atlantic Ocean [1]. All the countries, as well as the settlement coordinates in the past, belong to the Mediterranean of today in a broader geographic sense; historically and geographically, countries forming the Mediterranean are: Gibraltar, Spain, France, Monaco, Italy, Malta, Slovenia, Croatia, Bosnia and Hezegovina, Montenegro, Albania, Greece, Turkey, Cyprus, Syria, Lebanon, Israel, Egypt, Libya, Tunisia, Algeria, Morocco [2]. The rest of the data were taken from (Tabula of Europe) with the settlements in the internal and external parts of the Mediterranean. Ptolemy's first ecumene map was done in simple conic projection. This projection might also be referred to as gnomonic one or shadow projection because its coordinates were determined by using the declination of the Sun. Ancient geographers determined geographic positions using some astronomical phenomena, such as, for instance: star places in the sky, the ratio of the height to the length of the shadow during a year, the longest daytime duration within a year for the same terrestrial position. To the ancient geographers, the most useful star was, certainly, the one observed from the Rhodes and Alexandria. It was Canopus in the Carina constellation [3]. Almost all of these coordinates were investigated and the analysis of latitude and longitude was performed by means of GIS analysis and the method of geospace dispersion [4]. Between the caps occupied by circumpolar and anticircumpolar constellations, there is a zone defined in the following way

$$\varphi - 90^0 \le \delta \le 90^0 - \varphi \tag{1}$$

Then for a star attaining the zenith in its upper culmination it is valid $\delta = \varphi$.

So the coordinates of a point on the Eath's surface (latitude) could also be determined from a lunar eclipse. Two towns where the measuring took place were Arabela and Catagena. The major measuring error between the two towns exceeded 110 in longitude [5]. For the further analysis of data, we used Ptolemy's coordinates, and those which were missing were obtained directly from the map after its georeferencing. Most of the coordinates contained errors, so we minimised them using the equation (error is smaller in latitude, larger in longitude). Ptolemy obtained the coordinates as a part of degree measured from the equator which was then relatively precisely determined. The longitude was most likely determined from the prime meridian, then located at ~30°.60 from the Greenwich. It is also known that the settlement positions (their coordinates) have higher precision in the internal Mediterranean; its value being 5 arc minutes. Finally, the total number of Ptolemy's coordinates is 8000, 233 of which were taken for the purpose of this manuscript from the regions of Hispania, Italia and large islands near Greece, Asia Minor, Levant and Egypt. The missing coordinates were obtained by means of specially created algorithm wherein the relative error in (longitude) within ~1*4 was taken into account. We also used special tools in GIS in order to determine the coordinates today.

2. Ptolemy's Simple Conic Projection

One of the first projections made with precision belongs to Ptolemy. In Ptolemy's conic projection the parallels are given as concentric circles (*circle outsides*). The meridians are given as straight lines. However, the historical importance of this projection is that it was the first to indicate a given point with the help of a coordinate (longitude, latitude). In constructing the cartographic grid, the prime meridian belonged to the Rhodes parallel (φ_0). From the Rhodes parallel all other radii of other coordinates from the map are drawn (see Eq.2).

$$\rho_0 = R\,\mathrm{ctg}\varphi_0 \tag{2}$$

where R is the radius of the terrestrial sphere reduced according to the map scale. Arc (arcsecant) of the other parallels starts from the common centre. The radius is equal to that of the standard parallel (see Eq.3).

$$\rho = \rho_0 + R\Delta\varphi \tag{3}$$

The angle (δ) obtained from the meridian grid, as well as the meridian approaching angle, is found by applying the formula for chord length within equilateral triangle. The chord length, as well as the angle between meridians, is calculated by using the following equations (see, Eq.4, Eq.5).

$$\frac{d}{2} = R\,\mathrm{ctg}\varphi_0 \sin\frac{\delta}{2} = R\cos\varphi_0 \sin\frac{\Delta\lambda}{2} \tag{4}$$

$$\delta = \Delta\lambda \sin\varphi_0 \tag{5}$$

In Ptolemy's conic projection the direction and the

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shape of the prime meridian depends on the direction of its extension. The standard parallel of this projection has preserved the zero deformation only. As the standard parallel becomes more distant, the deformations of lengths, angles, as well as of the areas, enormously increase. At the poles the deformations are infinite. The basic formula for construction of Ptolemy's projection is given in Equation (6).

$$\delta = \Delta\lambda * \sin\varphi_0,\ \rho_0 = R * ctg\varphi_0,\ \rho = R * ctg\varphi_0 + R(\varphi_0 - \varphi),$$
$$\rho_E = R * ctg\varphi_0 + R\varphi_0,\ x = q - \rho * \cos\delta,\ y = \rho * \sin\delta,\ n = 1,$$
$$m = \frac{\cos\varphi_0 - (\varphi_0 - \varphi) * \sin\varphi_0}{\cos\varphi},\ p = m,\ tg\left(45^0 + \frac{\omega}{4}\right) = \sqrt{m} \qquad (6)$$

In ths equation (ρ_E) is the radius of equator projection, (*q*), is the radius of the parallel, (*n*) is the linear scale for the parallel direction, (*m*) is the linear scale for the meridian direction, (ρ) is the area scale, (ω) is the maximal angle deformation. According to Ptolemy, the end of the cartographic grid is the south geographic tropic which is presented as a circle arc of a length equal to the presentation of the north geographic tropic (*parallel of Syene, today Aswan in Egypt*). Due to the appearance of deformations, Ptolemy himself corrected the projection so that it is not completely conic in its shape (Figure 1). There are the settlements and their coordinates of the Mediterranean ecumene partly taken from the map of Ptolemy's ecumene [6].

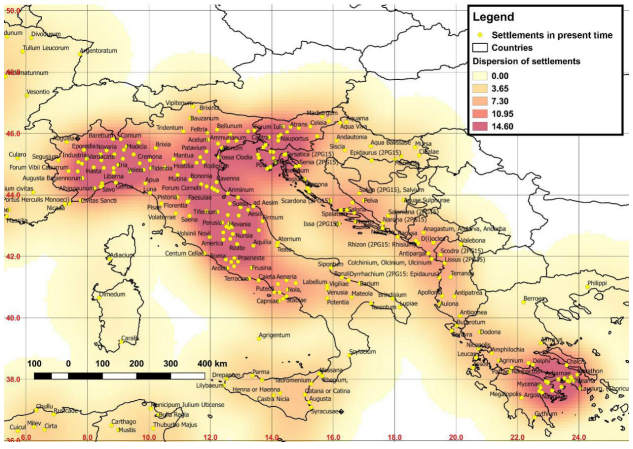

Figure 1. The ecumene as it is today. The coordinates of the settlements from the period of the Roman Empire and Ptolemy are preserved in this presentation

3. Historical Background of the Mediterranean

The Mediterranean is today a region of diverse sociological, cultural and religious communities. Any determination of its frontiers in the past contributes to a better insight of its present state, but also of its future. Following some theoreticians who minimalise the frontiers, the Mediterranean is bordered by olive dispersion to the north and the south. Following the maximalist definitions, the Mediterranean is given through historical transition zones. In the present paper, the authors are focussed on the Mediterranean within the Roman Empire presented in [7]. In the 1st and the 2nd century, the population was partly assimilated by the Roman Empire so that the frontiers of the ancient Mediterranean states were removed, since the Mediterranean economically and culturologically merged into the Roman Empire. Within the Roman Empire the central place of the Mediterranean certainly belonged to the capital Rome, whereas the other parts were regarded as provinces [8]. According to the usual standpoint, the past of the Mediterranean is, in fact, the past of its towns or cities [9]. Therefore, we also refer to the Mediterranean settlements which were most frequently mentioned in the Roman Empire. A concise and detailed review by James C. Russell gives a definition that within the Roman Empire it is possible to distinguish the Western Mediterranean - Italy, Iberia and North Africa - and the Eastern Mediterranean with regions - Greece with the Balkans, Egypt, Asia Minor and Israel [10]. Italy with its cultural and religious capital Rome had between 7 and 7.5 million inhabitants then, the other centres being: Neapolis, Capua, Catania, Bologna, i. e. Algeria, Caralis, Panormus and Syracusae on the Balearic islands. The most romanised parts of the Empire comprised following towns: Gades, Tarraco, Cordoba and Carthago-Nova, which had more than 6 million inhabitants (*Ibid.,74*). The population of Nothern Africa in the 1st and the 2nd century was between 4 and 4.5 million. Important trade and cultural centres were: Tingi, Caesarea, Cirta, Utica, Carthago, Leptis-Magna and Cyrene. Greece with the Balkans, which was positioned between the western and eastern parts of the Roman Empire, had about 5 million inhabitants [11-13]. The towns of this Mediterranean part were the most important cultural and social centres, in some of which the first philosophical thought was developed, the most important being: Athens, Corinth, Rhodes, Thessalonica, Salonae and Dyrrhachium. In the eastern parts of the Roman Empire, though they were provinces, the Hellenistic elements survived all the time. The proof is in towns abundantly filled with features of cultural living milieu, cultural heritage, as well as the settlement shape [14-17]. On the territory of Egypt, Asia Minor, Syria, Israel, the number of inhabitants was between 20 and 25 million. In that part of the Empire, some of the former Hellenistic towns were transformed into Roman ones. Among the most important urban centres the following should be mentioned: Alexandria and Memphis in

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Egypt, Ephesus and Miletus in Asia Minor, Antioch, Tyre, Palmyra and Hierosolyma in Syria (Figure 2).

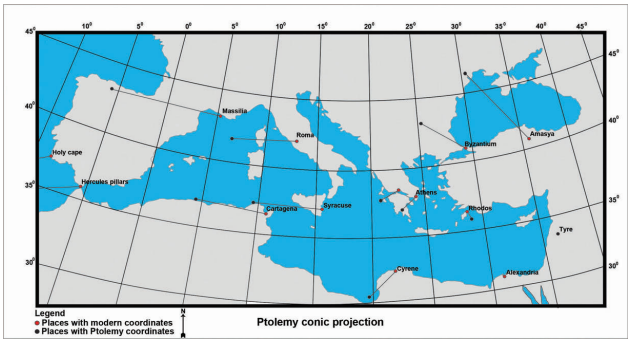

Figure 2. Modern map of the Mediterranean in Ptolemy's conic projection. Comparison of old Ptolemy's coordinates and modern coordinates. Most errors visualized in the direction of parallels

4. GIS Background Analysis

Geographic Information System (Abbrev.GIS), and the numerical modelling of geographic data appear as very powerful tools in the calculation and treatment of a large data body. GIS also offers the possibility of redesigning old maps, and by using the interpolation technique and special spatial analysis ordinary kriging (KR) and a special algorithm (IDW), it becomes possible to treat all points (coordinates) from Ptolemy's old maps. In modelling the inner and outer Mediterranean parts, the coordinates of old and new settlements and determining the ecumene of Ptolemy's time all treated geospatial data are used. Ordinary global kriging and Inverse distance weighted (IDW) methods are also used as auxiliary open source QGIS and SAGA (GIS-a) using special extension of Geo-spatial Analyst. Although there are a few other methods, the priority is given to ordinary kriging because it includes autocorrelation or the statistical relationship among the measured points. This method of treating geospatial data unlike the other ones is not based on the distance of measured points only, but it minimises the variance and the standard error between the points of geospace. Settlements of the inner and outer Mediterranean parts are presented on the maps (see Figure1; Figure2). During the data treatment, we included the well-known settlements from Ptolemy's maps and books and compared them to the present coordinates (see Figure3). The first Mediterranean zone is divided into states of Italy and Greece. The other Mediterranean states are divided and classified depending on the geographic position of the towns. We also determined the approximate date of Ptolemy's projection since the precise dates of modern projections concern the 19th century only. The other coordinates were georeferenced directly from Ptolemy's ecumene map (ecumene). Other sources used for the purpose of data determining were: archaeological localities, historical books, historical archives and old maps. All coordinates, both from Ptolemy's ecumene map and the ones from new maps, are given in the Universal Transverse Mercator projection, after georeferencing. The largest errors are found between the parallels, and the average measured error lies between 80 and 110 (see Figure 3), on the prime Rhodes Meridian being approximately ~1*3, farther from it approximately [17,18]. The inner Mediterranean presented on Ptolemy's ecumene map has errors by 40% less when compared to the outer one [20].

Ecumene in the Ancient Times

Notwithstanding their incorrectness, the coordinates from Ptolemy's map have an enormous importance. The errors are also due to non-single measuring system; geographic latitude is determined by applying astronomical methods, local times are often discordant. The Alexandria parallel was assumed by Ptolemy to be the prime meridian and also as a referent one (Alexandria 60°30′). The known ecumene on Ptolemy's map is given within a small quadrant (see, Figure4). After the treatment of the coordinates of settlements and their dispersion, the highest density of population and towns includes Italy, Greece and Spain. Here the ecumene has preserved the shape by direction of 180°. The border is abruptly deformed from the coast of the Iberian Peninsula and in the east towards India. Among the reasons for this error is also the fact that Ptolemy had no knowledge whether this part of the ecumene was populated. Another theory is in favour of Ptolemy's basing his first conic projection on the Eratosthenes square projection which also gave a similar form of ecumene. The second reason concerns the fact that both Eratosthenes and Ptolemy adopted the prime meridian at the Rhodes. Therefore, the other parallels were drawn concentrically on the maps from this parallel and, as a consequence, the errors increased as being farther from it. The third reason lies in the fact that Ptolemy's second projection (pseudo-conical) had more accurate coordinates than the first one, but he, for reasons known to him only, in presenting the ecumene preferred the first projection. After the data treatment in (GIS), also see (Figure 1), the highest density of settlements occurs in the territory between the Rhodes and Athens, and further in the territory of the Apennine Peninsula and the central parts of the Iberian Peninsula and France. The coordinates which Ptolemy used for the parts of Eastern and Southern Europe differ significantly

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in sources from which they were obtained, concerning their accuracy. Due to the small amount of data taken from the parts of Eastern Europe, the error in coordinates is 10% higher than in the coordinates from Southern Europe, in terms of geodesy [19].

After GIS analysis, the conclusion is that the lowest density in the Mediterranean in Ptolemy's time was 2.56 settlements per 1000 km^2, i. e. in parts with somewhat higher population it was between 2.56 and 5.11. The highest density on the Mediterranean territory was between 7.68 and 10.23 per 1000 km^2. In some parts near Rome and Athens, also Alexandria, it was even more than 10.23 settlements per 1000 km^2, but this is only 3 % of the total area. In treating the data, one should bear in mind that even Ptolemy himself did not treat all the Mediterranean settlements and, as a consequence, he did not indicate them on the maps. Present Mediterranean settlements which cover the same territories as from Ptolemy's map show some deviations, but the population density is surely higher. The central Mediterranean parts have the highest density of population and settlements. It decreases towards the north and the south. The lowest density of settlements is 3.65 per 1000 km^2, in denser parts between 3.65 and 7.30 per 1000 km^2. The Mediterranean regions more densely populated are within 7.30 to 10.95 per 1000 km^2, for even denser parts within 10.95 to 14.60 per 1000 km^2, whereas for 10% of the area the density of settlements exceeds 14.60. The first conclusion is that the number of settlements compared to the situation of Ptolemy's time has increased more than 20 times, the second one that there are settlements which existed in Ptolemy's time, but today are known under different names. On the other hand, some settlements have vanished completely from the territory of the Mediterranean during the long period of the history of civilisation (see Figure 3).

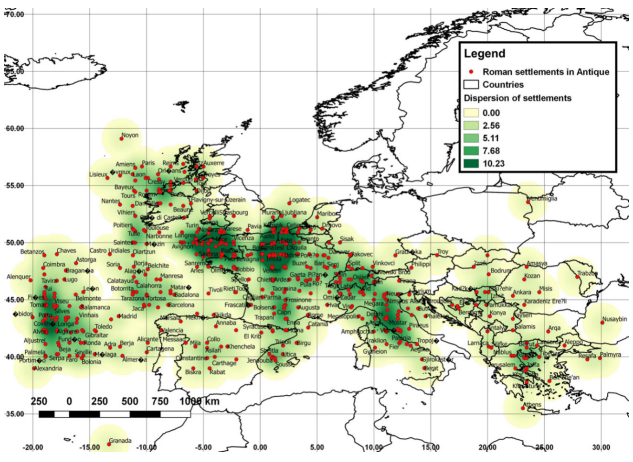

Figure 3. The ecumene as it is today, projected in Universal Transverse Mercator. Settlements given with Ptolemy-`s coordinates from the period of the Roman Empire

5. Discussion and Conclusion

The relationship between terrestrial measurements and astronomical phenomena contributed to the development of ancient geography which developed on the territory of the Mediterranean. Geometric methods and the use of units such as stades and steps made it possible to perform the first direct measurements and to present the results on the maps. For instance, ancient geographer Eratosthenes used his excellent knowledge of astronomy for the purpose of determining the circumference of the Earth, which, according to him, was equal to 252,000 stades (39,690 km), whereas Ptolemy estimated this circumference to 180,000 stades (28,350 km), (1 stade was approximately 157.5 m, whereas the Roman stade was approximately 185 m). Ptolemy's merit, in addition to the precisely determined geographic position (longitude and latitude), is also the defining of the prime meridian with respect to which the other meridians were determined. Consequently, on the Mediterranean territory for the first time, local times could be applied. Ptolemy then determined the geographic longitude for Alexandria to 60°30 ′, from the Isle of the Blessed. The best-known part of the ecumene (Figure 4) is indicated in the quadrant of his ecumene map. It was most densely populated, its shape being similar to a cloak worn in ancient times. This quadrant extended by 1800 westwards to the Iberian coasts and eastwards to the central parts of India. Its southernmost point was on the southern hemisphere reaching the latitude of -16° 25′. It was parallel to the Egyptian town of Meroë. The northernmost point reached Thule, latitude of 63°00′. The main parallel (meridian) divided the outer Mediterranean at Rhodes, longitude of 36°00′. This meridian was also known as a diaphragm or Ionic Equator. This diaphragm divided the ecumene into western and eastern, southern and northern parts. Ptolemy put the central part of the ecumene in the heart of the Mediterranean. The ecumene area inside Mediterranean according to Ptolemy was 72000 x 350000 stades, approximately 62 million km^2 (see Figure 4). Another importance of Ptolemy's ecumene map is contained in using, for that time, up-to-date scientific means and techniques such as gnomon, orthographic projection, quadratic-cylindrical projection, pseudo-conic projection, simple conic projection, stereographic projection, stades and others. In the present paper, the comparison of two kinds of geographic data is successfully carried out, one body of data being from Ptolemy's Geography (book), the other body being from his map of ecumene. In determining the area and shape of the Mediterranean ecumene, the fact that the notion of the

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prime parallel - equator was applied for the first time in cartography is kept in mind. Knowing the history of the ancient Mediterranean one can also verify the present positions of past settlements, discover new archaeological localities or describe the history of settlements which no longer exist. Ptolemy's view inside the Mediterranean is almost 2000 years old, and it shows the historical importance of this region. The errors in this projection of Ptolemy, despite their existence, did not reduce the significance of the fact that the settlements were indicated on a map for the first time, by the use of geographic longitude and latitude. Therefore, the Mediterranean was presented realistically for the first time, and after 19 centuries it is possible to note the distribution of settlements by using modern scientific tools like GIS.

