Over Population Shaped Escalation Settlement Acreage Region in Thar Desert, Pakistan

Vol. IV, **No.** III (Summer 2019) | **Pages:** 492 – 500 | **DOI:** 10.31703/grr.2019(IV-III).53
p- ISSN: 2616-955X | **e-ISSN:** 2663-7030 | **ISSN-L:** 2616-955X

Sujo Meghwar* | Muhammad Qasim Nizamani† | Farheen Qasim Nizamani‡

Abstract *Overpopulation led to the deterioration condition for natural and cultural apprehension that is an alarm to land morphology. Thar desert headed the most populous region in the world in the distribution of the population of 44 people per square kilometres. These dense disseminations upsurge the settlement. The anthropogenic responses were analyzed in SPSS, and it results in a huge land degradation transpired. The GIS investigated a village that is spreading 36 square kilometres during 67 last years. It is directed the alarming situation in future. The study suggested overpopulation creates problems for land, human, the environment and wildlife through different characteristics. In the imminent of time, it caused the geomorphic shifting.*

Key Words: Overpopulation, Deterioration, Cultural, Dissemination, Settlement, Anthropogenic, Human, Degradation

Introduction

Thar desert was one of the richest deserts in the world, which sustained multiple natural and cultural ecosystem. The world desert structured with different shape and environments such as terrestrial land area 2 percentages of North America, 30 percentages terrestrial region of Australia 45 percentages terrestrial land plastered by south Asia and Africa led 23 percentages terrestrial land in the globe (Tsoar,2005; Wolfe,1997&Alsharhan, A.S., Glennie, K.W. and Whittle, G.L.,1995). The desert found in both hemispheres (Northern & Southern); hence northern hemisphere is wrapped up in the large sand Sea with active physical phenomena (SanFilipo J.R., and et al., 1992&Imbrie, J. and et al., 1984), which is mainly located at the subtropical region in the world (IPCC, Cambridge, Climate Change,2007, Pye, et al.2009, Moharana P.C. and et al.,2013 &Alsharhan, A.S., Glennie, K.W. and Whittle, G.L.,1995). This region extended toward Arabia, North Africa, India sub-continent, mid-latitude and a basin of central Asia, was categorized by arid region (Sommer Stefan and Pfannkuche Olaf, 2000, Petraglia, M., 2007, Haslam, M., 2010, Mckee, 1979&Rupa Kumar and et al., 2006). It was generally appreciative major all continents were arid in the past year, which generated instability physically and culturally (Kar A., Moharana and et al., 2007, Stamp 1965&Serrano SMV and Moreno, J.I.L., 2005). But last two centuries, climatic and atmospheric circulation have been changed naturally, and its arid ratio was different such slight arid is 52.1 percentages, moderate arid 29.1 percentages and 18.5 percentages, sever arid land and 0.2 percentages were very severe arid land in the world(Sharma, K. K. and S. P. Mehra, 2009&Swanson, D., S. Barg, and et al., 2010). Therefore in the 20th century is counting the climatic variability. (Dregne 1986&Andrews E.Julian and et al, 1998).The land area of Thar was geographically influenced by the pacific climate since 17 century then; after the world climate changed, it was affected by the Indian monsoon system, which led to further climatic transformation to the Arabian Sea (Gupta, M. Shyam and Fernandes, A.A.,1997), which brought many climates changes toward the Thar desert (Dahl, Kristina, A. and at el., 2005, Rouault, M. and et al.,2003 &Wang,x., 2005). However, in recent centuries, the Indian monsoon is to be called the backbone of climate over the sub-continent (Andrews E.Julian and et al., 1998&Bhakar, R., 2007).

*Assistant Professors, Department of Geography, University of Sindh, Jamshoro, Sindh, Pakistan.
Email: sujo@usindh.edu.pk
†Assistant Professor, Department of Media & Communication Studies, University of Sindh, Jamshoro, Sindh, Pakistan.
‡Department of Media & Communication Studies, University of Sindh, Jamshoro, Sindh, Pakistan.

The world population is expected to increase; hence the desert population is successful risen (Boivin, Michael and et al., 2009 &Kar, A., 2009). It is estimated that all over desert population had been grown 0.39 to 2.5 billion during 1960-2000, it is calculated desert population has been increasing 13 percentage to 38 percentage during reported period (Reynolds et al. 2007). This expansion influenced to settlement feast, and it steered toward land degradation. The condition of the increasing population in South- Asia is highly dissimilar to other part of the world due to natural disaster like drought, famine, less monsoon. Especially Thar is the most populated region over this planet with 955,812 (Census 1998) in an area of 22000 km^2 (Alvi et al. 2008; Bhakar, Rajesh, 2007, Arif, 2009; Jiang et al. 2005). The high rate of population increased land degradation in the form of the increasing of settlement area (Bakliwal, S.K., Bhakar, Rajesh, 2007, and Wadhawan, S.K., 2003). Whereas in the 19thcentury, human activities have been increased in order to produce food, cultivation, harvest agricultural and building house(Hugenholtz, H. and Wolfe A. Stephen, 2003). These anthropogenic activities led to be a cause of land degradation.

This land deprivation demonstrated arid area over the period as aridity condition originated since Pleistocene glaciation geological era and it extended the land area frozen to ice cap (Misra, V.N., Rajaguru, S.N., 1989). Therefore it reported from Pleistocene that global ocean level shrinkage in the range of 100 meters to the modern epic produced more aridity over the globe (Stamp,1965&Alsharhan, A.S., Glennie, K.W. and Whittle, G.L.,1995).in this contrast land area of Antarctica and Greenland decreased that yielded more sand region to Asia, Europe and Australia continents. This land enforced to change in pattern in trade on equator and tropical which caused more arid and desert region over Asia and sub-continent (Stamp, 1965, Fontugne, M.R. and Duplessy, JC (1986) & Daniel, C.Edwards and Mckee, B. Thomas, 1997). Hence evidences demonstrated 14.2 percentages the world land area covered sandy desert, and this disorder of natural phenomena increased (Sankararaman, S., 2016). This enhancement reached 21 percentages of arid land area over the globe. But land ecosystem was used to be continuously, and it was increased 41 percentages arid land area from the land degradation ratio 38 percentages land appeared in great environmental problems where 7 billion population settled around the world (James, 2007&Alsharhan, A.S., Glennie, K.W., Pielke, R. A. and et al., 2002 and Whittle, G.L.,1995, Dearing, J.A. and et al., 2006). The ratio of the desert is higher in the southern hemisphere than in the northern hemisphere. As it is believed, worlds' biggest deserts, like Sahara, Gobi and arid regions in the world, are present in the northern hemisphere (Herani, M.Goband, Rajar Allah Wasayo and Khaskheli Muhammad Ali, 2007). In this environmental setting, the Thar desert has been used to be located in the northern hemisphere, and it was the most populous desert in the world (Pandey, D. N., 2007, SCOPE, 2010&Daniel, C.Edwards and Mckee, B. Thomas, 1997). This region used to be badly affected under harsh climatic condition, which produced aridity.

The aridity in the Thar desert created instability of climate, is led to demonstrate the scattering settlement (Ragab, R. and Prudhomme Christel, 2002). Thar desert is situated at the tropic of cancer in the northern hemisphere, is covered 22000km^2 land area.

The dust storm forced the population to live in desert vegetation as it is believed that vegetation is a succession of sand movement (Moss, R.H, 2008 and Clarkson, C.,2009). The peak time of dust storm used to be in June-September. This could distinguish the worst climatic condition, and it was triggered due to the El Nino system of the Arabia Sea (Rajbhandari, R., 2014). This sand movement of Thar desert caused the scattering settlement (Moss, R.H, 2010 and Moncel, M.-H., 2017)

Thar desert is covered 21 percentage of land from the total land area of Pakistan, which is represented a high density of population from the arid region. Land degradation is significantly occurred by the spread of settlement and cultivation (Figure 1). Because the degradation through cultivation is related to increase population, this region economy depended on rain-associated cultivation (Petraglia, M.,2009). Rain is the only water resource for the livelihood and economy of this area (Rockström, J., 2009). Therefore, cultivation land increasing through the growth of population (Salpeteur, M. and et al.,2015). Hence cultivation, population and settlement are demonstrated triangularly in the Thar desert (Winterhalder, B., C. Puleston, and C. Ross., 2015)).

Figure 1: Location Map of Thar Desert

This land degradation is an alarming factor to destroy the natural Phenomena of the region; it is urgent to take notice of these changes (Onaindia et al. 2017; Polissar et al. 2012, Roonwal, M.L., 1983& Li, Wenhing, 2008).