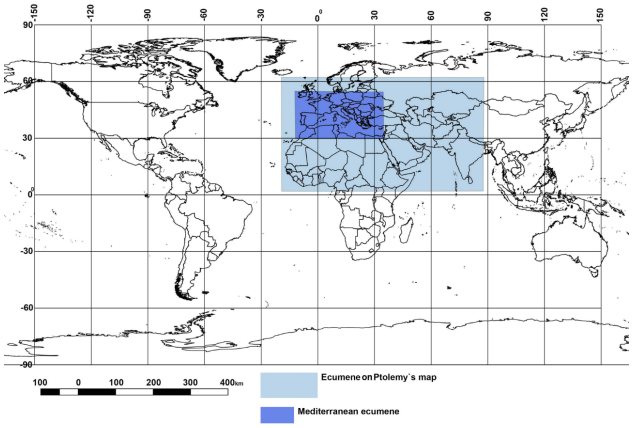

Figure 4. Ptolemy's map of the ecumene comprising the area of Mediterranean in Equirectangular projection

6. Future Research

Some authors successfully reconstructed history and climate after the Roman Empire. This pioneering venture established new comparative study called interdisciplinary history. Some authors found strong connection of History and Natural sciences, such as ecology. These principles used geographical, historical and ecological investigation for better conlusions. Also, we found a strong connection between history, geography, cartography, astronomy and mathematical geography and history, with the help of GIS tools. A map is an important means not only in geography, but also in history. Historical cartography is important, and it can always be used in various fields as a referent scientific discipline. Ptolemy's map has been an important historical and geographic source. The distribution of settlements, scattered when observed, can be compared to the distribution of settlements today. After implementing all the Mediterranean settlements from Ptolemy's ecumene map in the database and with the help of his epochal Geography, it is possible to determine the Mediterranean population for the period in which the map was made (the 1st and the 2nd century) much more accurately. By applying other scientific disciplines and methods, such as - historical, demographic, culturological, archaeological, medical, etc. - it is possible to obtain more precise data on the life in the Mediterranean in the ancient times.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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ARTICLE

Dreaming Forward: Postidentity and the Generative Thresholds of Tourism

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The flows of possibility (of tourism)

ABSTRACT

This manuscript from Hollinshead and Vellah calls for researchers in Tourism Studies and related Fields to reflect upon their own role in refreshing the social imaginaries of "after-colonialism" under the nomadisms of our time. Deleuzian in outlook, it positions the "post" of postcolonialism not as an end to colonialism's imperatives but as a generative-portal through which new-seeds-of-"becoming" are discernable as the postidentities (rather than the "identities") of populations are interpretable in multidirectional, non-hierarchical, and not easily-predictable ways. In provoking (after Deleuze) thought per *rhizomatic processes* (rather than via *fixed concepts*), the manuscript - critiquing these dynamic matters of "postidentity" - then harnesses the insights of (Leela) Ghandi's on hybrid-nomadic-subjects, and of Venn on alternative-(com)possible-futures. Thereafter, these concerns of and about "after-colonialism" are critically contextualised within Aboriginal "Australia", via the views of a pool of Indigenous intellectuals there, who synthesise the disruptive dialectics of belonging-cum-aspiration which they maintain that they and fellow Aboriginal people (of many sorts) face today. Throughout this manuscript, the agency and authority of tourism hovers in its sometimes-manifest / sometimes-latent generative power to project empowering postidentities for the world's "host" or "visited" populations today.

1. Introduction: Identity and Discourses of Being and Becoming

1.1 Tourism and the Inscription of Being and Becoming

In this manuscript an attempt is made to examine the role and function of tourism as an industry and research site the texts and utterances of which make meaningful exposition of and about the world *after* the zenith of colonialism, that is under the so called postcolonial or neo-colonial temper of our time. Initially based upon the Foucauldian concept of governmentality (following Foucault [1]), it inspects the ways in which *the world after colonialism* is seemingly discursively talked about today generally across the social sciences. An attempt is accordingly made to critique how those wider understandings and misunderstandings relate to the specific orientations of the tourism industry (mainly through Tourism Studies, with its particular forms of knowledge about the peoples, places, pasts, and presents of the postcolonial/neo-colonial era).

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To these ends, in the paragraphs that follow, an effort is made to inspect some of the lead discourses of and about the postcolonial/neo-colonial moment while these hailings of and about populations and their places/spaces seemingly hold sway, as they serve as Foucauldian regimes of discursive truth (see Dean [2]) on Foucauldian "governmentality" (i.e., on "regimes of institutional thought-space")). As such, these held discourses are known to favour certain ways of speaking about peoples living in potent after-colonialism scenarios) and coterminously denigrate other less-potent ways. And these discursive maps of meaning of and about peoples and their cultures will then be loosely translated to scenarios within tourism/Tourism Studies. In the manuscript, therefore, tourism will *not* thereby deemed to be a neutral medium in the cultivation and articulation of values and understandings about populations under postcolonialism/neo-colonialism - viz., within this paper, for the Indigenous peoples of Australia, in particular - but will be seen to be an active constructor of meaning and a determinant maker of "subjects". In this light, it is the author's intention to highlight not only the pre-established givens that might already lie with the naturally occurring discursive texts of and about "after-colonialism", but to critique how tourism (in concert with other industrially-scripted industries) conceivably echos what is generally communicated about our postcolonial/neo-colonial times. Thus the inherent mission behind the paper is to infer what may be interpreted about the power of the discourse of tourism to project freshly corrective or newly-empowering visions of being during our current era - an age which has supposedly followed after the conceivable peak of colonialism - for peoples who (and for places which) are striving for improved external representation. In this regard, the manuscript inherently elides into a critique of the projective and empowering here-and-there futurism of tourism, and it responds to the undergirding question as to what tourism does and/or can potentially generate to help populations freshly enunciate *themselves* to the wider world or otherwise be freshly scripted and articulated *by others* across and beyond the industry. In these senses, this discursive scrutiny of established forms of governmentality of and about the postcolonial mood or neo-colonial condition interpretively morphs into an inspection of the potential and positive inscriptive agency of tourism. To this end, it inspects the role of tourism to contour the myriad values, forces, and desires in which (in particular and ultimately, for this paper) the Indigenous populations of Australia are enmeshed today, sometimes wittingly and willingly, sometimes not so. Thus what might begin as a Foucauldian treatment of projected and already-produced "being" speedily metamorphoses into a Deleuzian assay of what such Indigenous populations might "become" rather than just "be". In this Deleuzian regard, then, the manuscript conceivably transmutes into a neovitalist Deleuzian commentary on the states of flux in which postcolonial populations/neo-colonial cultures are ensnared during our vibratile moment "after-colonialism". All told, the manuscript consequently probes for the flows of possibility and plausibility that may lie within the conditions of fluidity and along the contours of mutability under the ongoing effects of the changing and unhinging relationalities of globalisation.

In what follows, discursive understandings of and about matters of the identities and the post-identities of peoples "after-colonialism" will be inspected from three particular fields of vision:

(1) Firstly, they are further examined per medium of Deleuzian thought on *virtual* versus *actual* "being", under the nomadic logic and the generative allegiances of today;

(2) Secondly, they are distilled via Gandhi's perambulation through the complexities of both *the colonial aftermath* and *postcolonial remembering* which have been witnessed over recent decades; and,

(3) Thirdly, they are refined in terms of Venn's insights on the emergent *transmodern and alternative challenges* which the world's postcolonial peoples freshly face today.

Thereafter, an attempt will be made to reflect somewhat more penetratingly upon the specific found condition of Indigenous peoples, per se, today as set against these fissures of the after-colonialism era. This will be carried out:

(1) by initially perusing what *a select collation of Indigenous intellectuals (in Australia)* themselves voice about their varied life-spaces and aspirations today, as deciphered from Grossman's [3] cornerstone edited text *Blacklines: Contemporary Critical Writing by Indigenous Australians* … hereafter referred to as *Blacklines*; and then,

(2) by scrutinising what Dibley and Turner have uncovered about the on the grounded effort of Indigenous groups and communities to work with the government of Australia to establish *a national television service for all Aboriginal peoples* across the dry continent. The Dibley and Turner analysis is important since it covers collaborative efforts to secure enunciative freedom for such seemingly newly enfranchised Indigenous groups and communities as those very endeavours rub up against the larger real-world policies of "nationing" for all manner of things, including television services. The critique of and about Dibley and Turner's treatment of the cross-cultural politics of self-determination and sovereignity thus com-

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poses a deep consideration of what Graham and Penny [4] style as "the applied performance of Indigeneity". Although it is pitched within the media industry here in this paper, it portends much for the projection of the postcolonial condition of "the Indigenous realm" through tourism and related projective industries.

In all these aforesaid (three plus two) five instances, an attempt will be made to translate what is specifically learnt about this and that under the postcolonial imperatives and the neo-colonial impulses being covered to the overall concern for tourism and Tourism Studies. This will be carried out via the provision of five *RUMINATIONS FOR TOURISM/TOURISM STUDIES* reflections as provided within the body of the manuscript.

The word *RUMINATIONS* has been purposely adopted here because Deleuze had a distinct distaste for what was commonly regarded as the proper and established institutional / disciplinary "knowledge" of en groupe specific bodies and associations: what he supported instead was the continued live thinking about all of the supposed "things" / all the supposed "issues" / all the supposed "subjects" that such institutions and disciplines peddled (May [5]). What mattered to him was ongoing alert / vital / viable cogitation, contemplation, and pensiveness about the events and encounters of the world, hence the choice of the word *RUMINATIONS*, here. In a nutshell, to Deleuze, held "knowledges" all too frequently become dogmatic entities themselves, and in that state of obstinate over-certainty they can quickly stifle subsequent reasoning: what has to be cultivated within each body or association is the ongoing practice of deep and assiduous / rich and responsive "thought".

2. New Vistas on the Ontology of "Identity": Deleuze and Interrelationality

Let attention now be turned to the first of the aforementioned three start-up vistas over postcolonialism/neo-colonialism. At this early stage in the exposition of the reasoning uncovered in this paper, it is thus useful to dwell a little further on some platform Deleuzian insights on matters of "identity" for people today. Indeed Deleuze himself works to an ontology of and about life that does *not* indeed privilege identity, per se. To him, what really counts is not only the difference between people and the difference between things, it is pointedly the never-fully-fixed/never-completely-sure difference between people/people and (in like fashion) the difference between things/things that matters. To him, advancing ideas as first put forward by his co-researcher the psychotherapist Guattari (see Dosse [6]), identities are too readily deemed in almost all (in veritably all?) fields to be set and secure codes of understanding that are articulated within rather concrete and structured forms of stratification and bureaucratization. To him, identities tend to be overdetermined ascriptions of being. They tend to be accepted axiomatically by routine-loving institutions: they tend to be propelled within interest group doxa without sufficient forethought. In these regards, they are *molar* in the sense of the tangible, the specific, and the calcified, but (to repeat the point) they are inclined all-too-frequently to be overdetermined. To Deleuze, understandings of identity ought to be held in a more hesitant fashion in order to account for what is increasingly (these days) the disjunctive features of both our emergent "ascriptions of identity" and our unfolding "associations of being". In this regard, interpretations of identity and being ought to tune into the flow of contemporary life with all of its starts and stops, its accelerated influences, and its failed as well as its hailed intricacies within the era after the summit of colonialism. To Deleuze, master-signifying "identities" are rather troublesome understandings to invest in therefore, and attractions of difference ought be thereby deemed to be *molecular* (thus related to influences of flow and flux) rather than "molar" (and thus be heavily and concretely structured).

Following Deleuze, this manuscript is predicated upon the view that primacy should be given not to "identity" per se, then, but rather to the interpretation of influences of or acts of "becoming", that is, to matters of association and aspiration that are continually being created and thus never reaching a or any state of completeness. Hence to Deleuze, matters of becoming are always *in process*, and social scientists thereby need new vistas for registering how people actually belong, where, and to and with whom, when. In this Nietzschean regard, such Deleuzian vistas compose not only new ways of seeing life and the world, but new ways of thinking about life and the world, and thereby importantly help discover and invent *new possibilities of life* (Deleuze [7]), especially under the new connectivities of postcolonial/neo-colonial existence.

Such new vistas of and for thinking consonantly tend to refuse fixity, and are *rhizomatic* in that they seek to register the associations and connections that "people" have, that "things" have, and that even "ideas" have, which crop up randomly and uncertainly, but which have no readily-traceable origin cum beginning and no readily-predictable goal cum endpoint. Rhizomatic understandings built upon changeable molecular frames of reference thus tend to admit multiple connections of belonging from a variety of Deleuzian perspectives of becoming (May [8]). And while it is difficult and somewhat

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unwise to try and develop comprehensive understanding about these nuanced matters of "difference" under the vicissitudes of life after the suzerainity of colonialism, it is healthy and productive to cultivate richer and deeper thought about them per medium of increasingly-relevant (but again, never absolute nor complete) *palpation* about them. Under Deleuzean thoughtlines, it is "palpation" rather than dogmatic comprehension we require where our efforts to understand any matter of being or becoming inevitably touches upon that which cannot be directly perceived nor promptly discerned. Palpation is thus the serious effort to gradually gain suspected or subtle insight into angles or aspects of difference which might have eluded the theoretical grasp of our existing registers of knowing (May [9]).

Hence, these Deleuzian interpretations of identity - or rather, these insights into our changeable molecular ties of "belonging" and "becoming" - are both Guattarian and Nietzschean in spirit. But they also Spinozean in character is that they seek to account for the ways in which the differences between people (and the differences between things, and the differences between ideas) importantly "fold", "unfold", and "refold". Thus, such differences may then be seen to be "substantive" in the Spinozean sense where substance is not that which is fixed/concrete/transcendent in the normal meaning of the term but that which is labile/expressive/immanent (see the Deleuzian and Spinozean concept of "immanence" in Deleuze [10]). Consonantly, the Deleuzian ascription of difference composes an ontology that celebrates not only *the real* (i.e., what loosely could be termed "the really-real") it also celebrates *the possible* (i.e., what loosely could be termed "the possibly-real"). Put another way, the real is *the actual* to Deleuze, and the possible is *the virtual* to him where it exists in terms of its potential effects. Hence, while the virtual is not actual (or it would be "actual"), it can itself be actualised in order to changeably fold, unfold or refold via its molecular connectivities into something (or into somethings) expressive and immanent.

To recap, Deleuze's commitment was to the teeming immanence of folded/unfolded/refolded "changing things" in opposition to orthodox views on the elemental substance and secure transcendence of "constant things" (Deleuze [11]). To him what counts is not so much the known factuality of heralded subjects and objects but the fresh/fecund/fertile *possibility* of new and unheralded relations between fluid and fluctuating forces whatever they are rhizomatically, wherever they have come from rhizomatically, and wherever they are folding towards rhizomatically. Thus Deleuze may be interpreted as an observer of inconstancy, an imaginative thinker about oscillation. He is a philosopher of the shifts and swings of not mere "relationality" perhaps (for that might take us back too strongly towards substance and transcendence), but to the hesitating and vacillating *interrelationality* of the dynamic rhizomatic forces in and of life between "people", "things", and "ideas". His interest is not so much in stable entities but in the rich potency of life and of the momentum that might occur consequent to a particular (but not so predictable) "event" or molecular "confluence" at any moment. And so, to Deleuze, the postcolonial period is no singular age divorced from colonialism or from a or any much later era of "after-colonialism". To him, it is something of a flaccid and scarecely discernable rhizomatic "event" that is interrelational both with that supposed past and that supposed future. Such is Deleuzian temporality, where he prefers to see time not as something linear and predictable, but something rhizomatic: and he labels this version of dynamic time as "duration".

2.1 Rumination upon Tourism: Deleuzean Ontologies of / about the Responsive / Creative (Generative) Agency of Tourism

And so, under the vicissitudes of postcolonialism/neo-colonialism, how connective is a found or encountered population with other populations, how multidirectional is its culture/its spirituality/its environmental-awareness with those of other populations? And so, in the past-impressed-present and in the future-incited-present, what role does or can tourism play in either promoting richer interrelationality between populations, or in otherwise enabling an inflow of fresh and empowering imagination as to how life might indeed be lived "there"? Such is Deleuzian ontology: an ontology of and about the process of continual creation - an interpretation of "how might life [connectively] go" and "how one might [fruitfully] live" (May [12]). It is thus an important role for those who work in tourism to reveal/to present/to project the different durations of different peoples, and under the strengthening posthumanist impulses of "today", the durations of particular landscapes/particular ideas. While Aldo Leopold [13] might famously have wanted us to learn to "think like a mountain" in order to gauge our connective place in the world, Deleuze appears to want us to know where a mountain may be rhizomatically journeying to and in molecular association with whom and what.

3. Background: The Discourse of Colonialism and Its Aftermath

So far in this manuscript, Deleuzian understandings have

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been introduced about the discursive articulations of belonging and becoming which are gaining ascendancy in the social sciences/humanities over older orthodoxies of identity and being. Having thereby accounted (per medium of Deleuze) for the states of nomadic flux that characterises so much emergent subjectivity today, it is now helpful to specifically inspect what tends to be hailed with the postcolonial/neo-colonial (or "after-colonialism") discourses of our moment. This endeavour will be approached by means of the provision of:

(1) a short depiction of some of the principal issues involved in postcolonial attempts to escape from the infections of colonialism, duly catalysed by the work Gandhi [14]; and,

(2) a short distillation of some of the principal fresh (?) and liberated (?) futures which are seemingly on the horizon for so called "postcolonial populations", duly catalysed by the work of Venn [15].

3.1 The Discourse of Postcolonialism: Gandhi and the Colonial Aftermath

To Gandhi [16], postcolonialism is something of a transitional and transitory moment in which groups/communities and organisations/states seek to escape the universalising geography of empire and the representational violence of colonial discourse. Under colonialism, a contiguity had seemingly existed between Western forms of knowledge and colonial power, and if a brief reification is permitted, *colonialism expected everything to come from itself* (Gandhi [17]). To her, under the new rhetorics of futurity of postcolonialism, attempts are made here and there across the world nowadays to engage in many new sorts of negotiation as the values of the non-West are more pointedly addressed and new-old and new-new knowledge systems and counter-narratives of the colonised are correctively or remedially encouraged. The suzerainity of (largely) Western hierarchies of understanding are under ongoing challenge.

To Gandhi [18], then, postcolonialism is an era where bodies and institutions of many sorts have to allow for more complex understandings about being and seeing as the touchy politics of "knowing the other" is increasingly turned to. Under postcolonialism, the positional superiority of Western consciousness is growingly challenged via new-old and new-new imaginative anxieties, and as various attempts are made across the continents to imagine particular counter-textualities to the sorts of eurocentrisms experienced under colonialism. But postcolonialism is-proving-to-be a difficult psychic and discursive time according to Gandhi, for supposedly enfranchised groups and communities find it impossible to return to what could have been their pre-colonial contours and conditions, and ruling bodies within supposedly liberated states face all kinds of turmoil to legitimate reclaimed or unravelled fictions of nationhood or recaptured visions of tribalhood / peoplehood.

Generally, Gandhi considers that postcolonialism is ostensibly a celebrated moment of "arrival" for many populations who profess or exhibit a postcolonial amnesia and a strong desire to escape from "their" colonial past and largely denounce "European" myths of progress and humanism as they recover "their" own sense of being. But Gandhi judges that the sought therapeutic retrieval of old customary ways and the new-state self-invention of a historically informed en groupe identity are both very difficult things to secure, and most postcolonial settings are typified by the confusing noise of an often unpleasant babel of loudly contending voices (Ghandhi [19]). In this regards, the so called postcolonial period may readily be interpreted by many as just "a disappointing colonial aftermath" in which many ties of "unfreedom" persist, in which much "dreadful secondariness" (after Said [20]) is still experienced, and in which many residual traces of neo-colonial subordination indeed endure. Thus, to Gandhi, the so called postcolonial era proves to a continued time of stress for many supposedly disenthralled peoples, who cannot fast escape the perverse mutualities of colonialism, nor the spectrum of many kinds of ambivalent relationships with former colonising countries and organisations. And all too commonly, in her view, some of the emergent national "governing classes" who hold new power in postcolonial states are seen to act as self-interested and hardline "associated sector" elites who decidedly favour their own economic and material *sectional advancement* with dubious regard to the concerns and benefits of those overall peoples whom they come to govern.

In Gandhi's assessment, considerable debate exists around the world as to whether, after-colonialism, colonised territories can readily effectively restyle themselves as postcolonial nation states, and indeed whether such "national" effort is even desirable. Here and there across the world, dispersed and dislocated populations still exist (after many of the ties of colonialism have fragmented). But these peoples/these subjects resist ready enclosure within the ideological apparatuses that colonialism has bequeathed/is bequeathing to the world. To Gandhi, the inspirations and the impairments of nationalism and of nation-ness are Western-cum-European hand-me-downs, yet many supposedly liberated populations (after-colonialism) adopt a mimetic articulation towards such erstwhile European concepts of civility and

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the reputedly anti-colonial character of group and communal belonging often slides or stutters into fanatical but equivocal versions of the disliked/detested European-style *nationalist* legacy. To Gandhi [21], then - following Fanon [22] - there is not only "an imaginative lethargy" within the sterile conformities of so many of these new "national" governments, there is also (drawing from Soyinka [23]) a similar academic shortfall of conceptuality across the social sciences in characterising the new state assemblages of our time.