Research Methodology

The satellite image and aerial photograph were selected in the central part of the Thar desert, which demonstrated spread-out villages during 1950-2017. Aerial photographs selected the central part of the Thar desert to the location area of village Sobhihar and Malhiar because the central portion represented virtually the Thar desert. The aerial photograph was collected from a survey of Pakistan, which was taken under the Columbus plan 1950 under the supervision of the Canadian Government. The focal size of the camera was six (06) inches during a survey of taking a photograph.

The aerial photographs of 1950 marked with co-ordinates 70° 18' 05' east and 25° 19' 42' north, which were scanned at 800m resolution by EPSON scanner No. GT-7000 and it was overlapped the satellite Aqua and Terra images 2017 with the same co-ordinate in GIS 12.3.1 software at Universal Transverse Mercator (UTM) to the scale 1:40000 and a recent Google image 2017, which was marginalized by polygon between 1950-2017. The aerial photograph and satellite image were converted into ground distance map distance units in the following method.

Scale = focal lens/ flying height
Focal lens: 6 inches
Flying height: 20,000 feet
Unit conversion
Both the measurements should be in the same unit.
1 ft.= 12 inch then,
= 20,000×12= 240000 inches
As per formula
Scale = focal lens/ flying height
= 6/240000= 1/40000 = 1:40000

The survey questionnaire (250) was used to get an anthropogenic perception of local people about settlement spread. The survey questionnaire was emphasized over respondent of above age of 50 years old, because, this age

group were well aware of temporal changes. Questionnaire analyzed in software SPSS 22 (statistical Package for Social Science) with significant of 0.5 level.

Result

Thar desert is the highest rate of population with a densityof 44 km^2, is investigated directly to spread the land area of Villages. The help of structural questionnaire responded the overpopulation led to the enhancement of settlement and land area.

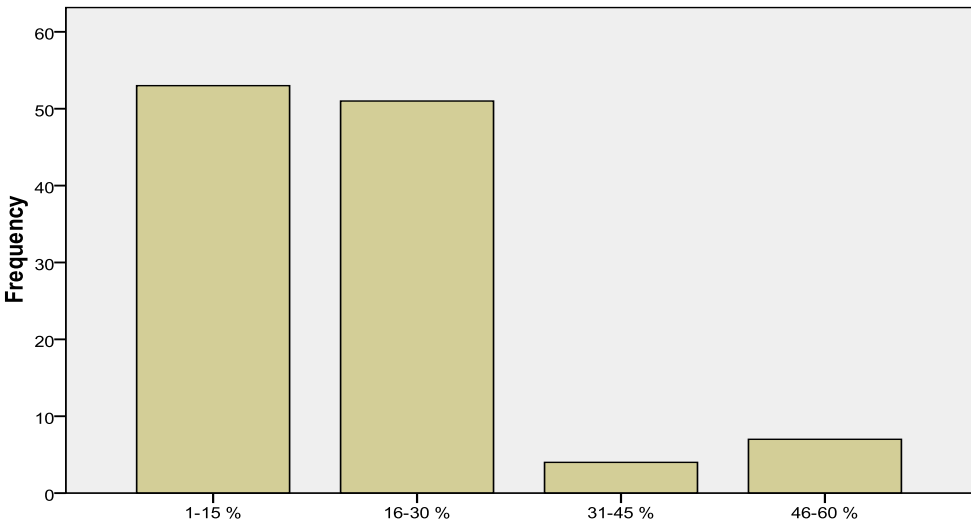

Figure 2: Expected Land Cover by Settlement

The 90-percentage anthropogenic response demonstrated around 27 land area covered by the settlement. This is a significant effect of the population over the land.