3.2 Rumination upon Tourism: Ghandhian Ontologies of / about the Continued Eurocentric Dogmatisms of Tourism

To Gandhi [24], then, the overriding danger is that theory about postcolonialism has too comfortably arisen within Western formulations of culture and being. Like Ashcroft et al. [25], she recognises that all postcolonial projections and inscriptions are unavoidably complex: they are ineluctably hybridised. In tourism - following her entreaties - we just therefore need much more sustained rigorous reflection upon these situationally-idiosyncratic transmogrified aspirations and transmuted affinities which tourism bodies and organisations necessarily have to project, propel, and perform in everyday but cumulative fashion. In her vision, such is the current state of the half-visible dynamics of our contemporary ruptured processes of becoming. And in all of this, how eurocentric is the tourism industry today? Is it still a field replete with "powerful professional ethnocentrics" who tend to be blind to (and rather uninterested in) the deeper cultural warrants of other/distant/remote populations, as Hollinshead [26-29]) has so often claimed?

3.3 The Discourse of Postcolonialism: Venn and Compossible Action

Venn [30] is another social scientist who has reflected generally upon the vicissitudes of the so called aftermath of colonialism. Gandhi had drawn out salient connections between understandings about postcolonialism and intellectual debates about poststructuralism, postmodernism, Marxism and feminism, and had covered the subject by substantive reference to lead thinkers such as Said, Spivak, Bhabha and Fanon (Gandhi [31]). In contrast, Venn was inclined to search for *liberated forms of collaborative thinking and action* that may-have-evolved/may-be-evolving under the postcolonialism. Like Gandhi, Venn has welcomed the attention given at the start of the twenty-first century to concerns of "identity" as an object of conceptual consideration, and as a site of new grounds for imagining within and via fresh non-eurocentric forms of enlightenment. In examining the dissonances / reconfigurations / limitations / usurpations of postcolonialism, Venn has sought to craft a deep and critical "postcolonality" which potently theorises about the role and function of the self, and which inspects the late performativities of postcolonialism.

In probing the changing knowledge hegemonies of and under postcolonialism, Venn's theorisations explore the governmentalities that string-pull local and international action nowadays after the ontological, epistemological, and ethical violences of Western-cum-European structures and values have conceivably or expectantly begun to be slowly dismantled *after-colonialism* (although he too does not use this specific term). In probing the degree to which the iron-cage of received north-atlantic / eurocentric mindsets still hang over so called postcolonial settings today, Venn [32] addresses the extent to which that closed colonial thinking eliminated/is-still-denying *alternative ways of life* under the aftermath of colonialism. He searches for postcolonial scenarios where the presence or the shadow of the national, unitary, solipsistic subject still lingers "there" in the found place. He compares such scenarios to those other sites and settings where both the old legitimations of *precolonial* being and the entrant legitimations of *colonial-being* have crumbled, and thereby where there conceivably is today a relative absence of ruling "traditionality".

In all of this distillation of the changing ways of being and belonging, Venn's distinct contribution to knowledge about the aftermath of colonialism and for postcolonialism revolves around issues of *coarticulated development*. In condemning the failure of theorists of culture and identity to generally appreciate the potential for both the co-articulated material development of things *and* the coarticulated projected communication for things, Venn suggests that Western / eurocentric thinking in the academy still submits itself almost ubiquitously to the protracted paramountcy of positivism. He bemoans the commonplace attention accorded to the distinct/separate/singular entity with its own supposed agency or influence. Hence, Venn is substantively alert to the logic of the new economical orders that might appear in postcolonial/decolonised settings where fresh interlocking networks of the economy with different dynamisms of "the social", "the cultural", "the political", et cetera, might interactively arise (Venn [33]). In evaluating such new intersubjective reticulations of action and/or communication, Venn celebrates not just the under-realised possibilities of intertwinement but the veritable *compossibilities of* such strategic meshwork. To Venn, those on the ground who recognise the value and

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even the necessity of such compossible activity tend to invest consciously and interactively in substantively-embodied "relations" and in hopefully mutually-rewarding "experiences" with important other bodies/interest groups/populations (Venn [34]). And thus, to him, *scheming through compossibility* is a set of deliberate actions that are predicated for such bodies upon a diagrammatic representation of possible future worlds duly translated into and via the cultivation of manifest-to-latent strategic "relationships".

3.4 Rumination upon tourism: Vennian Ontologies of / about the Regular Failure in and through Tourism of Industry-leaders to Recognise the Alternative and the Compossible Visions of so Called "other" People and their Cherished Places

Although, Venn scarcely mentions the word "tourism" in his critique, his insights on the under-recognised potential of compossible action are very tall for the industry and field. To some degree, tourism is a misrecognised domain, a field that is too frequently over-labelled by many outside observers as just an inconsequential realm of travel and leisure. Interest groups and institutions in tourism can fruitfully deploy Venn's encouragement towards "alternative possible futures" and towards "compossible multiplicative relationships" to link the tourisms they cover in more deliberately and concertedly with other industries and with other registers of being and becoming. Tourism can play fresh and large roles in the emplotment of new storylines of aspiration and becoming, and in new Vennian configurations, deconfigurations, and reconfigurations of identificatory being or Deleuzian trajectories of becoming. One could readily argue that there are too many veils of ignorance about what is achievable through the development of tourism opportunities and through the related broadcast of corrective narratives of unexercised storylines. Just as in the arts, in film, in television, and in the media, tourism can invoke that which is locally fresh, that which is locally untapped or inactive, and that which is locally abeyance or unconsumed.

Thus, in worldmaking terms (after Hollinshead [35,36] and Hollinshead and Suleman [37]), tourism potentially constitutes what (Venn [38]) might call as an immense metaphoric site of "presentation", a site or space where the already-oriented eye of potential inbound travellers and existing locals/residents can be strategically or tactically "reoriented". It thus has a sizeable "alternative possible futures" productive role in meaning-making and in legitimising old-old/new-old narratives. And it has powerful and responsible capacities to inscribe and project new sorts of understanding about that which has been othered under colonialism, and/or which is still-othered under its aftermath. And, in the domain of Tourism Studies, Bertella, Fumagalli, and Williams-Grey [39] have indeed got this message. See their recent article in Tourism Recreation Research *on such target reciprocities where wild animals are envisioned as "co-creators" in wildlife tourism. This set of authors do not seem to have read Venn ipso facto, though, having taken their own stimulus on collaborative action and compossible "development" from Ind and Coates [40], instead.*

4. Matters of Voice: Emergent Indigenous Intellectuals Speak Across Australia

Having provided foundational coverage of paramount "colonial" and "neo-colonial" / "postcolonial" outlooks on matters of identity and being/becoming today, it is now useful to concentrate more certainly upon substantive issues of decolonisation and after-colonisation as they are experienced in a particular place. For this purpose, attention will now be turned to the nation cum continent of Australia and to Grossman's [41] edited text *Blacklines: Contemporary Critical Writing by Indigenous Australians* … hereafter called *Blacklines*. In this sixteen chapter Melbourne University work, Grossman attempts to assemble for the first time a pool of leading Indigenous intellectuals - that is, a virtual cohort of well-respected Aboriginal thinkers who are highly-saluted internally within Aboriginal communities and institutions across Australia - in order to capture their present-day views on Indigenous concerns of history, identity, and representation. The Grossman collation is consonantly an attempt to corral what a number of Indigenous intellectuals say about the culture and knowledge of Aboriginal populations across Australia per both national and global outlooks. As its coordinating editor (Michele Grossman, herself) suggests, the very width of it presents a critical mass of Indigenous voices that mark a definitive or otherwise significant moment of "production" for Indigenous people (♦ Grossman [42]). [*Nota Bene*: Chapters from the individual contributors to the *Blacklines* collection, itself, are hereafter marked as ♦ within this manuscript here in the *Journal of Geographical Research*.]

The *Blacklines* text, itself, makes no claims to be fully representative of the perspectives of all Indigenous people in Australia. It does, however, comprise a collective work of sapient Indigenous commentators who have been selected *domestically* to help non-Indigenous Australians (and to help non-Indigenous outsiders *in-*

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ternationally) recognise many of the ways in which the Indigenous peoples of Australia have been misperceived and misrepresented over the last two centuries or more. They were also selected to help stimulate the restoration of Indigenous agency in effective declarations of seeing and being. The publication is a large collective testimony to the kaleidoscope of contemporary "postcolonial" responses of and amongst intellectual Indigenous "Australians". As ♦ Sonja Kurtzer [43] points out, it has generally been the colonial oppressor who has even defined *Aboriginality*, itself, and the bodyweight of hegemonic views that tend to name it under these succeeding years of protracted-colonial power and neo-colonial impulse continue to largely encapsulate the fears and desires of such "outside oppressors" rather than of "Aboriginal" peoples, themselves.

The sixteen chapters of *Blacklines* were not specifically commissioned up-front to comprise a or any fresh volume (but they rather compose a pool of Indigenous essays each of which had already appeared in a specialist journal or other, elsewhere). They are envisioned by ♦ Philip Morrissey [44], however - in his "Afterword" to the book - as providing something of a unity in terms of cardinal "hypostases of difference, distinction, and disagreement" as they sing-the-place of Indigenous "Australians" today, and as they thereby shake the firmament of fixed extrinsic representations of and about Indigeneity. But how that term "*nation-status bestowing*" *term* "Australian" is a difficult (and inherently "political") word to deploy vis-à-vis the concerns of the primal populations of the dry continent!

Thus, one may perceive the Grossman text as a finely interweaved collection that critically voices up/voices out Indigenous worldviews today vis-a-vis issues of identity, history, and knowledge. Any non-Indigenous individual or non-Indigenous institution that wishes to know what contemporary Indigenous intellectuals think about such concerns of inheritance and aspiration should note that the Indigenous intellectuals who contribute to *Blacklines* tend to argue that:

(1) Aboriginality, itself, is no firm and totally stabilised entity;

(2) hegemonic "Western" textual representations are still inclined to define (in mainstream society) what is taken to be *authentically Aboriginal*;

(3) considerable care needs to be taken in terms of who can speak when and where on Indigenous matters;

(4) there is never any single "Aboriginal view" on any subject;

(5) the right to creatively de- or re-project Aboriginal being or becoming must be self-defined;

(6) the emergent conventions of art production - a very important sphere of spiritual and associative activity for Indigenous Australians - are much more flexuous and pliant than most non-Indigenous people would currently imagine;

(7) many strong external misrepresentations of Aboriginality today were not just monumental in the past, but actually remain "towering misapprehensions" today;

(8) many strong *external* projections of Aboriginality today remain fixated only upon what is perceived to be "strange and alien" to such outside observers yet also "enchanting and tantalizing" to them: they do not so much attend upon what is "ordinary" to them or what is similar to the life of such mainstream non-Aboriginal persons;

(9) many of the genuine and veritable Indigenous ways of seeing and celebrating the world remain some distance beyond the received scope and current discernment of so many influential non-Indigenous individuals and institutions; and that

(10) Aboriginality, itself, is not (to Indigenous "Australians") restrictively and exhaustively a matter of *physical* heredity nor impeccable *ancestral* consanguinity.

Such is what ♦ Philip Morrissey [45] considers to be the interweaved critical grasp cum collective sense of the *Blacklines* compilation. The Grossman text is a work which shows how non-Indigenous observers who deal with Indigenous groups and communities will face ongoing difficulties if they do not come to terms with the acute contextualities by and through which Aboriginal populations and organisations proclaim themselves. He notes that they might sometimes wish to speak via a "One Mob/One Voice/One Land" singular perspective (as is for instance conveyed via the embrace-all logo of the national Aboriginal newspaper *Land Rights News* (see Central Land Council, [46]). But he immediately reminds that (at other times), they might wish to fashion in new *highly-particular* en groupe "communal" fragmented ways and *highly-differential* fragmented means the received but variegated Aboriginal songlines and inheritances (♦ Lin Onus [47]) where there is evidentially no such felt "absolute cosmological unity" across the nation (i.e., across *Indigenous humanity* over the continent).

All told, the fifteen Indigenous intellectuals who were brought virtually together in *Blacklines* provide a litany of compelling arguments around the historical and contemporary concerns facing Indigenous Australians today. As ♦ Michael Dodson [48] neatly summarises it for this supposedly postcolonial moment, Aboriginal people seek to engage in "the repossession of our past [and thereby indulge in] the repossession of ourselves". The contributions to *Blacklines* thereby are advocations of steady

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transition built upon informed but exhilarative notions of tradition. As ♦ Michael Dodson [49, emphasis added] usefully states it: "Our peoples [in the past] have left us deep roots of survival, *but not of constriction*. They are the roots from which all growth is possible." Accordingly, none of the *Blacklines* contributors appears to be close-minded sustainers of hardline cultural or adamantine cosmological insularity. Indeed ♦ Hetti Perkins bemoans the fact that - in her view, especially within art - non-Indigenous observers all-too-regularly fail to appreciate the interactivity which Aboriginal people actually seek to have with others (i.e., with non-Aboriginal people). She cites Stratton's [50] view of "the ethnocidal tendencies of colonialist capitalism [which inherently appears to seek] the destruction of Indigenous cultures through Western impact [as it] excludes … the recognition of [Indigenous] culture as dynamic and [of] the transformation of cultures through [collaborative] *interaction*" (Perkins [51, emphasis added]).

In significant ways, then, the conglomerate contributors to *Blacklines* here and there echo some of the ideas about postcolonial / neocolonial discourse that have already been raised in this manuscript in the *Journal of Geographical Research*. When ♦ Philip Morrissey [52] queries whether the knowledge of settler populations and Indigenous People can harmoniously and proactively ever anywhere inhabit the same fields at study or consiliently and fruitfully grace the same arenas of activity together, one is reminded of the accent that Deleuze puts on "events" which rhizomatically mesh together different ideas/different forces/different people. One is reminded of the Deleuzian uncovering of scenarios where what might have previously seemed to be quite dissimilar ontologies can actually entangle to generate new forms of admixed being-in-the-making (i.e., new "becomings") and new possibilities for experiencing life. And to Deleuze, these new beings-in-the-making might flourish upon not only different but unanticipated plateaus of sensation (see Deleuze and Guattari [53]), here, on the infinite plateaus of our time, and indeed of any time). Thus, Philip Morrissey could be deemed to be rather Deleuzian in his call for richer dialogue by Aboriginal people with "others" (i.e., with non-Aboriginal people) and thereby through such not always predictable fresh events of folded/refolded engagement.

When ♦ Marcia Langton [54]) laments the fact that so many non-Indigenous people who come into contact with "Aboriginal affairs" find it difficult to deal with Aboriginal people (generally finding the communications to be just too hard, confusing, on disorientating), one is reminded of Gandhi's [55] search for "postcolonial" models for living. Gandhi's quest was for cominglings which empower different peoples to flourish alongside each other more respectfully where they might indeed have had the opportunity to get to "know" respective cultural difference rather more deferentially. In ♦ Marcia Langton's [56, emphasis added] view "the central problem [under this so called postcolonial age] is the failure of non-Aboriginals to comprehend us Aboriginal people, or to find the grounds for a [mutual] understanding. Each policy - [for instance, policies of] protection, assimilation, integration, self- management, self-determination, and perhaps reconciliation - can be [such kneejerk] *ways of avoiding understanding.*" And this reverberates with Gandhi's [57] call for postnational readings of the colonial encounter which privilege "the global amalgam of cultures". It tallies with those interpretations which positively celebrate "the mutual contagion and subtle intimacies between coloniser and colonised" rather than continually cultivating imposed bureaucratic regimes/ patriarchal policies which force "the colonised world" of suppressed populations to perpetually submit to forms of cultural transformation and to the broad momentum of *nationalist* (i.e., oh dear, that troublesome "nation-making" word, again!!) governance.

Rumination upon Tourism: Indigenous Ontologies of / about the Received Traditional Inheritances and the Experienced Transitional Experiences - as Faithfully / Potentially Captured (or not) through the Projections of Tourism

And tourism will clearly be imbricated in and across all of these sensibilities over the other and the hyphen regarding Indigenous "Australia" (see Huggan [58] on tourism and hyphenated "being", today). In such zones of precious and life-sustaining sensibility, the inscriptive/ projective agency of tourism is an important powerful tool, and one which clearly needs considerable creative thought-processing behind its deployment. Given the identifactory vicissitudes underlined in Blacklines, those who work in a vivid representational field like tourism (Salazar [59]) must be ever-vigilant to not only assimilative and exploitative traditions of the industry, but to those of research institutions too. What the collective commentators of the Grossman enchiridion (or chrestomathy) on decolonisation implicitly instructs those in tourism/Tourism Studies - who wade into the wildlands and the murky waters of global-postcolonial identification - is that each and every industry (like tourism) and each and every research domain (like Tourism Studies) can never be a neutral force for unmediated knowing. The pool of Indigenous commentators in Blacklines

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collectively suggests that currently such industries fast-function as potent handmaidens of mainstream knowledge and/or heavily-commodified ideation.

Tourism has its structures, its codes, its heritages, its industrial predilections, and its research-fold disruptions, and all of them are loaded with the potentials for mis-identification and misrepresentation (Kishenblatt-Gimblett [60]; Hollinshead [61]; McKay [62]; Hollinshead and Suleman [63]). But tourism and Tourism Studies also stand as a mighty vehicle (or as mighty vehicles, plural) for the articulation of new and unthought Vennian possibilities for previously-colonised/still-colonised peoples and their revered places and spaces. In reading what the Blacklines commentators say about the meditative role of industries and services in the connective or emergent declaration of populations and their honoured territories, one may judge that tourism indeed has a crucial role to play in the representational mediations and the de-mediations of the twenty-first century. As the sixteen Indigenous contributions to Grossman make clear, no one can ever map out a step-by-step process to guide these society-declaring/society-destroying dialectical relations, but they will conceivably be representationally-pivotal as they will be for other inscriptive or enunciatory industries (refer, here, to Fine, Tuck, and Zeller-Berkman [64] on the power of "awakening" via dialectical others).

5. Caveat: Indigeneity and the Complex Processes of Becoming

In recent years, Hollinshead has defined compossibility for the field of Tourism Studies and related subjects in a number of workshop presentations across the continents for The International Critical Tourism Studies "Network", but not too many researchers nor practitioners have yet run far with the concept. Perhaps the nearest other co-creationist which the domain of Tourism Studies has spawned (other than the aforementioned Bertella, Fumagalli, and Williams-Grey) comes with the special issue of the *Journal of Teaching in Travel and Tourism* in early 2019. In their editorial for this volume, Paddison, Hockert, and Crossley [65] address the worldmaking function of tourism - refer to Hollinshead [66-68] on "worldmaking", ipso facto - and they pointedly call for *enhanced co-creative activity* in both Tourism "Studies" and Tourism "Practice". While their focus is pitched within the relatively contained arena of "storytelling" in and through tourism, Paddison, Hockert, and Crossley do recognise the need for those involved in tourism to sincerely and strategically engage with "the experiences of [relevant/situational] others". They acknowledge the longterm gains which can accrue from co-creating "new alternative stories" with other interest groups, other sanctioning institutions, and other aroused populations. Leibniz - the late seventeenth century German advocate of and for compossibility - would clearly be pleased to note their recommended sallies into such complicitous action (even if, in their 2019 editorial, they offer no explicit references to "God" that his own philosophical orientation would have demanded!)). And Deleuze would clearly be laudatory about their efforts to think beyond the bounds of the organisations/the ontologies/the over-stories which are resident within their own life and work purlieux (see Deleuze and Guattari [69]). As Deleuze and Guattari [70] state it - where Deleuze was himself an ardent interpreter of Liebniz's compossibilist notion of the problem of "future contingency" - philosophy only begins "to think" and life can only really be amply "lived" once it (philosophy) and it (life) can each step away from received and ultra-orthodox images of mind, reason, and humanity.