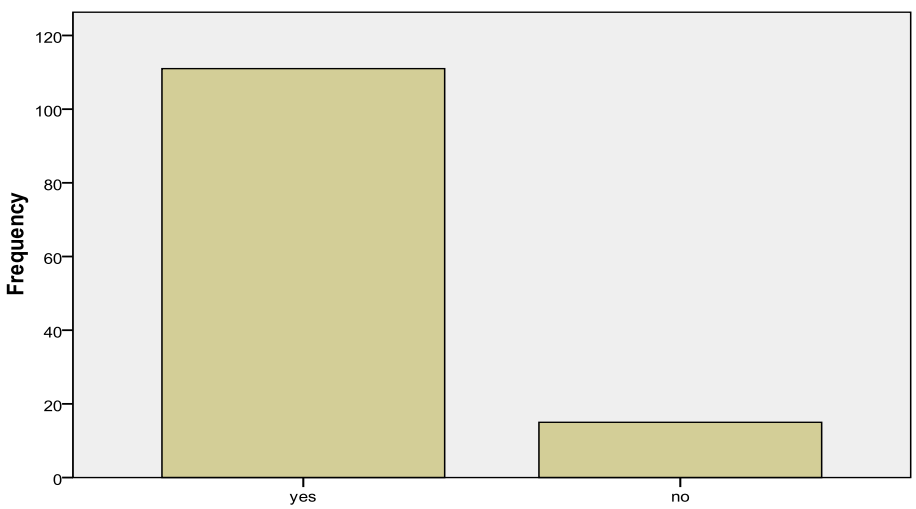

Figure 3: Over Polulation Enforce Increase Settlements Land Area

The land is severally affected by overpopulation through the anthropogenic survey, which was main a source of the changing of morphological structure in this region. The 88 percentages public responded to overpopulation enforced to increase settlement (Figure 3). It is suggested population force is alarming for multiple changes in future such as climate, environment, and geomorphologies.

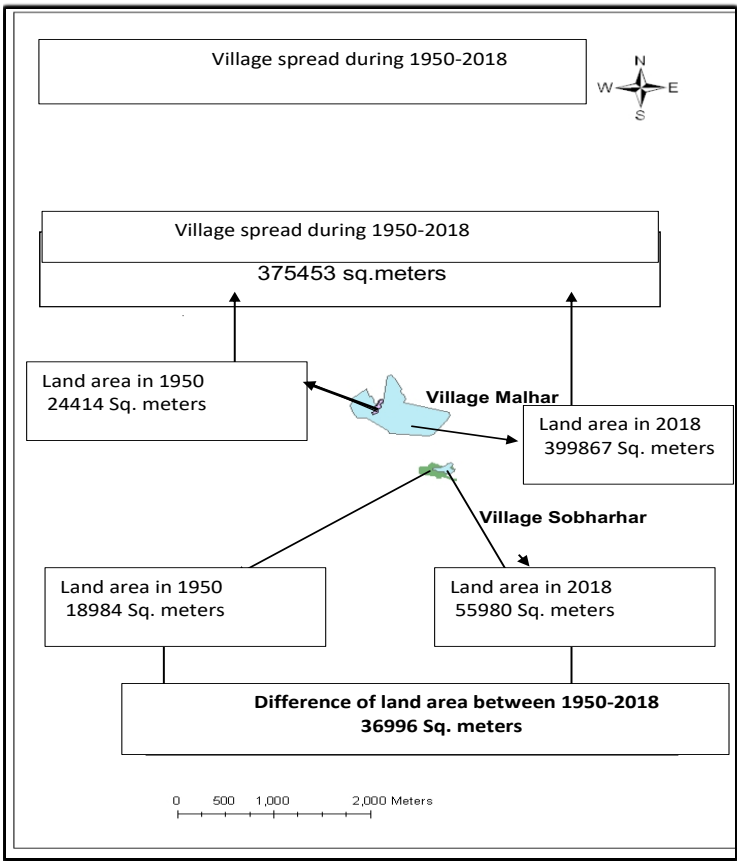

Figure 4: Actual Land Area Spread between 1950-2008

Despite these changes in the Thar desert, the large ratio of land area used for settlement, which commanded the increasing of settlement. In this context, the village Malhar land area was 24414 square meters in 1950, and it increased to 399867 square meters in 2017. That showed spread 376 square kilometres (375453 square meters) during 68 years. While village Sobharhar's land area was 18984 square meters which ranged to 55980 square meters with a difference of 36 square kilometres (36996 square meters) during reported years. This demonstrated significant land utilized by the population. This is suggested population is one major caused to spread out a settlement, is damaged geography and geology of Thar Desert in future. That could be in uncontrollable formations.

Reference

Alsharhan, A. S., Glennie, K.W. & Whittle, G. L. (1995). Quaternary deserts and climatic change: proceedings of the International Conference on Quaternary Deserts and Climatic Change: al-Ain, United Arab Emirates, 9-11 December, Taylor & Francis.

Alvi, S. K., Asghar, U., Parveen, F., Khan, F. A, & Usmani, T. H. (2008). Ground water quality of District Tharparkar, Sindh, Pakistan: Focus in fluride and Fluorosis. *Journal of chemical society of Pakistan*, *30*(3) 273.

Andrews, E. Julian & et al., (1998). Do Stable Isotope Data from Calcrete Record Late Pleistocene Monsoonal Climate Variation in the Thar Desert of India? Quaternary Research *50*, 240-251.

Arif, K. (2011) Combating desertification through agro-forestry approaches in semi-arid Tharparkar district, Pakistan, SCOPE.

Bakliwal, S. K., & Wadhawan, S. K. (2003). Geological evolution of Thar Desert in India - issues and prospects. Proceedings, India Natural Science Academy *69* A, 151-165.

Bhakar, R. (2007). Analysis of hydrological system and land cover for assessment of risks to irrigation agriculture in Thar desert: Charanwala system of the Indira Gandhi Canal project, M.sc Thesis for International institute of Geo-information sciences and Earth observation Enschede, Netherland.

Clarkson, C., Petraglia, M., Korisettar, R., Haslam, M., Boivin, N., Crowther, A., Ditchfield, P., Fuller, D., Miracle, P., Harris, C.,(2009) The oldest and longest enduring microlithic sequence in India: 35 000 years of modern human occupation and change at the Jwalapuram Locality 9 rockshelter. Antiquity 83, 326-348.

Dahl, Kristina, A. and at el, (2005) Terrigenous Plant wax inputs to the Arabian Sea: Implications for the reconstruction of winds associated with the Indian monsoon, Geochimica et CosmochimicaActa,USA, Vol.69, No.10, 2547-2558.

Daniel, C.Edwards and Mckee ,B. Thomas, (1997) Characteristics of 20th century drought in the United states at multiple time scales, Climatology report no.97-2, department of Atmospheric Science Colorado State University, Atmospheric Science paper no.634.

Dearing, J.A. and et al., (2006) Human-environment interactions: learning from the Past, Regional environment change Vol. 6, Numbers 1-2, Copernicus GmbH on behalf of the European Geosciences Union, 1-16.

Dregne, H. E. (1986) Desertification of arid lands. In *Physics of desertification,* ed. F. El-Baz and M. H. A. Hassan. Dordrecht, The Netherlands: Martinus, Nijhoff.

Fontugne, M.R. and Duplessy, JC (1986) Variation in the monsoon regime during the upper Quaternary: evidence from carbon isotopic record of organic matter in north Indian Ocean sediment cores, Palaeogeography, Palaeoclimatology, Palaeoecology 56, An International Journal for the Geo-Science 69– 88.

Gupta, M. Shyam and Fernandes, A.A.,(1997) Quaternary radiolarian faunal changes in the tropical Indian Ocean: inferences to Plaeomonsoonal Oscillation of the 10° s Hydrographic front, Current Science, Vol.72, No.12, 965-72.

Haslam, M., C. Clarkson, M. Petraglia, R. Korisettar, J.Bora, N. Boivin, P. Ditchfield, S. Jones andA.Mackay (2010). Indian Lithic Technology Prior to the 74,000 BP Toba Super-eruption: Searching foran Early Modern Human Signature. In K. Boyle, C.Gamble and O. Bar-Yosef (eds.), The UpperPalaeolithic Revolution in Global Perspective:Essays in Honour of Paul Mellars. Cambridge: *(PDF) Vol. I_IV.9. Ravi Korisettar and B. Janardhana*. Available from:https://www.researchgate.net/publication/261640831_Vol_I_IV9_Ravi_Korisettar_and_B_Janardhana [accessed Jan 05 2020]. McDonald Institute for Archaeological Research,pp. 73-84.

Herani, M. Goband, Rajar Allah Wasayo and Khaskheli Muhammad Ali, (2007), Reforming farming and rangeland in Tharparkar: Suggested implementations for income generation, Indus Journal of management & Social Sciences, Vol.1, 16-36.

Hugenholtz, H. and Wolfe A. Stephen, (2003) Recent stabilization of active sand dunes on the Canadian prairies and relation to recent climate variations, Geomorphology 68, 131-147.