In order to critique the operational practicalities of being seriously collaborative and manifestly compossible - and thereby render the subject contextually germane for this manuscript - attention will now be turned to Dibley and Turner's [71] inspection of the cultural production and consumption of "Indigeneity". They focus upon the act of compossibility vis-a-vis *the everyday nationing of Australia*: see Rowe, Turner and Waterton [72] for an explanation of "nationing" in terms of the banalities of nation-formation/nation-building/cultural nationalism, per se. One may regard the Dibley and Turner depiction of the travails of the National Indigenous Television Network as a Vennian attempt to secure *alternative possibilities and modernities* in the scripting and projection of Indigenous culture via partner agencies and other implicated bodies. But, as Dibley and Turner inherently reveal, such Vennian acts of compossibility (i.e., such Deleuzean acts of live and continued "responsive" thinking) are troublesome and prospectively contestable on the ground, within such mundane realworld settings. Dibley and Turner show how in the contemporary climate of schematised nationing across "postcolonial-Australia", a satiety of interest-group imperatives and a plethora of commercial motives have to be negotiated. They maintain that this requirement for vigilance applies "even within the context of a publically-funded broadcasting organisation, [and] can frustrate and complicate what are self-evidently worthwhile initiatives [of collaborative action]" (see Rowe, Turner, and Waterton's [73]) introduction to the work of Dibley and Turner on the projection of Indigeneity vis-à-vis the cultivation of *na-*

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tionness). Thus the critique of Dibley and Turner shows how efforts to develop an Indigenous television network that is replete with a sufficiency of Indigenous content but which also reflects both Aboriginal and broad mainstream-Australian interests, is confronted by a host of operational challenges, some of which are generally edificial or architectural within-the-industry and others of which are particular-to-each-involved-institution.

Thus, in the development of the National Indigenous Television Network in Australia under the postcolonial moment, the positioning of the fledgling Indigenous Network in television is a complex cultural and political matter. The task of providing an identifiable service for Indigenous groups and communities rubs up against the coterminous task of fulfilling wider "nationing" responsibilities. Representational decisions over "inclusion" chafe against the accountabilities faced by the-particular-partner/other-bodies. The imperative to faithfully and consistently produce programmes which richly reflect the Indigenous inheritance (or inheritances) grates against the governing remit for all television companies to maintain high audience numbers across the whole nation (refer Dibley and Turner [74]).

5.1 Rumination upon Tourism: Emergent Deleuzean Ontologies of / about the Role of Tourism in Echoing Other Projective Industries in Making and Maintaining "Nations", per se

Just as difficulties exist in the media industries between the local scale of the communication requirements of Indigenous populations and national/international policy-making scale in Australia, so problems have occurred between the smaller level interests of the cultural politics of Indigenous tourism and broader "nationing" interests. Drawing on Whitford and Ruhanen [75], Gibson notes that

government policies continue to position cultural tourism as an instrument for sustaining Indigenous communities [across Australia and as] a panacea for socio-economic disadvantage in remote communities. Yet, they invariably rest on [mere] rhetoric rather than [concrete] substance - [that is, upon] policies that lack the rigour and depth to realise any legitimate moves towards achieving sustainable tourism development for Indigenous peoples. [76]

It seems that under our continuing postcolonial/neo-colonial moment, the tourism industry of Australia indeed mirrors the television and media industry with its commonplace breaches of service as it seeks to admix its regard for "due cultural care" with its "commercial nous" while endeavours to decently pitch and properly position what Altman [77] calls its hybrid economic institutions.

6. Summary: Negative Capability on and Around Postidentity

In this manuscript, no attempt has been made to provide any macro-theory on postcolonialism/neo-colonialism, nor any effort to yield any grand-theory on the representation of Indigeneity via tourism under the apparent moment of after-colonialism. In principally working via a Deleuzian ontology, the aim has *not* been to provide full and dangerously-dogmatic answers to who is doing what to whom during our conceivable postcolonial moment. It has rather been to unsettle some held commonplaces about the role and function of tourism as an industrial inscriptive force which is entrusted with the task of revealing this and that about (at the end of this paper) the projection of Indigenous "Australia" under the nomadic logic of "our time". Hence, the Deleuzian ideas in this paper offer a view of both tourism"/"Tourism Studies" and of "Indigenous Australia" as living and fluid things which each fold, de-fold, and re-fold in increasingly unpredictable ways while being buffeted by other rhizomatic forces of many different sorts. This article has thereby not explicitly been an account of Aboriginal being as projected through tourism, it is more a flirtation with matters of *Aboriginal becoming* as Indigenous "Australians" dream forward (under their own agency/agencies) but also as they have much dreaming done for them under proxy by the powerbrokers of tourism. Thus, this manuscript (on both the generative thresholds of tourism and on the debilitating hindrances of tourism) is not so much a clean and clear designatory assessment of Indigenous identity today. It stands more as a nuanced Deleuzian text on the foggy lines of flight which may be commonly encountered in-our-time both within Indigenous "Australia" and through the governmentalities of tourism and its related inscriptive industries. Hence, the manuscript has its lacunae as one might expect as it traverses Gandhian uncertainties as to whether there is indeed any bona fide postcolonial age as such, and as it peregrinates round and about Vennian ideas on alternative (com)possible futures. It has thereby been a text on Deleuzean ambiguities and ambivalences rather than one on precise field or disciplinary pellucidity.

In these regards, this manuscript has been composed with what Keats (in yesteryear, when examining the expressive achievements of Shakespeare) called "Negative Capability" - a phenomenon borrowed by and succinctly explained by (Tim) Smith-Laing [78] in his own present-day critique of (Emma) Smith's [79] recent text *This is Shakespeare*. According to Smith-Laing, Keats accorded the brilliance of Shakespeare to his (i.e., to the

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dramatist from Stratford-on-Avon) subtle but perduring competency at communicating ideas to think by while still remaining content to deal in uncertainties, enigmas, and perplexities rather than in exact fact and fastidious reasoning. And how Deleuze would applaud such *negative capability*, whether it be within Shakespeare (himself), in Keats (his analyst from yesteryear) or in Smith (his scrutiniser today). Accordingly, then, this paper here in the *Journal of Geographical Research* on the generative thresholds of tourism, has not been adulterated by what (Emma) Smith [80] might positively call (in her own domain of interest) its "[deliberate] gappiness" it has creatively empowered by that generative concaveness. In this Deleuzean light, in our so called era of after-colonialism, readers in Tourism Studies (and in related fields inspecting acts of projection and agencies of aspiration and belonging) should have much of relevance and provocation to chaw and chomp on. One hopes that they can ruminate just where and when hard identities end and soft postidentities start, but they can simultaneously judge why such identities so often *necessarily* do so in ambiguously and ambivalently fashion.

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ARTICLE

Climate Change Management Strategies to Handle and Cope with Extreme Weather and Climate Events

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ABSTRACT

Increasing the concentration of greenhouse gases causes rising in global warming and carbon dioxide emissions. With further efforts to reduce carbon dioxide, it is possible to prevent the warming of the earth, but the effects of climate change that we have already created can not be reduced. Recent observed and predicted alterations in the global climate require a double policy to react to the decline in climate alteration and its adjustment (coexistence) to explain the key factors and their effects. Measures to reduce climate alteration through decreasing greenhouse gas releases or removing them from the atmosphere are possible. Execution of more reduction measures at the present time will require less adaptation in the future. Meanwhile, inadequate measures to curb climate change presently increase the risk of catastrophic consequences, so that adjustment costs will rise unreasonably and adaptive capacity will face further constraints. Climate change adaptation measures concentrate in increasing our capability to deal with or prevent damaging effects or the use of new circumstances. Increasing temperature and changes visible today due to climate change mean that adaptation strategies should be applied. In this paper, strategies for reducing climate change and adaptation are reviewed and various strategies are presented. Meanwhile, this paper looks at the economies affected by climate change, our involvement to climate alteration, and the ways in which the economy has influenced climate change and the ways in which it can provide logical options.

1. Introduction

Greenhouse gases can effect on climate parameters (such as precipitation and temperature which are the most important factors). The Greenhouse gases can cause reduce rainfall (because of increasing dry spells) and increasing temperature significantly. Practical measures to reduce greenhouse gases and reduce the climate change impacts are two several however harmonizing methods to tackling climate alteration [1]. Fighting is contributing to climate alteration, whereas adapting to its influences on society and the ecosystem [2].

Reduction is a necessary measure to prevent the

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influences of climate alteration [3]. The idea that less measures to reduce today will lead to further climate alteration and the consequence of further quantities for future adjustment will be the basis for the immediate reduction of greenhouse gas emissions [4]. If no reduction measures are taken, the greenhouse gas emissions in the atmosphere can double by 2035, before the industrial revolution, and in practice increase the average global temperature by more than 2 degrees Celsius [5]. In the long run, an average temperature of up to 5 ° C can be increased by more than 50% [6]. This increase in temperature is equal to changing the mean temperature from the ice age (11,000 to 13,000 years ago) to this day [7]. This great change will lead to major changes in people's lives and lifestyles. It also means that all areas of the world will be affected by these major changes [8,9]. At present, adjustment to observed and predicted climate alteration, although limited, is working [10]. Some examples of disrupted adaptation measures include drought-tolerant crops, more resilient to climate happenings, flood and coastal fortifications, and mangroves to decrease susceptibility to storm and high waves [11,12]. Coming to the sea level. In the following, different methods of reducing climate change and adaptation to it are explored and described [13,14].

2. Materials and Methods

2.1 Greenhouse Gas Emission Reduction Methods:

Reducing greenhouse gases may be reached by a mixture of methods, machineries and other procedures, most notably:

(1) Low-carbon energy sources include renewable energy like solar energy, wind energy, geothermal energy, water energy, waves and ocean energy of biofuels, and biomass of fuel conversion (for example, from coal to natural gas) and more contentious, energy are nuclear.

(2) Increasing energy reserves and energy productivity:

If technologies and energy efficiency methods are integrated into different greenhouse gas emitters, they can provide the same goods and services with the least energy or use the potential of unlimited energy [15-17]. These include insulation and use of low-energy bulbs, designing heating and cooling systems in buildings, developing fuel productivity in transport, or altering the energy basis of automobiles (such as hybrid fuels, hybrid batteries, biofuels), the modal shift of goods and Passengers from road to rail, burning waste and methane revival of burial wastes will improve energy and optimize heat and energy in the industry [18,19].

(3) Carbon capture and storage. Spreading carbon reservoirs:

The capture and storage of carbon is a method that traps greenhouse gas releases in the same source of releases and before it enters the atmosphere. Point bases like central power plants are perfect for this because they are still non-commercial practices. Recently, the use of biomass, such as forests as carbon reservoirs, has proven to be a proven and practically carbon-capture method. Also, preservation of existing reservoirs of forests is a main factor of effectual absorption, although in some areas, due to increased periods of drought due to climate change, forest fires are a threat to this policy [20,21].

(4) Lifestyle and low carbon consumption options

The main source of emissions of greenhouse gases is human use, so that if no utilization of profits and facilities was available, greenhouse emissions from human activities were not carried out. However, the increase in population along with the development towards Western-style use has added to the long list of ecological pollution issues of land, water and the atmosphere. Lifestyle alterations and low-carbon options such as purchasing local produce, eating less meat and applying public or non-motor vehicles are altogether feasible methods to reduce greenhouse gases. Reduction measures should combine, harmonize and balance all existing concepts for a desirable and cost-effective outcome [22]. In fact, reductions do not necessarily have to be considered as costs, but also possible profits in the previous mentioned measures for economic improvement, market development, health and technology improvement, as well as reducing greenhouse gases [23,24].

2.2 Policy Tools to Promote Greenhouse Gas Emissions

At the moment, there are various strategies that, if applied fast, can decrease greenhouse gas releases and thus assist reduce the most critical impacts of climate alteration. Developers can create institutional, policy, legal and controlling agendas for empowerment and an incentive to reduce emissions of greenhouse gases plays a vital role [25-27]. Proper policy mixing with appropriate tools, including economic and legal guidelines, may affect the economic, technological, informational and behavioral difficulties in the market [28,29]. The most important of these tools are:

(1) Incorporated policies, including climate alteration, as an element in larger policy improvement to assist the application of reduction procedures.

(2) Legal standards make confidence and stability on greenhouse gas emission levels and signal a specific sig-

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nal to prevent the "usual business" approach. By setting standards, the government can use materials and equipment that damage the climate.

Prohibit or attempt to replace them. For instance, standards may be used for buildings (energy productivity), fuel consumption through means of motor vehicles, energy productivity in households, and the substance of fuels.

(3) Decreasing greenhouse gases for deforestation and forest deprivation, policy methods and positive inducements for topics related to

Decreasing greenhouse gas releases from deforestation and forest degradation, in addition to the character of preservation, sustainable forest organization and increase forest carbon stores are concerned.

(4) Voluntary agreements are a tool for interactions between industry and government that have voluntary partnerships in environmental and other matters, and are often procedures for legislation. Theoretically, industries will be forced to take steps to reduce greenhouse gases if they have more costly legal controls.

(5) Voluntary measures: Companies, governments, civil society and nonprofit groups can innovate. Sometimes the best interest rates are best. For example, a 4-member family with an electric heater, on average, is reliable for the emission of approximately 8 tonnes of carbon dioxide per year, which is approximately twice that of a new conventional machine. Despite the fact that solar water heaters are an energy saving solution in warm and sunny regions, their price of purchase is extremely high for numerous parts. Banks usually do not like the costs and profits of tidy energy. Therefore, mortgages are often not extensively accessible. However, the return on investment in solar water systems occurs in less than four years, and from there onwards, hot water is supplied free of charge. Enter prosol is a new initiative among the Italian Ministry of the Environment and the National Bureau of the Seas and Drought for Energy Conservation, which helped the 10,000 Tunisian families borrow $ 60 million of their solar-powered loans, which would leverage significant initial costs 2.56 Million Dollars Prosol. The Tunisian solar water market showed that when low-interest loans are provided to households, a significant increase in their interest is seen through reimbursements collected through electricity bills. This decreased the danger for local banks. At the same time, borrowers saw the effect of using solar heating on their electricity bills.

2.3 Economic Tools

Taxes and costs impose costs on publishers per discharged pollutant unit. For instance, a carbon tax is an environmental tax on carbon derived from fuel. It may be applied through taxing fossil fuels, coal, oil derivatives such as diesel and fuel, as well as natural gas, relative to their carbon content. Therefore, they become more costly to usage. Consequently, a carbon tax will increase the power of competition for non-carbonic technologies (such as wind, sunlight, hydro and nuclear energy), that will help preserve the environment along with increased revenue. The important thing is that taxes and fees should be high enough to make a difference in consumer behavior rather than an excuse to increase government revenue [30,31].

Financial inducements like discounts and tax cuts may be applied to motivate novel markets for creative technologies. For instance, a sales tax reimbursement for purchasing and installing solar panels can be a stimulus to install these technologies. Consumer licenses also provide a market and a market cost for pollution, which means carbon is ours here [32]. A general limitation for the permitted greenhouse gas emissions is laid down, and this amount is distributed in greenhouse gas permitting sources (industry) in the form of a license [33]. Then the licensees can either use these licenses or buy them and sell them as traditional stock markets. The government or companies that need to increase greenhouse gas emissions must purchase licenses from those who are less in need. In this way, the buyer will have to pay more for pollution, while the vendor will benefit from greenhouse gas emissions. So, people who can release gases

Reducing greenhouse gas emissions at lower levels than purchased licenses will result in less polluting costs for the country.

2.4 Adapting to Climate Change: Facing a New Event

Climate change and climate alteration are reflected in the implications of the need for adaptation and reform in both natural and human systems. Such adaptations say adaptability that balances damages or exploits useful opportunities. Although individuals and communities always adapt to these climatic changes, it is often not enough to respond to the present and future climate alteration. Adaptation is classified into both theoretical and practical categories.

2.5 Theoretical Compatibility-Compatibility classifications

In the theoretical compatibility, compatibility responses can be divided into several sub-classes that represent factors, scheduling, and systems. Table 1 displays instances of compatibility measures for several classes of adaptation.

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Table 1. Examples of adaptation strategies

		Forecasted	Reacted
Natural system	Public	N.A	-Changes in growth rates during growth seasons -Changes in the elements of ecosystems -Destroying the wetlands
	Private		
Human system	Public	-Buy insurance -Build the urban infrastructure and buildings with standards - Redesign oil infrastructure	-Changes in the performances of cultivation -Changes in insurance -Buying air conditioner
	Private	-Pre- awareness system -New codes for building contracture -New standard for moving potential buildings	-Financial aids for hazards events -Financial aids for rebuilding the buildings

Independent adaptation, through ecological changes in natural systems, through changes in the market or wellbeing services in human organizations, instead of a sensible reaction to climate alteration. Alternatively, the adapted design is the consequence of a considered acronyms established on the knowledge that the circumstances have altered or are changing. The predicted adaptation takes place before its effects appear, while responsive adjustment happens after the preliminary effects of climate alteration have been revealed.

Also, there can be a life-based differentiation in which the natural organization or human organization adapts. In human systems, public or private compatibility explains how private and public interests are the driver of decision-making for compatibility.

The initially phase in adjustment organization is to identify current and future susceptibilities and assess the climate dangers. Susceptibility could be defined as a stage in which an organization is sensitive or incapacitated to counteract the negative influences of climate alteration. The vulnerability of an organization depends on its experience, sensitivity and capability of compatibility. Vulnerability valuations, alterations in socioeconomic and environmental circumstances, biophysical and socioeconomic influences from climate tensions, as well as adaptive capacity of a system. So as to realize the possible for future vulnerability, the main factors require to be recognized. In case of assessing future climate dangers, it can often be probable to apply scenarios and simulations to predict them. Once the perception of the vulnerability and climate risks in the face of a society or a region, the subsequent phase is to recognize probable options for adaptation. Adaptation possibilities may be considered to make profits under all possible future scenarios, containing climate alteration, or may include measures taken to predict climate change. Table 2 provides some examples of possible measures of adaptation in response to different climate tensions.

Table 2. Adaptation strategies for climate change

Extreme events of climate change	Adaptation strategies
Drought	Rain water harvesting, conservation of water and control water losses, restore ecosystem, plant the vegetables which are adapted to drought, improve economic variations
Flood	Improve land cover near rivers, build buildings higher than surface land, road which are resistance to flood, changes in crops, changes land users, pre-awareness programs
Sea level rise	Preservation of wetlands and coastal regions, build dike, pay attention to the influences of climate alteration on making foundation
Increase temperature	Conservation of livestock, plant the adapted trees, improve health care, control disease
Extreme winds	Build the resistance buildings, restore forests, new technologies which are resistance to wind, pre-awareness

2.6 Economic Section of the Problem and Solution

When the production, market and consumption of goods and services are considered as the main causes of climate change stemming from human activities, choices are made by governments, companies and individuals. A good example of these options is dependence, especially in our country, which transport and heating is based on burning fossil fuels. Economic assessments that lead to such scenarios have been controlled not just via markets and costs however similarly through environmental, social, cultural and political elements. At the national stage, society can share in three ways climate change:

2.7 Preventing Economic Growth Associated with Environmental Degradation

Economic development assists to make engagement and save people from scarcity. Also, green development may direct to more ecologically pleasant creation and use activities by utilizing more efficient resource management and reducing greenhouse gases. National use stages define how many national supplies are required to estimate the whole requirement for community properties and facilities, and how much waste is produced directly. This is especially true of developing countries such as Iran, where the manufacture and establishment of properties and facilities have produced the destruction of the environment. Therefore, reforming policies, technologies, resource management, and wise business will allow the economy

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to prevent economic growth caused by environmental damage.

2.8 Population Size

Many of the environmental issues, containing those caused by climate alteration, are affected through population growth. Different demographic groups contribute in a variety of techniques. Age structure, household dimension, spatial dispersal and, above all, developmental stage, whole influence per capita releases of greenhouse gases. In most cases, countries with high population growth rates have a relatively small share in preventing greenhouse gases. Except for countries that are pursuing new and low carbon development routes. Also, high values of living can direct to an increase in per capita greenhouse gas releases.

3. Results and Discussion

One of the most important factor for adaptation of climate change is analyzing capacity of economic value and policies in a specific region. The accurate calculation of the influences of climate alteration on critical policies for climate change reduction and adaptation is crucial as it enables the government to estimate the amount of preventable risks, besides the allocation of costs to each of the measures taken to control the climate. This assessment may account for the definitive losses of climate change in monetary terms, as these losses are related to market prices or "market effects" (such as the destruction of the physical properties of a business in the climate). Otherwise, it is difficult to calculate monetary value since they are not relevant in market deals; these are called "non-market effects" (such as the environmental effects of damaged forest reserves, the damage of human life or the reduction of retrieve to safe drinking water). In another view, climate alteration cannot just lead to straight economic losses, however also incidentally constraint economic improvement because of the harm inflicted on people and natural organizations. Also, an ecosystem service assessment may assist to make decisions about reducing and adapting as well.

The results for policies and actions related to climate change mitigation depend largely on the economic method approved for assessing climate harms. Therefore, it is significant to discriminate among two kinds of "conventional / traditional" and "novel substitute methods" approach in looking at the issue.