Imbrie, J., J. D. Hays, D. G. Martinson, A. McIntyre, A. C. Mix, J. J. Morley, N. G. Pisias, W. L. Prell, and N. J. Shackleton (1984) The orbital theory of Pleistocene climate: support from a revised chronology of the marine d18O record. In Milankovitch and climate: understanding the response to astronomical forcing: proceedings of the NATO Advanced Research Workshop held 30 November–4 December, 1982 in Palisades, NY. A. Berger, J. Imbrie, H. Hays, G. Kukla, and B. Saltzman, eds. Pp. 269–305.

IPCC, Cambridge, Climate Change (2007) The Physical Science Basis. Contribution of the Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 996 pp. [Solomon, S., D. Qin., M. Manning., Z. Chen., M. Marquis., KB Averyt., M. Tignor and H.L.Miller (Eds)]. Cambridge University Press, Cambridge, U.K., and New York, the USA, 2007.

Jiang, L., Yufen, T., Zhao, Z., Li, T. and Liao, J. (2005) Water Resources, Land Exploration and Population Dynamics in Arid Areas: The Case of the Tarim River Basin in Xinjiang of China. Population and Environment, 26 (6), 471-503.

James F. Reynolds and et al., 2007, Global Desertification: Building a Science for Dry land Development, Science 316,847-851.

Kar A., Moharana P.C., Singh S.K., (2007) Desertification in arid western India. In: K.P.R.Vittal, R.L.Srivastava, N.L.Joshi, A.Kar, V.P.Tewari, S.Kathju (eds), Dryland Ecosystem: Indian Perspective, Central Arid Zone Research Institute, Jodhpur, and Arid Forest Research Institute, Jodhpur: 1–22.

Kar, A., (2009) Wind erosion potentials in the Thar-Megathar region from AD 1951 to 2100: Patterns and implications, Abstract in International conference on Nurturing Arid Zones for People and The Environment: Issues and Agenda For The 21st Century, November 24-28, 2009, CAZRI, Jodhpur, Rajasthan, India, pp. 24-25.

Li, Wenhing, (2008) Observed change of the standardized precipitation index, its potential cause and implications to future climate change in the Amazon region, Philosophical transactions of the royal society B 363, 1767-1772.

Mckee, D. Edwin (1979) A Study of Global Sand Seas, Geological Survey Professional Paper 1052, United Government Printing office, Washington, 187-199.

Michael Petraglia, Christopher Clarkson, Nicole Boivin, Michael Haslam, Ravi Korisettar, GyaneshwerChaubey, Peter Ditchfield, Dorian Fuller, Hannah James, Sacha Jones, Toomas Kivisild, Jinu Koshy, Marta Mirazón Lahr, MaitMetspalu, Richard Roberts, and Lee Arnold (2009) Population increase and environmental deterioration correspond with microlithic innovations in South Asia ca. 35,000 years ago. Proceedings of the National Academy of Sciences of the United States of America 106, 12261–12266.

Misra, V.N., Rajaguru, S.N., (1989) Palaeoenvironments and prehistory of the Thar Desert, Rajasthan, India. In: Frifelt, K., Sorensen, P. (Eds.), South Asian Archaeology 1985. Scandinavian Institute of Asian Studies Occasional *Papers 4*. Curzon Press, London, pp. 296–320.

Moharana P.C., Gaur M.C., Choudhary C., Chauhan J.S, Rajpurohit R.S., (2013). A system of geomorphological mapping for western Rajasthan with relevance for agricultural land use. Annals of Arid Zone 52:163–180.

Moncel, M.-H., Arzarello, M., Boëda, É., Bonilauri, T., Chevrier, B., Gaillard, C., Forestier, H., Yinghua, L., Sémah, F., Zeitoun, V., (2017). Assemblages with bifacial tools in Eurasia (second part). What is going on in the East? Data from India, Eastern Asia and Southeast Asia. Comptes Rendus Palevol.

Moss, H.R; Babiker, M; Brinkman, S; Calvo, E; Carter, T; Edmonds, J; Elgizouli, I; Emori, S; Erda, L; Hibbard, K; Jones, R; Kainuma, M; Kelleher, J; Lamarque, JF; Manning, M; Matthews, B; Meehl, G; Meyer, L; Mitchell, J; Nakicenovic, N; O'Neill, B; Pichs, T; Riahi, K; Rose, S; Runci, P; Stouffer, R; van Vuuren, D; Weyant, JWT; van Ypersele, JP; Zurek, M (2008) Towards new scenarios for analysis of emissions, climate change, impacts, and response strategies. Geneva: Intergovernmental Panel on Climate Change.

Moss, RH; Edmonds, JA; Hibbard, KA; Manning, MR; Rose, SK; van Vuuren, DP; Carter, TR; Emori, S; Kainuma, M; Kram, T; Meehl, GA; Mitchell, JFB; Nakicenovic, N; Riahi, K; Smith, SJ; Stouffer, RJ; Thomson, AM; Weyant, JP; Wilbanks, TJ (2010) 'The next generation of scenarios for climate change research and assessment.' Nature 463:747–756.

OnanidiaMiren and et al (2017), Vegetation diversity and vertical structure as indicators of forest disturbance, Forest ecology and management 195, 341-354.

Pandey, D. N., (2007) Sequential Restoration for Enhancement of Biodiversity and Productivity in Thar Desert, In, UNESCO-MAB International Workshop on Ensuring the Future of Drylands: Towards Implementing the MAB Agenda for a Sustainable Future of Drylands, 11- 15 November, 2007, AFRI/CAZRI, Jodhpur, India.

Peters, GP; Andrew, RM; Boden, T; Canadell, JG; Ciais, P; Le Quéré, C, Marland, G; Raupach, MR; Wilson, C (2012) 'The challenge to keep global warming below 2°C.' Nature Climate Change 3(1): 4–6. doi:10.1038/nclimate1783.

Petraglia, M., Korisettar, R., Boivin, N., Clarkson, C., Ditchfield, P., Jones, S., Koshy, J., Lahr, M.M., Oppenheimer, C., Pyle, D., Roberts, R., Schwenninger, J.-L., Arnold, L., White, K., (2007) Middle Paleolithic Assemblages from the Indian Subcontinent Before and After the Toba Super-Eruption. Science 317, 114-116.

Petraglia, M., Clarkson, C., Boivin, N., Haslam, M., Korisettar, R., Chaubey, G., Ditchfield, P., Fuller, D., James, H., Jones, S., (2009). Population increase and environmental deterioration correspond with microlithic innovations in South Asia ca. 35,000 years ago. Proceedings of the National Academy of Sciences 106, 12261.

Pielke, R. A. and et al, (2002) The influence of land-use change and landscape dynamics on the climate system: Relevance to climate-change policy beyond the radiative effect of greenhouse gases, Philosophical Transactions Royal Society London, B360, 1705–1719.

Polissar ,Pratigya J. and Freeman,H. (2012) Katherine, Effects of aridity and vegetation on plant-wax dD in modern lake sediments, Geochimica et CosmochimicaActa 74, 5785-5797.

Pye Kenneth and Haim Tsoar, (2009) Aeolian sand and sand dunes, Verlag, Heidelberg, Springer, Bern.

Ragab,R. and Prudhomme Christel, (2002)Climate change and water resources management in arid and semi-arid regions (Keynote paper): Prospective and challenges for 21st century (Keynote paper), Biosystems engineering, 81(1), 3-34.

Rajbhandari, R; Shrestha, AB; Kulkarni, A; Patwardhan, SK; Bajracharya, SR (2014) 'Projected changes in climate over the Indus river basin using a high resolution regional climate model (PRECIS).' Climate Dynamics 1–19

Reynolds, J. F., Mark, D. S.S., Eric F. L. , Turner, B. L., Mortimore, M., Simon P. J. B., Downing, T.E., Dowlatabadi, H., Fernández, R. J., Herrick, J.E., Sannwald, E.H. , Jiang, H., Leemans, R., Lynam, T., Maestre, F. T., Ayarza, M. and Walker, B. (2007) Global Desertification. Building a Science for Dry land Development Science, 847-851.

Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin, III, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. Schellnhuber, B. Nykvist, C. A. De Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. Foley., (2009) Planetary boundaries: exploring the safe operating space for humanity. Ecology and Society 14(2):32

Roonwal, M.L., (1983) Fauna of the Great Indian Desert (Past and Present composition). In: Singh, A. (Editor). Desert Resources and Technology-I. Scientific Publishers and Geo-Tech. Academy, Jodhpur, India. 1-86.