Traditional economic simulations are consistent with either of the following two methods:

(1) A pure concentrate on market effects

(2) Allocate financial principles to their effects as much as probable and combine them under a particular assessment.

If just market effects are taken into account, general climate harms will be severely undervalued. If non-market influences selected, these effects are valued arbitrarily and controversially due to the high use of cost-benefit examination in public policy creation. The cost-benefit analysis contrasts the values of managing greenhouse gas releases in the interests of preventing climate damage. The question of the cost-benefit analysis approaches both the foundations of theoretical economics and ethical and social principles. Since it alters the concept of principles related to social welfare. There is also evidence that the usage of a traditional economic attitude has led to the ineffectiveness of a climate-based policy that makes people less likely to take action today as they take intense action. This despite urgent scientific indication of human-induced climate alteration that can have disastrous values over longer periods, requires urgent achievement.

4. Conclusion

Greenhouse gases can effect on climate parameters (such as precipitation and temperature which are the most important factors). The Greenhouse gases can cause reduce rainfall (because of increasing dry spells) and increasing temperature significantly. So different policies need to reduce the effect of the greenhouse gases. Correct climate policies may participate to the valuable reduction of climate change and adjustment and can develop the outlook for service, sustain economic development, decrease deficiency and attain other economic and social profits. Measures taken for a leading climate can provide better and more opportunities for pushing the country towards a green economy. They can also contribute to promoting human well-being and reducing inequalities in the long run, so that future generations are less vulnerable to environmental hazards and ecological hazards. Elements that maintain our economy as service, ecological value, equality and social fairness (including the general feature of life) will make superior benchmarks in contrast to policy implementation and must be prioritized over economic development goals.

In this regard, hydrological cycles are also closely linked to climatic changes, especially the temperature of the planet. Modifying rainfall patterns, intensity, duration and frequency, increasing evaporation and transpiration, and reducing soil moisture are among the factors that are caused by climate change and reduce water availability for plants, animals and humans. This issue is more acute in Iran due to its geographical, social and cultural con-

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texts, and affects different sectors of agriculture, surface water and underground resources, health, biodiversity, as well as coastal areas such as the country's wetlands. Also, changing patterns of rainfall will lead to an intensification of the water crisis and the occurrence of severe floods that will have severe consequences. Therefore, correcting, developing and managing water correctly in order to adapt to climate change is essential.

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ARTICLE

A Short Note on Linkage of Climatic Records between Terai and Mid-mountain of Central Nepal

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ABSTRACT

The steep North to South (N-S) gradient and complex topography marks significant variations in the spatial and temporal patterns of climatic variation surrounding within a few distances in the Nepal Himalayas. Hence, to validate climatic linkages between the stations under two distinct topographic conditions, the study examines the observational climatic data from 106m a.s.l. and 1801m a.s.l., as a representative station from a plain and hilly area. Different statistical tools including Pearson correlation analysis and a best-fit regression model were applied to analyze climate data. The analysis of 13129 daily average temperature records and 13147 daily total precipitation records showed that the variation in their sum and average of daily, five days, ten days, and monthly values between the stations in the different elevations marked significantly.Despite these variations, temperature records are measured to be consistent in different altitudes and strongly correlated. The precipitation data showed a comparatively weaker correlation. The coefficients (0.85-1.6) with R^2>0.50 in the regression models for the lower elevation and higher elevation station in the mid-mountain region except for the monsoon season. It indicated a similar fluctuation of temperature between these two stations in the respective area. The strong degree of association and the change of climatic parameters in different range and elevations indicate the possibilities of using climatic data from Terai to represent the Mid-mountain region of central Nepal.

1. Introduction

Nepal's steeply geographical variation results in the changing of climatic characteristics like; temperature and precipitation have heavily depended upon seasons. The steep North to South (N-S) gradient and complex topography marks higher variations in the spatial and temporal patterns of climatic variation surrounding a few distances in the Nepal Hi-

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malayas. Consequently, within a span of less than 200 km, the country encounters almost all climates ranging from subtropical to polar and arid environments [1]. The observed contrasting features of climate within a short distance create a microclimate variation that also enhances vegetation variation within the short distance. Therefore, to understand the climate of the complex terrain of Nepal Himalayas, more climatic stations with advanced measurement devices are always desirable. The weather records from high-altitude regions in the central Himalayas are inadequate due to logistical difficulties in inaccessible terrains [2-4]. Understanding the mountain region's climatic characteristics is complicated due to a lack of observational data in spatial and temporal resolution. Furthermore, covering the mountain region's complex terrain by current general circulation climate models (GCMs) is not enough as expected, which hinders our understanding of the climate of complex terrain [5].

Many studies suggest that the mountainous region displayed a more significant and higher warming rate than the global mean air temperature [6-9]. Observational study using long-term observational data of surface air temperature over Nepal showed that the warming trend is more rapid at higher elevations than in the lower elevation region [6,10-14]. While precipitation possesses distinct features; most of the studies found an increase in rainfall with increasing altitude up to a specific elevation and begin to decrease with increasing height [15-21]. Therefore, the Middle Mountain and some high mountain areas receive maximum precipitation with the east-west contrasting pattern [16,19,22-25]. Satellite-based precipitation studies also showed the heterogeneous nature of precipitation over Nepal [20,26,27].

Despite these studies on temperature and precipitation trends, whether it is possible to use the climate data from the rich network site at lower elevation can useful to quantitatively the climate at the poor network site of a high hill or not is a subject out of scientific focus. Very few studies focus on this approach [28,29]. This assessment of the climatic linkage between the stations in the different physiographic region provides the basis for developing a best-fit regression model. This study could also be beneficial for the calibration purpose of paleoclimate studies. This paper aims to determine/quantify the linkages of climatic records along an altitudinal gradient between the stations at Taulihawa (106m a.s.l.) and Khanchikot (1801m a.s.l.). We set up our hypothesis that temporal variations in temperature between the stations have good homogeneity, while precipitation displays substantial spatial heterogeneity.

2. Material and Methods

2.1 The Study Area and Climatology

The study selects the station in the lowland area known asTerai (60-300m a.s.l.) and highland in the hilly region, also called the Middle Mountain (Mid-mountain1, 500-2,700m) as shown in Figure 1 based on the criteria: (1) representative of the different physiographical region of Nepal (2) greater than 1500 m in an altitudinal difference between the stations and (3) Daily meteorological data available for more than three and a half decades.

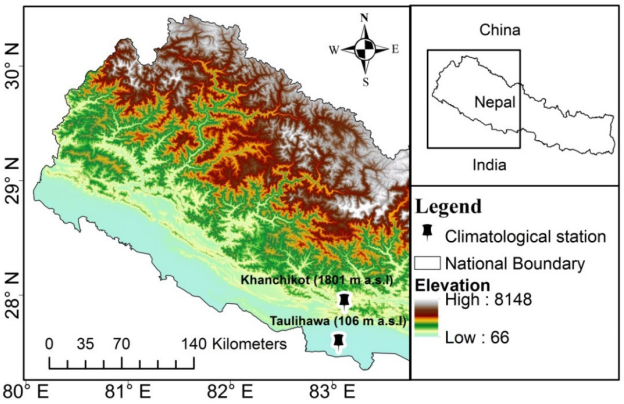

Figure 1. Location of climatological stations under study

Seasonal variation is one of the influencing factors of the climate of Nepal; hence this study is one of the alternative options to set a remarkable benchmark. The season of Nepal is divided into four groups based on the temperature and precipitation; (1) winter, (2) pre-monsoon, (3) monsoon, and (4) post-monsoon. The previous year's December, January, and February of the current year fall in the winter season, March to May in pre-monsoon, Jun to September in monsoon, and October, November in post monsoon season, respectively. Monthly variations of temperature and precipitation based on the long-term averages showed that June is the month with the highest temperature, and January is the coldest month for both stations. In the same way, July and November are the months with the highest and lowest precipitation. Lower elevation station receives 87.5% of the total rainfall (1482mm) only during the summer season. In contrast, the Middle Mountain station receives 81% of the total precipitation (1810mm) in the same season. The mid-mountain station receives a higher percentage of rainfall (10%) in the pre-monsoon season than the Terai region (6.5%). The climatology of Taulihawa (27.571°N, 83.067°E, 106m a.s.l.) and Kanchikot (27.922°N, 83.129°E, 1801m a.s.l.) is shown in Figure 2.

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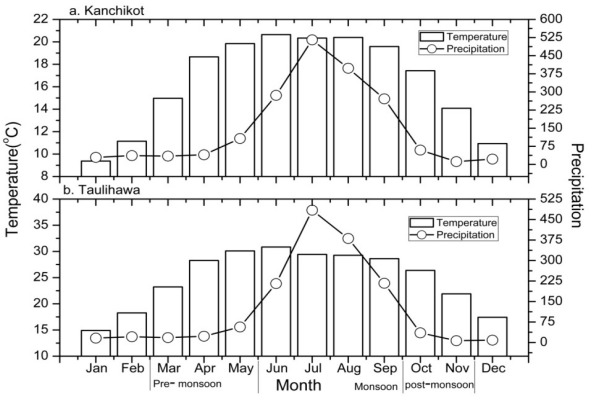

Figure 2. Monthly climatology of (a) Khanchikot station and (b) Taulihawa station

2.2 Data and Methodology

The climate data for Taulihawa and Khanchikot from January 1980 to December 2016 was collected from the Department of Hydrology and Meteorology (DHM), Government of Nepal. Altogether, 13129 daily temperature and 13147 precipitation records were used for the study analysis. In these data, daily, five days, ten days, and monthly looped climatic records were analyzed to measure mean temperature and sum of precipitation for a lower and higher altitude station, and these were compared to each other for 36 years. The parameters like mean and standard deviation were observed by the time series analysis and were checked by t-statistics (paired sample t-tests) and/or two-sample Kolmogorov-Smirnov tests. Moreover, Pearson's correlation was used to measure the degree of association among the temperature and precipitation records.

Similarly,the line of best fit to quantify the associations of climatic records between low and high elevation were done via regression model. It measures the trend of the association based on daily mean temperature and daily precipitation according to months. The Intercept, slope, and R^2–values are used to assess the physical parameters and quality of the regression models, as shown by [28,29]. The study used a regression model based on five days, ten days, and monthly mean temperature and total precipitation to confirm the daily data pattern. To catch the discrepancy and understand the magnitude of seasonal co-variation, the study pooled data from the 5-day mean, sum of temperature, and precipitation for the individual season.

3. Result and Discussion

3.1 Difference between Climate Records at Lower and Higher Altitude Station

Both the temperature and precipitation records at the higher and lower elevations stations show quite different interms of means and normality of data distribution. Based on the paired t-test, the daily and their looped for five days, ten days, and a monthly average of temperature and sum of precipitation for the study period are significantly different between Taulihawa and Khanchikot. Kolmogorov-Smirnov two-sample test (K-S test) of all the temperature data sets also shows a significant difference in their continuous distribution.

Figure 3 (a) and (b) show the monthly differences of precipitation and temperature between two stations at a distinct elevation range. The peak differences of rainfall are found during the early and late summer. The annual mean temperature at Khanchikot was recorded 8.4± 0.64℃ lower than at the lower elevation due to the elevation-dependent temperature [10,29]. These results clearly show that the high elevation region received more precipitation than the lowland region throughout the 36 years of duration. This result demonstrated that the annual rainfall increased with altitude for elevations below 2000m, and results are more consistent with most of the earlier studies [15-19,21,30]. Annual and monsoon season (June-September) precipitation at Khanchikot was 328.8±368mm and 174±321.4mm higher than on Taulihawa. Comparing the daily mean temperature by months (Figure 2) shows that the temperature at a higher elevation is 5.4°C to 10.3°C lower than the station in lower elevation. The differences

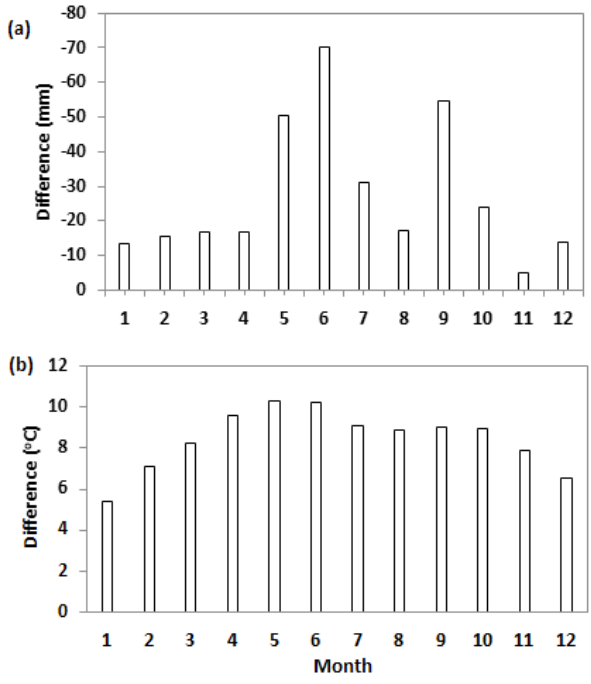

Figure 3. Mean monthly differences between Khanchikot (high elevation) and low elevation station Taulihawa daily precipitation (a) and daily mean temperatures (b)

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are higher from April through October (≥9°C) with smaller during winter months. While Analyzing the temperature trends between those two climatic stations, a higher increasing trend (0.039°C/year) was found at a high elevation mountain station than that at a low elevation station (0.0006 °C/year). Generally, cloud cover, water vapor (atmospheric moisture), other aerosols, and soil moisture could be the potential drivers of this elevation-dependent warming [6-9].

3.2 Association of Temperature and Precipitation Records between the Highland Station and Lowland Station

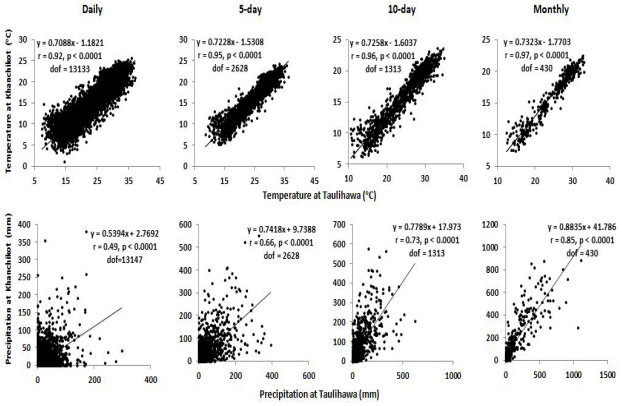

Figure 4. A scatter plot for the daily, 5-day, 10-day, and the monthly sum of precipitation and mean temperature at the Khanchikot and Taulihawa from January 1, 1980, to December 31, 2015.

The coefficient of variation (CV)measured from Table 1 shows that the mean daily temperature records between the Khanchikot and Taulihawa were found to be more consistent with CV less than 30%. The standard deviation (σ) for daily, five days, ten days, and the monthly temperature seems identical. As the length of time interval increases, the standard deviation of precipitation also increases and vice-versa in temperature. The significant correlations of daily, 5-days, 10-days, and monthly temperatures between the Khanchikot and Taulihawa (Table 1, Figure 4) were up to 0.92 for 13129 degrees of freedom (df) of the daily mean temperature series and 0.97 for the monthly means (df = 430). Similarly, for the precipitation, the correlations increased with increasing lengths of the time intervals, from 0.49 for the daily sum to 0.85 for the monthly sum, all were statistically significant for a p-value less than 0.0001 (Figure 3). Increasing the correlation with increasing time-windows for data sum suggested that low values of precipitation in both sites were complicated to model by linear regression [28,29].

Table 1. Standard deviation (σ), coefficient of variation (CV) of temperature and precipitation records on the Taulihawa / at Khanchikot stations with their Pearson correlation coefficients (ρ)for (p-value < 0.001 for all correlations) and the degree of freedom (df) from January 1, 1980, to December 31, 2015

Parameter	σ	CV	ρ/df
	Taulihawa/ Khanchikot	Taulihawa/ Khanchikot	
Daily precipitation	14.94/16.31mm	3.68/3.29	0.49/13147
Daily maximum temperature	5.67/4.31 °C	0.18/0.21	0.83/13133
Daily average temperature	5.74/4.41 °C	0.23/0.27	0.92/13129
Daily minimum temperature	6.64/4.76 °C	0.35/0.38	0.91/13136
5-days precipitation	45.5/50.96mm	2.24/2.06	0.66/2628
5-days maximum temperature	5.47/4.11 °C	0.18/0.2	0.87/2628
5-days average temperature	5.64/4.31 °C	0.23/0.26	0.95/2628
5-days minimum temperature	6.51/4.65 °C	0.35/0.37	0.94/2628
10-days precipitation	76.62/82.35mm	1.89/1.66	0.73/1313
10-days maximum temperature	5.36/4.01 °C	0.17/0.2	0.88/1313
10-days average temperature	5.59/4.24 °C	0.22/0.26	0.96/1313
10-days minimum temperature	6.46/4.59 °C	0.34/0.36	0.95/1313
Monthly precipitation	189.11/196.08mm	1.53/1.3	0.85/430
Monthly maximum temperature	5.12/3.86 °C	0.17/0.19	0.90/430
Monthly average temperature	5.45/4.12 °C	0.22/0.25	0.97/430
Monthly minimum temperature	6.32/4.47 °C	0.34/0.36	0.96/430

3.2.1 Using Taulihawa Low Elevation Climate Station Temperature to Represent the High Elevation (Khanchikot)

Using the elevation difference of 1695 m (1801-106m), the mean lapse rate was calculated as −0.51°C/100m with increasing altitude for all daily values, while those for different time intervals and seasons were slightly different. However, their standard deviation decreased with the increasing lengths of the time intervals, changing from ±0.144 °C/100m for the daily data to ±0.10 °C/ 100m for the monthly means. The mean lapse rate is close to the average temperature lapse rate of −0.54

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°C/100m reported by [6,11,12].

The regression analysis of daily and five-day data pooled is presented in Figure 5 with the intercepts, slopes, and R-square values of the highland station against the lowland. Such results fully supported our hypothesis that the variations of the daily and 5-day looped mean temperatures in the low elevation are excellent representatives for the upper elevation station in Arghakhanchi district. It is clear that from Figures 5c and 5d, the regression parameters possess distinct seasonal characteristics. Each regression parameters have their physical meaning and importance for the climatic information. In the case of the temperature, the intercepts of the regression models may not be very useful, which indicates a hypothetical 'base temperature' at Khanchikot for the corresponding 0°C temperature at the Taulihawa. The most useful parameter of the regression model is the slope. The slope of the model represents the degree of temperature changes at the Khanchikot per °C measured at the lower elevation station at Taulihawa.

During the monsoon season (June-September) observed interesting features of temperature change of high elevation Khanchikot corresponding to the Taulihawa; for every 1°C temperature change on the lowland, the highland temperatures changed only by 0.35 to 0.49°C, it may be caused by the natural dependency of temperature on precipitation. The Middle mountains are the first obstacles for summer monsoon in Nepal that often onsets mid-June [30]. Thus, the onset of monsoon and associated cloudiness in the Middle Mountain and comparatively dry and fair weather in the plain area might be the reasons for the large variation of temperature during the monsoon season (June-September). However, with the end of winter to the pre-monsoon (February-May) and the end of summer monsoon to the post-monsoon (September-November), the model's high slope possessed a strong association of temperature between lower and higher-elevation at Taulihawa and Khanchikot, respectively. After the retreat of monsoon, the post monsoon season begins and after winter, pre monsoon seasons, which are characterized by sunny days, clear sky and gradually decreasing / increasing in temperature throughout the country. Therefore, there is a strong association of temperature between the stations during these seasons. Similar results were obtained in the other similar study [21]. Both the daily and 5-day mean temperatures, the regression parameters have similar patterns with slight variation in magnitudes. These results clearly showed that temperature dependency high elevation increasing with an increase in the time interval.

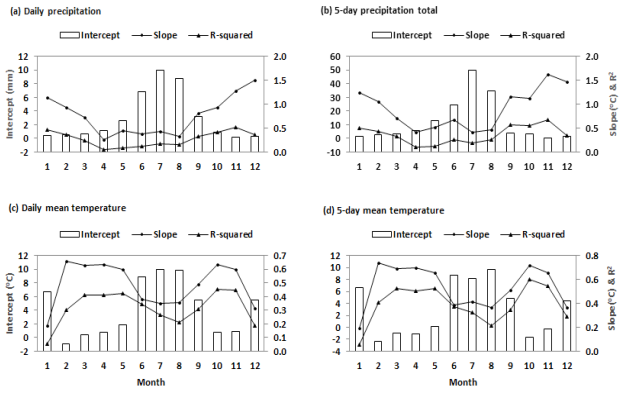

Figure 5. Theregression models by months with the Khanchikot temperature/ precipitation as the dependent variable and the Taulihawa as independent variables. Regression models using the daily (a) and 5-day (b) mean temperature data, and daily (c) and 5-day (d) total precipitation data

3.2.2 Using Taulihawa Low Elevation Climate Station Precipitation to Represent the High Elevation (Khanchikot)

Precipitation of any place depends upon the numerous factors such as topography, prevailing winds, orientation, land distribution patterns, etc. Therefore, it is not easy to use low elevation precipitation data representing high elevation stations in high-resolution temporal records in different elevation gradient of Nepal. The regression model results also satisfy our hypothesis in case of the precipitation records between two different elevation stations. The Figure 4 shows the statistically significant correlation of precipitation records between Taulihawa and Khanchikot. It is clear that the correlation only is improved with the increasing length of the time intervals. Thus, we must be careful when using the low elevation climatic data to represent the upper elevation station.

The intercepts of the regression models for precipitation have actual physical meanings. They represent the amount of rainfall at high elevation Khanchikot station for zero or no rain at Taulihawa. The model output results indicate that the monthly mean precipitation on the Khanchikot is approximately 42mm when there is zero precipitation at Taulihawa.

The regression analysis of the daily and five-day precipitation totals through month-wise grouping is depicted in Figures 5a and 5b. It shows that the intercept values were generally higher from April to September (summer precipitation). The relevancy of rainfall at the high elevation based on the low elevation seems to be increased up to 50mm at Khanchikot for zero or no rain at Taulihawa for 5-day looped total precipitation during July, a

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significant R^2 value of 0.20. It resembles that the high elevation Khanchikot station received higher frequencies of light rainfall than at the Taulihawa. On the other hand, the slopes were higher than 0.6 from late summer and early pre-monsoon season (September - March) with peak values of about 1.5 during December (Figure 5a). The variation of R^2-values shows that the values sharply declined after the winter months and increased with the late summer monsoon season (September). Throughout the summer months, the R^2 values were much lower. Similar patterns are observed for the 5-day data (Figure 5b). These results are consistent with other similar studies in the region [20].

4. Conclusion

This study used time-series data to examine the association of climatic linkage between the stations in diverse topographic conditions at the Mid-mountain and the Terai region of central Nepal. The daily precipitation and temperature data were analyzed and compared for 36 years from 1980 to 2016. The measure of daily, five days, ten days, and monthly data observed the magnitude of the discrepancy of temperature and precipitation parameters with time and geography. It varied significantly between the stations. Despite the discrepancy, the measure of the variation of temperature and precipitation between the mid-mountain and the Terai region is found to be consistent, and their agreement increases with an increasing time interval ($r=0.92$, $p<0.0001$, $n=13129$ for daily to $r=0.97$, $p<0.0001$, $n=432$, for monthly temperature and $r=0.49$, $p<0.0001$ for daily to $r=0.85$, $p<0.0001$, $n=432$ for monthly precipitation). It represents the strong degree of association of temperature between the stations. The regression coefficient near the unity (~1) with R^2 >0.50 indicates a similar change in temperature except in the monsoon season. Due to the heterogeneous topographical features and sharp elevation contrast, the precipitation association was not as strong as in temperatures, supporting our hypothesis. The study found that it is possible to use temperature data of the Terai region to assess the climate at the mid-hill quantitatively. However, corrections are necessary when the absolute values of climate are considered. The diversified geographical features of Nepal provided the unique opportunity to study the climatic linkage along the altitudinal gradient. However, the relation established by considering that a single station should not be over-interpreted. Still, this study represents a further step towards understating the connection between climatic records in different geographic settings. A forthcoming study will extend the data in spatial range over Nepal, enabling the climatic link throughout the physiographic regions of Nepal.

Acknowledgments

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ARTICLE

Upshot of Sprawl Incidence on Pattern of Land Use Changes and Building Physiognomies in Akure Region, Nigeria

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ABSTRACT

This study investigates the upshot of sprawl incidence on pattern of land use changes and building physiognomies in Akure and its environs. Using social survey research method (SSRM) to investigate the upshot, data were gathered via structured questionnaires on selected households in the region, involving Akure municipal and eight contiguous communities. Basically, the survey method involves interview, personal observation and photo-to-snaps to elucidate existing situation in the region. Average households' population in Akure municipal was estimated at 95,232 while 14,794 was estimated in the selected eight contiguous communities. From this, a sample of 1% was systematically selected, which amounted to 1100 sampled households. Findings show regular massive inflow of people into the city due to unguided expansions that have serious sway on land use determinant in the city and its contiguous communities. It also has significant influence on variation in building arrangements and facility distribution across the region. To mitigate this, the study advocates proactive efforts of stakeholders in urban management to employing inventive measures over private and public lands in logical manners. It also suggests the espousal of regional development programs to checkmate the rate of peoples' incursion into Akure, being the state capital. Local government headquarters and other major towns in the region should be reinforced with functional basic facilities to curtail the excessive influx into the city.

1. Introduction

Cities are epicentres of life, thereby attracting human influx that often leads to unprecedented growth. Urban growth is a worldwide phenomenon but the rate is faster in developing nations like Nigeria where growth is driven by unorganised expansion, rapid increasing population, increasing migration, and unchecked physical development. The aftermath result of these is incidence of sprawl in different parts of the nation. According to Banai and Thomas [1], sprawl is unintended consequence of lifestyle in suburban houses and auto-commute to work. They also considered it a waste of resources in matters attached with land, water, air, and energy; simply, because of its unregulated expansion that affected civic life, economy and society at large. From professional angle, Hayden [2] defines sprawl as a process of large-scale real estate development resulting in

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low-density, scattered, discontinuous construction, usually at the periphery of declining older suburbs and shrinking city centres. Bourne [3] and Owoeye [4] discussed sprawl as an extension or spread of development into valuable Greenfields and agricultural land areas. According to them, it involves increase in highway congestion, proliferation of new subdivisions of homogeneous low density, and single-family housing. It is a suburban area that is haphazardly developed, disorganized, poorly serviced with basic facilities, and largely unplanned for sustainable growth. According to Longman Dictionary [5], sprawl is the spread of city buildings and houses into areas with physical landscape; hence, the spread of urban congestion, urban outlook, activities and influence into contiguous suburbs of a city and its rural hinterlands.

Land use change, on the other hand, is urbanization-driven which has been recognized globally as urban problem present in most countries of the world. Balogun et al [6] posits that urban populations in developing countries increased by 40% between 1900 and 1975. They further predicted that the trend will continue to add approximately 2 billion people to the urban population of the presently less-developed nations for the next 30 years. In 2003, Arnfield [7] posited that the world was increasingly urbanized with 45% of the world's population were already living in urban areas since the year 2000. The United Nation Population Fund [8] projected 60% of the world's population to live in cities by the year 2025. Today, 55% of the world lives in cities with upward projection of 68% in 2050 [9]. Oduwaye [10], in his work titled "urban land use planning and reconciliation", anticipated 70% of world population living in urban areas by the year 2050 as induced by urban millennium initiation. These estimates show the inevitability of cities' unceasing sprawl with attendant alterations in land use patterns and building characteristics.

The growth trend of Akure is similar to this prognosis. Historic milieu of the city shows asymmetric increase in its population. Currently, the population has tripled what it was before it became the state capital and local government's headquarters in 1976. No doubt, this has brought ineffable changes on the physical landscape and structural development in the city. The thrust of this paper, therefore, is to investigate the upshots of sprawl prevalence in Akure on change pattern in land use and building characteristics with a view to providing essential information to solving problems associated with haphazard growth in the region.

2. Literature Underpinning

Sprawl in Nigeria is antedated to British colonization. According to Oduwaye [10, 11], the scenario in Nigeria is favoured by rapid rate of migration from rural landscape to urban areas, natural increase through birth, and ever changing socio-political and economic structure. Since urban explosion that was witnessed between 1970 and 1984, urban land use had been increasingly subjected to changes in different forms, sorts and types [11]. The explosion was triggered by the economic boom witnessed in Nigeria in that epoch before the downturn in the mid-eighties. According to Fabiyi [12], sprawl developments that featured prominently in the second epoch came in the form of shanties and ramshackle buildings when people migrated to cities in large numbers from the rural hinterland in anticipation to enjoy the benefits of urban economy. The effect was enormous as most Nigerian cities did not prepare for such upsurge of urban explosion that came thereafter which resulted in rapid human and environmental decadence.

Eludoyin, et al [13] employed land-sat image resolutions of 1986 and 2000 to assessed the spatio-temporal land use and land cover changes in Obio/Akpor Local Government area of Rivers State, Nigeria. The study revealed drastic reduction in farmland, mangrove, primary forest and sparse vegetation over time by 45.34%, 37.06%, 43.06% and 8.09% respectively while secondary forest, built-up area and water bodies increased by 5.88%, 74.55% and 3.43%, respectively. According to them, the primary forest has the probability of 18.6% to change to built-up area as the trend has the possibility to continue if not well managed. To avert this, the study recommended promulgation of laws to prevent unwanted expansion caused by illegitimate constructions of any form. It also encouraged public enlightenment whereby residents would be acquainted with the effects.

Adebayo [14], working on impact of urban land use changes on property values in metropolitan Lagos, acknowledged continual changes in the use of lands and buildings from lower order to higher order status in order to attain optimal productivity. Data obtained from sampled respondents for his study were analysed with the use of simple descriptive statistics; particularly frequencies, percentages and ratios. Result of his findings attested to remarkable changes in land use pattern from residential to commercial which had led to parallel changes in property (building) values in Lagos over time. But the consequence of the change has been devastating as conspicuously noticed in the area of traffic congestion, over stretching of infrastructural facilities, noise pollution, increase in housing demand, increase in crime rate, among others. He advocated for proactive measures on land use planning to manage the changes with less or no effect on the environment and residents. In similar

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studies, Oduwaye [10, 11] discussed nature of changes that accompany urban expansion and their implications on land use types; be it residential, commercial, industrial, educational, institutional, religious, circulation, parks or recreational land uses. With the application of factor analysis and principal components analytical techniques, he realized infrastructure and economic dynamics as major factors influencing land use in Lagos with high level of correlation between them. The consequence of this change was the significant distortion of Lagos Metropolitan Master Plan that led to the unforeseen physical land use problems in the city.

These submissions were corroborated in the work of Olofin [15] and Owoeye [16] who argues that urban sprawl poses serious challenges to food security as most agricultural lands used for food production are taken over by physical developments like building constructions and infrastructure provisions. Such developments lead to shortage of food production and supply which, consequently, encourage rural poverty. Oyinloye [17], Balogun et al [6], and Owoeye [4] observed that the rate of growth in Nigeria is much more rapid than it was in England and America some years back. While the growth in these two countries followed industrial revolution, that of Nigeria is motivated by socio-economic factors; most especially, the strong urge to enjoy improved amenities and quest for gainful employment opportunities in urban centres. This results in emergence of various socio-economic problems like housing shortage, joblessness, traffic congestion, high demand for transport facilities in urban centres, among others. It also results in shortage of food production, due to able bodies in rural areas migrating to cities in quest for greener pasture and urban life. Owoeye [4] specifically observed massive distortions in urban housing system; especially, at city centres where most residential buildings are being converted to commercial or mixed uses in an attempt to diversify source of income generation.

This scenario is not too different from China's experience where its cities have massively increased in size in recent decades. According to Smith [18], about 60% of its population are considered urbanised today with improved living standards of hundreds of millions. Counterintuitively, most of the cities are not dense enough yet faced with urban sprawl problems. The study reveals that China's unsustainable approach to urbanization has left millions of the country's 'floating population' in midpoint with their potential efficiency and productivity gains been diminished. The environmental impact of urban sprawl in China undermine the benefits of urbanization and has brought with it a range of negative economic and social consequences. For instance, sprawling cities lead to greater dependency on cars and longer commute time, which result in increased air and water pollution. Besides, the rapid conversion of rural to urban land poses a risk to food security by eating into the supply of arable farmland [18].

Earlier studies by indigenous urban geographers, like Omuta and Onoekerhoraye [19], identified two important features that marked the growth of Nigerian urban centres. The first is the intensification of land use with resultant modifications to the urban spatial structures within the already built-up areas of some cities. The second is the outward spread of the built-up areas of urban centers into rural hinterlands. According to them, intensification of land use in urban areas of Nigeria is a large feature of the pre-colonial urban centres. The process is an outcome of the pre-colonial pattern of land use in cities coupled with social changes and rapid growth after the establishment of British colonial rule. Subsequent studies further revealed that the growth viewed by the outward expansion of the built-up area contributed largely to the evolution of the contemporary land use pattern in most Nigerian rural areas and cities [6,4,20]. The continuous growth in this pattern leads to serious congestion in already built-up areas with physical expansion into peri-urban extension and contiguous rural neighbourhood.

As observed in cases cited in literatures, efforts were concentrated on the effect of sprawl on land use changes without much attention to serious alterations in housing situation as prompted by the incidence of sprawl at one time or the other. This study sees this as missing gap and a lunge area for enquiry as far as Akure region is concerned. The outcome is expected to provide essential information to solving problems associated with haphazard growth and rambling housing situation in the region.

3. Research Methods

3.1 Overview of The Study Area

The study looked at incidences of sprawl in Akure municipal and its contiguous communities over a period of 30 years (1985-2014). Akure, the capital city of Ondo State, is located on Latitudes $7^0 15^1$N - $7^0 28^1$N and Longitudes $5^0 6^1$E - $5^0 25^1$E. It spreads over an area of 15,500km^2 on fairly 370m above the sea level with a population of about 239,124 in 1991 and 360,268 in 2006 [21]. For this study, households' population was adopted, which was estimated at 95,232 for Akure municipal and 14,794 for the eight contiguous communities selected for the study. Figure 1 describe the geographical location of the study area in

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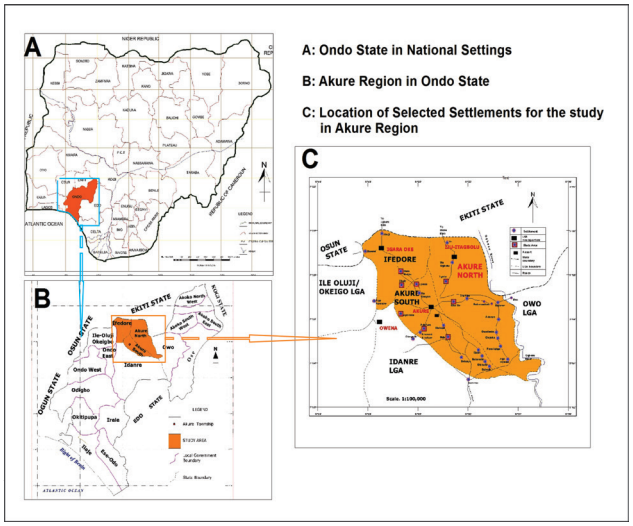

Figure 1. Locational Maps of the Study Area in National and Regional Settings

Source: Owoeye (2019)

As shown in the Figure, section 1c depicts the location of Akure and the eight contiguous settlements randomly selected within a range of 5-10km commuting radius away from Akure city centre. These settlements fall within the three Local Government Areas (LGAs) that constitute Akure Region; i.e. Akure South LGA (Ipinsa, Oda, Adofure and Aponmu), Akure North LGA (Igoba and Obaile), and Ifedore LGA (Ilara-mokin and Ibule-soro). The study investigated the outcome of Akure urban expansion, being the state capital, on these contiguous communities within the study period. The region possesses unified features that keep the inhabitants together, among which include language, socio-economic and cultural attributes. Thus, the study area has homogenous characteristics that qualified it to be called a region.

3.2 Research Data Base

Data assemblage for this study was principally done using Social Survey Research Method (SSRM). This method made use of questionnaire administration, photo-snaps, personal consultation and observation to evaluate existing situation in the region. These were supplimented with secondary information from government ministries and establishments where historical milieu of Akure city, base map and population data used for the study were obtained. The study area was subdivided into three precincts, namely: the urban core, the transition zone, and residential estates cum urban peripheries. A report on Integrated Household survey conducted by the Ondo State Bureau of Statistics [22] established 5persons per household (5pph) and 5households per building (5hpb) in urban areas of the state. With this, the total population of 476,159 projected for the three zones in Akure municipal and 73,972 in the eight contiguous settlements were estranged into 95,232 households in Akure and 14,794 households in the contiguous communities respectively. Consequently, a sample size of 1% was taken for questionnaire survey, which amounted to 952 in Akure urban and 148 in the contiguous settlements. These were randomly distributed to an adult in each building selected for survey in a sequential order of ten buildings intervals. Out of the total 1100 questionnaires distributed, 947 were retrieved in usable form; 818 in Akure municipal and 129 in the selected settlements. These were used in the analysis for the study through appropriate statistical tools. ANOVA test was conducted to validate existing interaction among the variables investigated in the study.

4. Results and Discussion

Result of findings on the effect and interaction of sprawl phenomenon with land use change and building physiognomies in the study area is presented and discussed under different subheadings as follow:

4.1 Descriptive Statistics on Land Use Pattern and Building Physiognomies in Akure Metropolis

The level of change in PURAQ (original purpose of land acquisition), BDGPUR (purpose of building) and ALTBDG (alternative uses of building) was determined using descriptive statistics as clarified in Table 1.

Table 1. Descriptive Statistics on Land Use Pattern and Building Physiognomies in Akure Urban

Variables	Frequency	Percentage
Original Purpose of Acquisition (PURAQ)		
-Residential	728	89.0
-Commercial	53	6.5
-Agriculture	27	3.3
-Institutional	9	1.1
-Others	1	0.1
Total	**818**	**100.0**
Building Purpose (BDGPUR)		
-Residential	553	67.6
-Commercial	54	6.6
-Industrial	7	0.9
-Institutional	5	0.6
-Mixed	198	24.2
-Others	1	0.1
Total	**818**	**100.0**
Alternative Uses of Building (ALTBDG)		
-Yes	390	47.7
-No	428	52.3
Total	**818**	**100.0**

Source: Field Survey (2016)

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From the table, the percentage of land area acquired for residential purpose was accounted for by 89.0%, while commercial was 6.5%, agriculture (3.3%), institutional (1.1%) and other land uses (0.1%). The table further reveals the original purpose for which buildings were constructed. About 68.0% were originally built for residential purpose while 24.2% were meant for mixed-uses and 6.6% for commercial purposes; only 0.6% was meant for institutional purposes. Investigation made on alternative uses of buildings in the area revealed that over 40.0% of land used for residential were shared with other land uses, aside the 24.2% that were originally allocated for mixed-uses. Examples of this clutter the city; especially, along Oyemekun, Adesida, Arakale and other major roads in the city, where most residential buildings are also used for commercial purposes, therefore, performing dual functions.

4.2 Kruskal-Wallis (H) Test on Patterns of Land Use Change and Building physiognomies in Akure

The chi-square (χ^2) value in H-statistical test was computed to assess the significant association between changes in land use pattern and building physiognomies in Akure metropolis as shown in Table 2.

Table 2. Kruskal-Wallis (H) Statistical Test of Land Use Change versus Building Physiognomies

Association	χ^2 Cal.	χ^2 Tab.	Df	P-value	Decision
BDGPUR vs. BDOWNER	15.081	9.488	4	0.005	S
BDGPUR vs. TENTYPE	8.104	9.488	4	0.088	NS
BDGPUR vs. PURAQ	272.855	9.488	4	0.000	S
BDGPUR vs. YLDAQ	29.678	9.488	4	0.000	S
BDGPUR vs. YBERECT	32.790	9.488	4	0.000	S
BDGPUR vs. BDTYPE	5.222	9.488	4	0.265	NS
BDGPUR vs. SZBPLOT	5.849	9.488	4	0.211	NS
BDGPUR vs. BDGCON	21.688	9.488	4	0.000	S
BDGPUR vs. WALMAT	33.610	9.488	4	0.000	S
BDGPUR vs. WALCON	5.983	9.488	4	0.200	NS
BDGPUR vs. RFGMAT	4.425	9.488	4	0.352	NS
BDGPUR vs. RFGCON	38.645	9.488	4	0.000	S
BDGPUR vs. NUMRM	12.275	9.488	4	0.115	NS
BDGPUR vs. SBDFIN	40.805	9.488	4	0.000	S
BDGPUR vs. BDMAINT	64.189	9.488	4	0.000	S
BDGPUR vs. ALTBDG	67.056	9.488	4	0.000	S

Notes: S = Significant, NS = Not Significant (at 0.05 alpha level). Grouping Variable: Building Purpose (BDGPUR)

Source: Field Survey (2016)

As shown on the table, sixteen variables that depict building physiognomies were examined out of which ten show significant relationships with BDGPUR at 0.5% alpha level. The remaining six variables, involving TENTYPE (tenure type), BDTYPE (building type), SZBPLOT (size of building plot), WALCON (wall condition), RFGMAT (roofing materials) and NUMRM (number of rooms per building) do not have significant relationship with BDGPUR. These were expunged from ANOVA test that was subsequently computed to validate the level of significant association between pattern of land use change and building physiognomies in the region.

The result of ANOVA test computed, as shown in Table 3, revealed that F-value of 7.022 is significant at 0.000 alpha levels with a mean score of 11.487. Therefore, the alternate hypothesis was accepted which affirm the existence of a significant association between changes in land use pattern and building physiognomies in the region as instigated by sprawl incidence emanated from Akure urban expansion. This corroborates findings in Owoeye and Omole [23] in their study on 'housing condition and environmental quality in the core of Akure'. In the study, it was strongly affirmed that longwinded and mismatched changes in land use often result in deterioration of housing condition and poor state of the environment with attendant consequences on residents' productivities and liveability.

Table 3. ANOVA Test on Land Use Variability and Building Physiognomies in Akure Metropolis

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	114.865	10	11.487	7.022	.000[a]
	Residual	873.527	534	1.636		
	Total	988.393	544			

Notes: Predictors: (Constant), ALTBDG, MATWAL, SBGFIN, PURAQ, BDMAINT, BDOWNER, YLDAQ, CODROOF, YBERECT. Dependent Variables: BDGPUR (Building purpose)

Source: Field Survey (2016)

4.3 Upshots of Sprawl Incidence on Changing Land Use Pattern in Contiguous Settlements

The resultant effects of monumental expansion experienced in the city was noticed in the contiguous settlements. This was examined in eight (8) selected settlements surrounding the city using descriptive statistical tool as shown in Table 4 and Figures 4-9. As illustrated in Table 4; nearly all the respondents (97.7%) interviewed in those contiguous settlements noticed essential influence of Akure urban expansion on their communities while only 1.6% seems not to recognize any. Such upshots or impacts are either negative or positive. The

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negative impacts include lack of labour for farm work, as noticed by 62.0% of the respondents, conversion of rural lands to urban land uses (24.0%), congestion on few available facilities in the communities (7.0%) and increased crime rates (5.4%).

Table 4. Assessment of the Upshot of Sprawl Incidence on LUC in Selected Settlements

Variables	Frequency	Percentage
Affirmation of Sprawl Incidence		
- Yes		
- No	126	97.7
Total	3	2.3
Negative upshots of Sprawl Incidence	**129**	**100.0**
- Increased Crime Rate		
- Conversion of lands to urban	7	5.4
land uses	31	24.0
- Lack of labour for farm work	80	62.0
- Congestion on few available	9	7.0
facilities	2	1.6
- Others	**129**	**100.0**
Total		

Source: Field Survey (2016)

Figure 4 revealed areas of positive influence, which midpoints on increase in level of civilization (37.2%), high cost of living (25.6%), upturn in housing demand (20.2%) and urban facilities delivery (16.3%). Level of accessibility to urban services in those connecting settlements was equally investigated, with a view to ascertaining the availability, functionality and adequacy of essential services for good living of residents in those communities. As shown in Figure 5; the level of accessibility to electricity takes the lead as specified by 39.0% respondents, followed by roads (35.0%) and schools (14.0%). Only 9.0% has access to clear communication network and 3.0% to water supply, with particular reference to places like Obaile, Ilara-mokin, and Igoba which are the closest locations to Akure among the communities investigated.

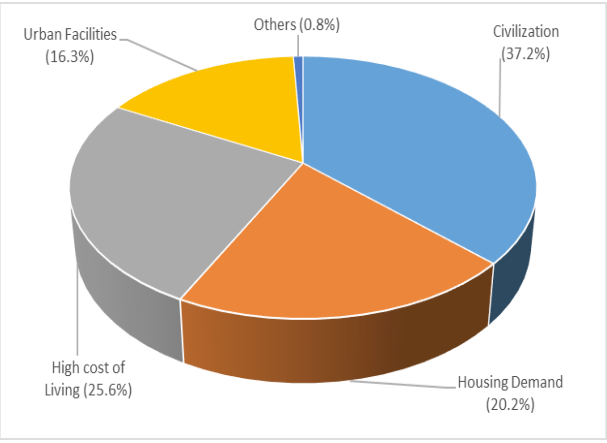

Figure 4. Specific Areas of Sprawl Influence

Source: Field Survey (2016)

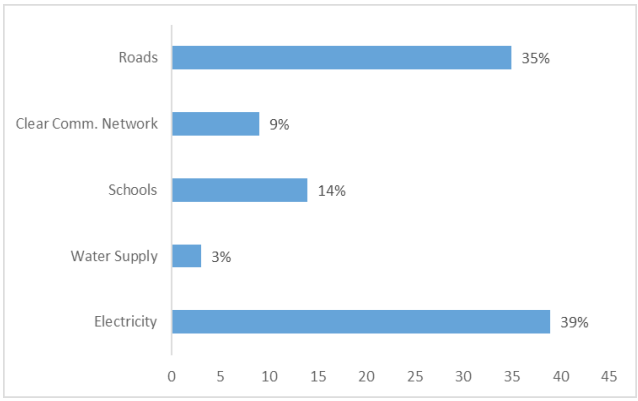

Figure 5. Accessibility to Urban Services

Source: Field Survey (2016)

Findings revealed astronomical upsurge in housing rents and land prices in Akure city due to ungainly population expansion. Invariably, this has increased the demand for housing units and lands for both residential and commercial purposes in the connecting settlements. Although, this scenario favours land owners and landlords of buildings as their level of income increased tremendiously, but daily upsurge in uncoordinated use of lands as evident in harphazard developments in these communities may inevitably result in series of planning glitches if not properly checked. It therefore becomes necessary to investigate housing characteristics in terms of physical condition, types and facilities delivery in the suburbs to ascertain the level of influence. Pictorial representations of existing status are shown in figures 6-9.

Figure 6. Representation of Physical Condition of most newly constructed buildings in the connecting settlemets

Source: Field Survey (2019)

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Figure 6 illustrates typical examples of newly built houses in Ipinsa community. As shown in the figure, the buildings were yet to be completed with necessary fittings (like windows, ceilings, plastering, wiring, plumbing and other household fittings) before they were occupied. Reasons for this includes increase in house rent, series of intimidations mounted on tenants by landlords and various other difficulties faced in securing accommodation at the city centre, which prompted some individuals to move into their uncompleted buildings. Some, because of frustration, often construct ramshackle structures on their plots of land and occupy it with their family, regardless of non-provision of basic facilities, security and space.

Figure 7. Ondo State Staff Development Training Institutes at Ilara-Mokin

Source: Field Survey (2019)

Figure 7 is a training institute built to train the administrative staff of the state government. It was located in Ilara-mokin (Akure suburb) as regional development scheme to upgrade the suburb and decongest the state capital.

Figure 8. The Akure-Obaile Road Dualisation Project

Source: Field Survey (2019).

Figure 8 shows road dualisation project along Akure-Obaile axis. This was initiated to ease tight vehicular movement generated by high traffic along the route. Most government workers and individuals working in Akure who could not secure accommodation in the city reside in this community. Hence, they ply the road daily thereby generating high traffic flow on daily basis. The extension of the road therefore becomes necessary to ease vehicular movement along the axis. The project was completed and commissioned in 2017.

Figure 9. Sunshine Housing Estate at Ibule-soro along Akure-Ilesha Road

Source: Field Survey (2019)

Figure 9 is the Sunshine Estate that was originally constructed by the Ondo State Government (ODSG) to provide residential services, like site-and-service and affordable rent, for people who could not secure accommodation or purchase plot of land in the city centre. But observation and personal interviews with respondents revealed that people could not secure the properties due to exorbitant price placed on them. Currently, the structures are being used by the Federal University of Technology, Akure (FUTA) as Centre for Entrepreneurship and mini-campus for the Pre-degree program (a business and academic venture). Definitely, the current use is at variance with the original purpose of acquiring the land and for which the construction of the property was made.

5. Conclusion and Policy Recommendations

The study examined the upshots of sprawl incidence on changing land use pattern and building physiognomies in Akure and its connecting settlements between 1985 and 2014. It assessed the physical condition, types and pattern of building arrangements as well as facilities delivery with a view to providing essential information towards

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solving problems associated with haphazard development in the region. Findings from the study show evidently the various upshots of unguided urban expansion on irregular alterations in pattern of land uses and slapdash housing development in the region. Most of these alterations are at variance with original purpose of land acquisition (PURAQ), building purpose (BDGPUR) and alternative uses of building (ALTBDG). The effect overflow into Greenfields and agricultural land areas in the suburbs and connecting settlements of the city. On this note, nearly all respondents interviewed in those communities acknowledged the effect on their areas, ranging from physical to socio-economic livelihood of residents. Even within Akure metropolis, the effects are conspicuously perceived in the area of haphazard housing development and poor state of the environment with attendant consequences on residents' productivities and livelihood. This calls for prompt attention of relevant stakeholders which is expected to begin with the process of land acquisition and allocation for various uses. Consequently, engagement of proactive measures to monitor both private and public lands across the region through effective zoning strategy should be encouraged. The Development Control Department in the Ministry of Physical Planning and Urban Development should be reinforced with strong tools to function in this regard; particularly, in the area of active monitoring of developments at sites and enforcement of planning standards for sustainable growth.

No doubt, the administrative status of Akure has encouraged regular inflow of people into the city. The impact of this on the city and its contiguous communities has been very great and well noticed. Hence, the implementation of regional development schemes will go a long way to curb this scenario. Local government headquarters and other major towns around the city should be upgraded and reinforced with functional basic facilities to curtail the incessant inflow of people from towns and villages into the state capital. This is one of the basic principles adopted in urban development policy framework in developed countries to curtail their sprawl phenomenon.

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Conflict of Interest

The author declares no conflict of interest regarding the publication of this article.

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ARTICLE

A Study on Anthropogenic Activities Influencing Flood Vulnerability in Ala Riverfront Residential Areas of Akure, Nigeria

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Akure

ABSTRACT

This research investigates anthropogenic activities influencing flood vulnerability in Ala riverfront residential areas of Akure, Nigeria with a view to identifying area susceptible to flood hazard in the river basin and to suggest possible mitigation measures. With respect to data gathering for the study, 265 questionnaires which amounted to 1% of the research population were administered using simple random sampling. Findings from the survey revealed erection of buildings on riparian land and indiscriminate dumping of wastes into river bodies as factors responsible for the blockage of river channels and waterways. It also exposed resident's poor dispositions to flood forecasts and non-adherence to other management measures. The study concludes by recommending public enlightenment campaign to reducing denizen's vulnerability to flood disaster. There is the need for provision of waste management and drainage facilities as well as regular dredging of the watercourse to stimulate its absorptive capacity in the event of heavy downpour. It further suggests creation of artificial lake as natural basin to collect huge volume of water discharged from all watersheds leading to the river. Ultimately, stringent efforts of environmental and town planning officers are needed to enforce total compliance to all intended management regulations to check the menace.

1. Introduction

The term flood is pictured as a body of water which overflow swathes of land not normally inundated [1]. It is apropos to assert that incidence of flooding is as old as humanity. Documental evidence showed that it all started with the Noachian deluge when the surface of the earth was submerged by water orchestrated by unabated torrential rainfall which led to the extermination of mankind with the sole exclusion of Noah's household [2]. The forgoing narrative thus suggest the necessity on the part of man to mitigate the effects of flooding in his environment by ensuring that all vulnerable landscape is identified and precautionary measures are put in place to tackle the impending challenge headlong.

Flooding is a global phenomenon ravaging both the developed and developing nations with its deleterious effects sparking serious attention; which has become sub-

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ject of research interest among climatologist, hydrologist, economist, urban planner and other professionals in the built environment. This is not unconnected to the fact that it is the most common and destructive of all natural hazards with wide reaching effects, wrecking havocs to the built and natural environments, as well as, endangering human health and material possessions [3]. Natural catalytic factors influencing flood disasters had been attributed to meteorological and hydrological phenomenon which include prolonged rainfall, storm surge, glacial melt among others [4]. It is imperative to emphasize that the degree of susceptibility of man and his environment to this natural catastrophe is tending towards socio-natural inclinations. The bottom-line of this discourse rested on the fact that flood hazard is chiefly of human origin, aggravated by hydrologic modifications and encroachment into flood prone landscapes.

In the words of Ogunbodede and Sunmonu [5], urbanization is one of the principal factors influencing frequency, intensity and magnitude of flood disasters across the globe. This is compounded in Nigeria by poor urban planning, weak urban governance structures and haphazard land use development. The impact of climate change as a result of industrialization and emission of greenhouse gases with respect to flooding was remarked by Okonkwo and Onyeizugbe [6] as factor that increase global temperature which, invariably, stimulate torrential rainfall, sea level rise and glacier melt. Socio-economic standings of man have also been adduced to be one of the elemental variables influencing vulnerability to flood disasters. Residents with low income status are often disposed to living in less hazard resistant structures in flood prone environment owing to intricate pauperism characterized by lack of alternative and well located safer places of abode [7].

The devastating effect of flooding in Nigeria is heartrending, leaving victims in a state of despair. Agbonkhese et al [8] documented that residents of Ibadan would not forget in a hurry the historic August 31st flooding that claimed 300 lives and rendered 50,000 people homeless while properties estimated at over 300 million Naira were lost to the flood. According to Federal Government of Nigeria [9], the national calamity of the 2012 flooding which was described as the worst disaster in forty years is still fresh in the memory of Nigerians where 363 people lost their lives, 5851 were injured and 3,891,314 affected in one way or the other while 387,153 were displaced. According to this document, flooding through watercourses occasioned by excessive downpour is a regular phenomenon in Nigeria, leaving these rivers overflowing their banks to proximate residential areas with dire consequences on health and socio-economic wellbeing of residents. It is an establish fact in literature that human interference on river catchments is a potent factor influencing flood behavior [3]. On this note, this study is set to examine anthropogenic activities influencing incessant flooding in Ala riverfront residential zones of Akure, Nigeria. It will identify areas vulnerable to flood risk using GIS device with a view to providing recommendations that could assist in upstream policy dialogues towards mitigating persistent flood hazard in the study area.

2. Literature Appraisal

Suffice to say that incidences of flooding have done more harms than good to humanity. Going by the words of Ajie and Frank [10], it is regarded as the worst natural disaster across the globe responsible for one-third of all natural exigencies with grave impairments on infrastructure, the built environment and human life. Thus, it becomes a source of concern to all and sundry looking at the fact that, whether developed or developing, no nation is immune to incidents of flooding.

Expositing on the issue of flooding in the developed nations, Salami et al [11] avowed that, in spite of technological advancement and increased technical know-how, calamities arising from flood cases is yet unabated. Jha et al [4] were of the view that modifications of Yangtze River Basin in Southern China through the process of reclamation which birthed cities like Wuhan, Changsha and Nanchang has heightened issues of flood disasters in the region. They further argued that human-induced activities in these vulnerable areas led to flood disaster in 1998 which resulted in the death of more than 4,000 people while economic activities and material possessions worth 25 billion US dollars were lost to the flood.

The United States is not left out in the fret of flood catastrophe. Nwala [12] reported that heavy downpour in mid-May of 2002 precipitated into flooding where homes were destroyed and fatalities recorded. Genovese [13] equally lamented that issues of flooding in Central Europe remained the most significant hazard to her environmental landscape, population and economy. It is worth noting to point out that cases of flood disasters in United Kingdom, Australia, and other developed climes are replete and well documented in literature. However, there is a consensus among scholars that the developed world had, over the space of time, put in place effective disaster management strategies coupled with strong institutions to prepare, respond and recover as well as mitigate effects of impending flood disaster in their environment.

Going by the level of vulnerability to flooding, it can be deduced that Africa is fast evolving as the epicenter

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of flood related disaster casualties. Mulugata et al [14] recounted that from 1990 to 2006, flood related problems have adversely affected almost 40 million Africans including 19,150 deaths and damages valued at about 4 billion US Dollars. Notable among these flood adversities include that of the Natal Province inundation in 2009 orchestrated by a non-stopping five-day rainstorm which swept away 400 lives and rendered 55,000 homeless in South Africa [15]. Kita [16] reported the Malawian flood tragedy in 2015 where 1.1 million people were affected; 230,000 displaced, 106 deaths recorded while 176 were declared missing.

The storyline is not different in Nigeria. It could be argued that instances of flood related disasters in the nation abounds in literature and could not be chronicled in a single piece of writing. Memorable ones include Ibadan flood calamities in 1980, 1985, 1987, 1990, 2011 and 2012 [6,17,18]. Osogbo in 1992, 1996 and 2002, Yobe in 2000, Akure in 1996, 2000, 2002, 2004, 2006 (even up to 2018, 2019 till date), as well as Kengana (Sokoto State) in 2010 [6,17]. Adamawa, Taraba, Benue, Niger, Kogi (Lokoja), Anambra, Delta, Edo, Rivers, Cross River and Akwa-Ibom in 2012 [19]. Others include Yenegoa in 1999, 2001 and 2012, Kano in 1988 and 2001 and Lagos in 2011, 2012 and 2017 [6,8,20]. However, the most devastating of all flood disasters in Nigeria in terms of magnitude, intensity and casualties was that of the 2012 cataclysm where 31 states were severely affected.

The scenarios illustrated above necessitated the need to create a flood disaster management cycle (FDMC) as a measure towards mitigating the adverse effects of flooding. In the work of Ranjan and Joseph [21] on Integrated Approach to Urban Flood Control and Management, some steps were advocated as necessary actions towards effective flood management and control. This is shown in Figure 1.

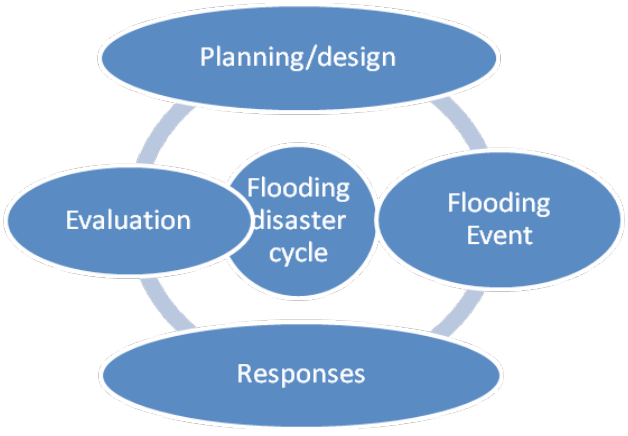

Figure 1. Flood Disaster Management Cycle (FDMC)

Source: Ranjan and Joseph [21]

From the figure, the cycle commenced with planning and design stage, otherwise called predevelopment stage, where all criteria set by client is measured and checked in acquiescence to the appropriate standards. The next stage is the flood event itself, where early warning signs and forecasting are made available; depending on the operating system in the observation area. This is followed by response stage, which often involve flood mitigation measures like flood insurance and damage control. The last phase is the evaluation stage where the level of damage and extremity of flood is being assessed. Essential factors affecting decision making at this stage is often determined by politics, costs, and national guidelines or operating standards.

It is pathetic to note that issues of flood disaster management in Nigeria is still largely unaddressed by both government and the governed thereby subjecting larger proportions of her citizens who are underprivileged to flood vulnerability. It is even disheartening to know that Nigeria is constrained of adequate infrastructure to deal with storm and surface water which tends to accelerate flood cases. To address this ugly development, the Federal Government of Nigeria, through National Emergency Management Agency (NEMA) put together a policy document known as National Disaster Management Framework (NDMF) to tackle flood and other socio-natural related disasters [22]. Conversely, Wahab and Faboyede [23] argued that the policy framework has not achieved significant result going by the review of flood related challenges in Nigeria. Their sticking point was not unconnected to the fact that NEMA orientation towards flooding over the space of time had been more of reactionary approach, centering on evacuation and provision of relief materials with little or no efforts on preventive and reduction strategies. In spite of technological innovations, Saleh [3] averred that scholars had come to a conclusion that incidence of flooding is inevitable. As such, it behooves on humanity to adopt resilient and harmonious synchronicity with flood issues. The crux of this matter is captured in the words of Ezemonye and Emeribe [24] where they concluded that the cost implication of recovery and rehabilitation measures are huge; thus, precautionary strategies should be accorded topmost priority with a view to stemming the tide of flood disaster in Nigeria.

It is therefore important to advocate for a paradigm shift in flood disaster management by employing geospatial technologies, which include remote sensing and GIS applications, to identify and map out vulnerable landscapes susceptible to flooding. Data from these applications, coupled with institutional forecasts from Nigeria

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Meteorological and Hydrological agencies, would help in aiding decision dialogues towards flood risk management with emphasis on raising resident's awareness to flood vulnerable zones and possible mitigating measures to combat the phenomenon headlong.

3. Materials and Method

3.1 The Research Locale

The study area is Ala river basin, situated in Akure city in Southwestern Nigeria. It covers the riverfront residential areas, demarcated with the aid of goggle imagery at 40m buffer left and right sides of the river. It occupies a landmass of 110 km^2, spatially located within Latitudes $7^0 14^1$N and $7^0 19^1$N of the equator, and longitudes $5^0 8^1$E and $5^0 16^1$E of the Greenwich Meridians. Generally, Akure is a city located within the tropical rain forest region of Nigeria where rainfall is high in about 8 to 9 months of the year [25]. It is the administrative headquarter of Akure South LGA and Ondo State capital. The centrality nature of the city put together with her administrative functions had seen the city growing in leaps and bounds, cutting across different sphere of development, as it provides home to people of different divide. Ala River is a major waterway that cut through Akure city. The total spatial coverage of the river is estimated at about 57km, flowing across regional boundaries through Oba-Ile to Edo State. Figures 2, 3 and 4 elucidate the study area in both national and local contexts.

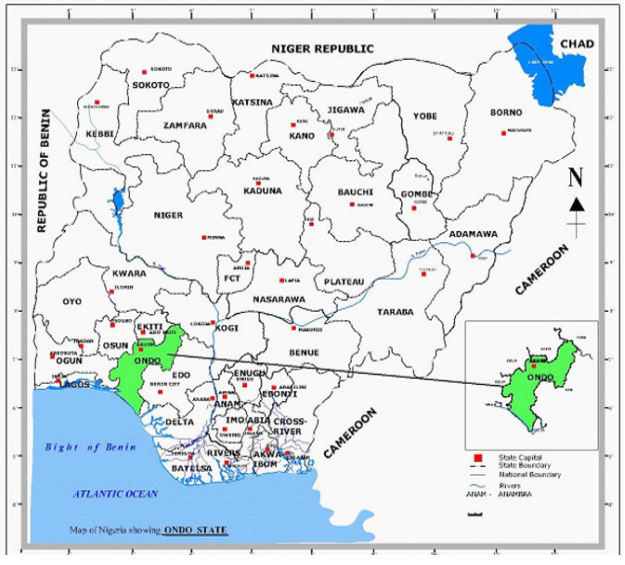

Figure 2. Ondo State in the National Setting

Source: Ondo State Ministry of Physical Planning and Urban Development (2019)

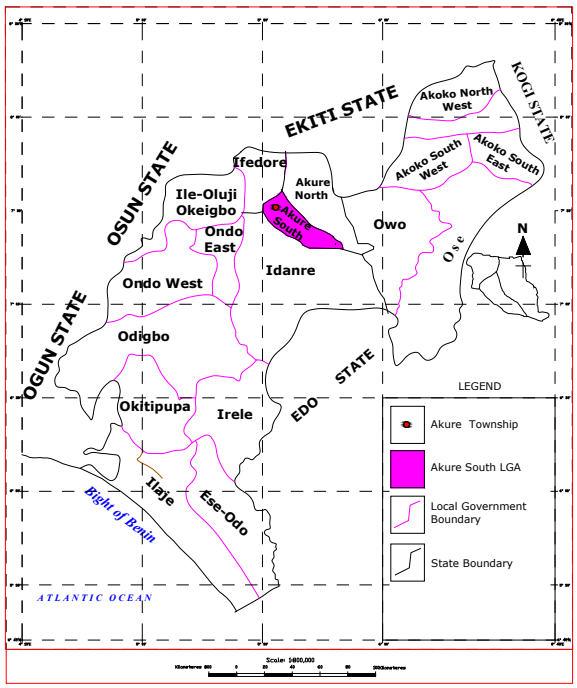

Figure 3. Ondo State Map Showing Akure South LG.A.

Source: Ondo State Ministry of Physical Planning and Urban Development (2019)

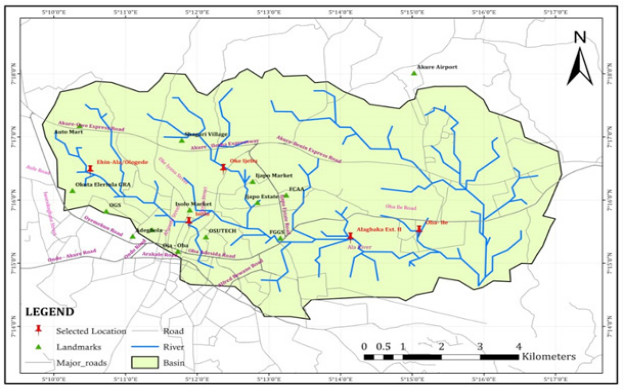

Figure 4. The Study Area - Ala River Basin - showing the River Course and its Tributaries

Source: Shuttle Radar Topography Mission (SRTM) Imagery (ArcGIS, 2019)

The study area is composed of rock outcrops which include Chanockite, Migmatite gneiss, Quartzite and Biotite gneiss among others [2]. For the purpose of lucidity, the spatial coverage for this study is limited to contiguous residential areas to Ala River. They comprise Oba Ile, Alagbaka Extension II, Oke Ijebu, Isolo and Ehin-Ala/Ologede communities, as clearly represented with red colour in Figure 4. With exponential increase, in terms of demography and morphology of the city; occasioned by urbanization, economic and socio-political development, the floodplain of Ala River was not spared. Riparian lands

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bordering this river had continued to witness invasive encroachment for developmental activities. The end result of this intrusion into the wetland area of the river is made manifest in recurrent flood discharge and displacement of people living in this area at the peak of every rainy season. Olatona, et al [2] accepted that issues of human and material possessions along contiguous neighbourhood to this river has always been an issue of major concern looking at the fact that properties worth billions of naira are damaged annually.

3.2 Research Database

With respect to data collection for this study, building population of the research locale were obtained through Google Earth Imagery and digitized using GIS device to arrive at 1061 buildings. The report of the Ondo State Bureau of Statistics [26] on Integrated Household Survey conducted put an average household size in Akure urban and other major cities in the state at five persons per family (5ppf) and five households per building (5hpb). Thus, the population of the study area was estimated at 26,525. For the purpose of questionnaire administration, 1% of the estimated research population (265 persons) was served with questionnaire, using simple random sampling with replacement. This is considered reasonable taking into cognizance the homogeneous environmental morphology and socio-cultural background of the study area. The 264 questionnaires retrieved from respondents were used for the analysis through descriptive techniques, involving frequencies, percentages and photographs.

4. Results and Discussion of Findings

Result of findings on the anthropogenic activities influencing flood vulnerability in Ala riverfront residential areas of Akure is presented and discussed under different subheadings as follow:

4.1 Distance Location of Buildings to Ala River

Data retrieved from respondents, as shown in Table 1, and personal observation made in the course of this survey revealed that overwhelming majority of residents in Ala River proximate settlements, amounting to 26.9%, 40.9%, and 10.2% erect their structures between 5-10m, 11-20m and 21-30m to the river. This was inconsistent and not in consonance with town planning regulations which stipulates minimum of 30m setback from waterways. These developmental activities had encroached on riparian land in this locale thereby aggravating people's vulnerability to flooding with devastating effect ranging from displacement of people, loss of hard-earned properties and human lives any time there is heavy downpour. This finding was in tune with the submission of Jha et al [4] who argued that issues of structures been subjected to town planning and building control was nothing to write home about in developing nations, like Nigeria.

Table 1. Location of Buildings to Ala River

Building Location in Meters	Frequency	Percent
5m - 10m	71	26.9
11m - 20m	108	40.9
21m - 30m	27	10.2
31m - 40m	49	18.6
Above 40m	9	3.4
Total	**264**	**100**

Source: Field Survey (2019)

4.2 Condition of Drainage System in the Study Area

Results from this survey with regards to condition of Ala River drainage channel showed that human induced activities have made the waterway becoming strait, thereby limiting its capacity to absorb excess water during torrential rainfall. The resultant effect is narrowed water channel that manifest in regular inundation of contiguous neighbourhood to the river as many of the drainages in those residential areas are in poor condition. This was empirically elicited in Table 2 with 46.2% of residents interviewed alluding to the poor condition of drainage system as major cause of incessant flooding while 28.4% assess the drainage system to be fair.

Table 2. Condition of Drainage System in the study area

Condition of Drainage	Frequency	Percent
Very Good	21	8.0
Good	46	17.4
Fair	75	28.4
Poor	122	46.2
Total	264	100

Source: Field Survey (2019)

This statistical discovery was in tandem with the findings of Uche [27] where he lamented that blockage of regular and synthetic drainage system in Nigeria was a principal factor triggering incidents of flooding. Figures 5, 6, 7 and 8 express the physical condition of drainage system in some parts of the study area.

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Figure 5. Ala River Channel at Ehin-Ala/Ologede Area

Source: Field Survey (2019)

Figure 6. Ala River Drainage at Oba-Ile Community

Source: Field Survey (2019)

Figure 7. Dredging of Drainages at Alagbaka Ext. II

Source: Field Survey (2019)

Figure 8. Inundating Drainages during heavy rainfall

Source: Field Survey (2019)

Figure 9 shows a radar topographical imagery of Ala river drainage system. As shown in the figure, the drainage system in the study area is very narrow and ineffective to allow sufficient passage of surface run-off during heavy rainfall; hence, the road surfaces are washed away, houses are inundated, lives and properties are lost annually. Figures 10 and 11 show some few casualties. Therefore, there is need for provision of efficient drainage system that will assimilate the volume of run-off generated by the river.

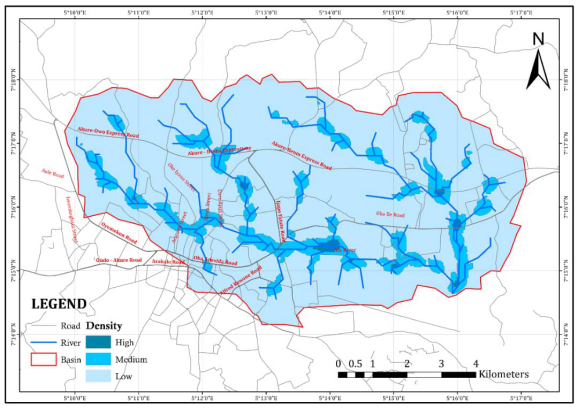

Figure 9. Map showing Drainage System in Ala River Basin

Source: Shuttle Radar Topography Mission (SRTM) Imagery (ArcGIS, 2019)

Figure 10. Houses submerged by flood at Isolo and Oke-ijebu area respectively

Source: Field Survey (2019)

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Figure 11. Motor-bicycle rider that was rescued and people whose properties were carted away by flood

Source: Field Survey (2019)

Table 3 shows the annual rainfall pattern in Akure between 2010 and 2019 as received from the Nigerian Metrological Agency (NMA). From the table, it can be deduced that the mean annual rainfall has been relatively high over the years, which accounted for the incessant flooding in the study area. There is need, therefore, to put in place effective management control measures to reduce this menace.

Table 3. Annual Rainfall Pattern in Akure between 2010 and 2019

Year	Rainfall (MM)
2010	170.3
2011	142.2
2012	132.6
2013	135.4
2014	134.6
2015	144.8
2016	134.29
2017	134.56
2018	134.87
2019	135.11
Mean = 139.873; SD = 11.8	

Source: Nigerian Metrological Agency (2016)

4.3 Methods of Waste Disposal Facility in the Study Area

It is nothing but a cliché to point out that issues of waste management in Nigeria is a hydra-headed problem with most of her urban and rural landscapes in dearth of infrastructure to manage their wastes. With regards to Ala riverfront residential area, it was heartrending to reveal that larger proportion of residents in this locale has been so lackadaisical in their attitude towards indiscriminate dumping of solid and liquid wastes on waterways. As shown in Figures 12 and 13, coupled with onsite observation, about 66% of the respondents dump their wastes in either drainages or directly into this river. This unhealthy practice often obstructs the swift flowing nature of this watercourse by creating bends and meanders which reduces its velocity and carriage capacity to contain excess water in the event of heavy downpour. The resultant effect of this unwholesome development did heightened incidents of flooding with devastating impacts on residents in the study area, ranging from health to socio-economic challenges. This finding is in consonance with the revelation of Akinola and Adewale [19], Owoeye and Adedeji [28] where it was uncovered that indiscriminate dumping of solid waste into streams, rivers and drainages, was a common practice in Ibadan and Akure metropolitan environment respectively with upsetting effects.

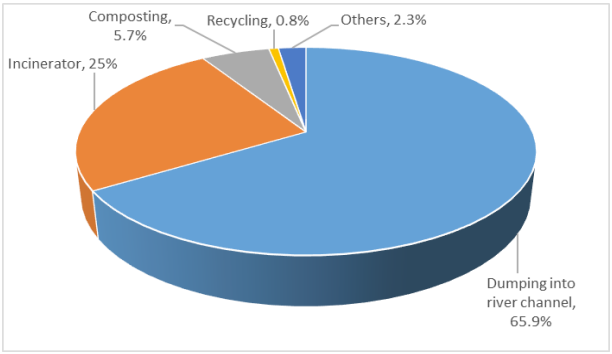

Figure 12. Waste Disposal Methods in the Study Area

Source: Field Survey (2019)

Figure 13. Drainage blocked by wastes in the study area

Source: Owoeye and Adedeji [28]

4.4 Level of Vulnerability and Community Compliance to Flood Control Measures

Issue of community participation in flood disaster management in terms of preparedness, response, recovery and mitigation is a topical discourse among scholars in Nigeria looking at the fact that the current top-down approach has failed from time immemorial. This is even considerate taking into account that matters of local peculiarities

and cultural anthropology would be better addressed. Conversely, data retrieved from residents in this locale with regards to this subject-view, as elicited in Figure 14, showed that community compliance to flood control measures was poor with about 56.1% of sampled respondents lend credence to this submission. Areas of concern by contiguous communities include contravention to town planning regulations, defiance to institutional forecast and warnings of impending flood incidents, among others.

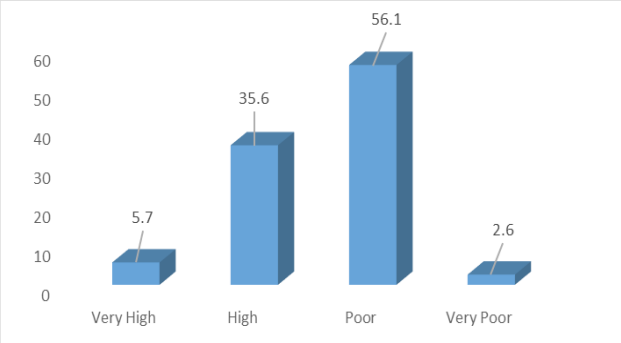

Figure 14. Level of community's compliance to flood control measures

Source: Field Survey (2019)

Quite disheartening to reveal from the interview with respondents that residents in these environs are hampered by socio-economic challenges which serve as principal factors accelerating their vulnerability to flooding. For instance, the income distribution of sampled respondents displayed in Figure 15 revealed that over 60% earn not more than N40,000 as monthly incomes. This practically reduce the capability to observe all precautionary measures by translating flood disaster forecasts and recommended mitigating measures into reality.

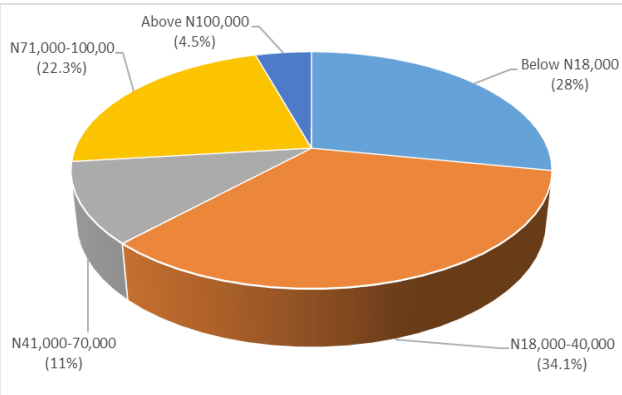

Figure 15. Monthly Income Distribution of Sampled Respondents

Source: Field Survey (2019)

The flood vulnerability map displayed in Figure 16 shows the area of high, medium and low vulnerability. The areas identified as highly vulnerable to flood are places where there is high drainage density with poor drainage system; especially, locations where the tributaries flow directly into the main river course. The medium and low vulnerable areas are less affected due to their distances from the main river course. Hence, there should be effective flood management measure for the areas vulnerable to curtail incessant flooding.

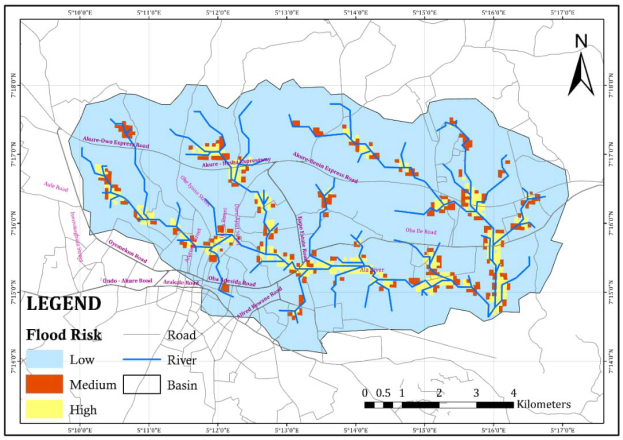

Figure 16. Map showing Flood Vulnerability in Ala River Basin

Source: Shuttle Radar Topography Mission (SRTM) Imagery (ArcGIS, 2019)

5. Conclusion and Policy Recommendations

Scholars across different professions in the built environment had overtime advocated for the need to reconcile human activities with nature so as to ebb down tendencies of socio-natural disasters arising from this binomial interplay. Paradoxically, this only exist in fiction as policy makers across different clime appears to show little or no commitment towards this direction. Investigation into human-environment interactions in the neighboring communities revealed indiscriminate erection of structures on wetlands, dumping of refuse into river channels and blockage of drainage system as well as defiance to environmental laws by residents in the community. The result of this incursion into Ala riparian zone had heightened issues of flood disasters in this locale with recurrent disruptions on socio-economic livelihoods and damages to material possessions. Thus, the following policy recommendations are proffered with a view to stemming the tide of flood disasters in the area:

(1) Public enlightenment campaign on the need to educate the residents on probable danger of flood disasters in their locality with a view to reducing their vulnerability.

(2) Enforcement of town planning regulations in Ala proximate residential areas by communicating appropriate notices to owners of buildings on flood prone landscape.

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(3) Provision of waste management infrastructure, which should be of utmost priority as residents are often constrained to dumping their wastes in river channels owing to dearth of these facilities within their vicinity.

(4) Regular cleanup of drainage systems in Ala contiguous communities should be enhanced with a view to ensuring free flow of water during heavy downpours to reduce incidents of flooding.

(5) Regular dredging of the river waterway to increase its capacity to absorb excessive water during and after torrential rainfall.

(6) Finally, the creation of integrated artificial lake as natural basin to collect large volume of water discharged from all watersheds leading to the river will be a sustainable invention to check incessant flooding in the area. This can, as well, be used for sustainable urban agriculture around the place in the form of irrigated farming and fishing activities.

Acknowledgment

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Conflict of Interest

Authors declare no conflict of interest regarding the publication of this article.

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