Rouault , M. and Richard, Y. (2003) Intensity and spatial extension of drought in South Africa at different time scales, water research, 29 (4)489-500.

Rupa Kumar, K., Sahai, A.K, Krishna Kumar, K, Patwardhan, SK. Mishra, P.K., Revadekar, J.V, Kamala, K, and Pant, G.P., (2006) High-resolution climate change scenarios for India for the 21st century. Current Sci. 90: 334-345.

Salpeteur, M., H. Patel, A. L. Balbo, X. Rubio-Campillo, M. Madella, P. Ajithprasad, and V. Reyes-García., (2015) When knowledge follows blood. Kin groups and the distribution of traditional knowledge in a community of seminomadic pastoralists, Gujarat (India). Current Anthropology 56 (3):471-483.

SanFilipo J.R., Wnuk Ch., Fariduddin M., Ahmad M., Khan S.A., Mehtab-ur-Rahman, Chandio A.H., Khan R.A., (1992) Potential for the occurrence of thick lignite deposits in Thar Desert and adjacent lower

Indus Plain, Singdh Province, Pakistan. Geological Survey of Pakistan and US Geological Survey, Open-File Report 92-576: 1–131.

Sankararaman, S., S. Mallick, N. Patterson, S. Sankararaman, S. Mallick, N. Patterson, and D. Reich., (2016) The combined landscape of Denisovan and Neanderthal ancestry in present-day humans report. Current Biology 26:1–7. Sankhyan, A. R. 2013. The emergence of Homo sapiens in South Asia: the Central Narmada Valley as witness. Human Biology Review 2:136–152. Shipton, C. 2016. Hierarchical organization in the Acheulean to Middle Paleolithic Transition at Bhimbetka, India. Cambridge Archaeological Journal 26:601–618.

SCOPE, 2010 Combating desertification through agro-forestry approaches in semi-arid Tharparkar district – Pakistan.

Sharma, K. K. and S. P. Mehra (2009), The Thar of Rajasthan (India): Ecology and Conservation of a Desert Ecosystem". Chapter 1 in: Sivaperuman, C., Baqri, Q. H., Ramaswamy, G., &Naseema, M. (eds.) Faunal ecology and conservation of the Great Indian Desert. Springer, Berlin Heidelberg.

Serrano S.M.V. and Moreno, J.I.L. (2005) Hydrological response to different time scale of climatological drought: an evolution of the standardized precipitation index in a mountainous Mediterranean basin, Hydrology and earth system sciences discussions,2, 221- 1246.

Sommer Stefan and Pfannkuche Olaf, (2000) Metazoan Meiofauna of the deep Arabian sea: Standing stocks, size spectra and regional variability in Relation to monsoon induced enhanced sedimentation regimes of Particulate organic matter, Deep-sea research-II, 47, 2957.

Stamp, L.Dudley (1965) A History of landuse in arid regions, UNESCO, Paris, 33-54,144-158.

Swanson, D., S. Barg, S. Tyler, H. Venema, S. Tomar, S. Bhadwal, S. Nair, D. Roy and J. Drexhage, (2010) Seven tools for creating adaptive policies, Technological Forecasting and Social Change, doi: 10.1016/j.techfore.2010.04.005, 2010. See also, Darren A. Swanson and SuruchiBhadwal (Editor), Creating Adaptive Policies: A Guide for Policy-making in an Uncertain World, Sage, IISD/IDRC/Sage, 2009, available at http://www.idrc.ca/openebooks/467-3/

Tsoar,H., (2005) Aeolian Geomorphology, Allen and Unwin, Boston.

Wang,x., (2005) evolution of the southern Mu Us desert in North China over the past 50 years: An analysis using proxies of Human activity and climate parameters,Land Degradation and Development , 16:,351–366 .

Winterhalder, B., C. Puleston, and C. Ross., (2015) Production risk, inter-annual food storage by households and population-level consequences in seasonal prehistoric agrarian societies. Environmental Archaeology. The Journal of Human Palaeoecology 20(4):337-348.

Wolfe, S.A., Huntley, D.J., David, P.P., Ollerhead, J. , Sauchyn, D.J., MacDonald, G.M. (2001) Late 18th Century drought-induced sand dune activity, Great Sand Hills, Saskatchewan, Canadian journal of Earth Sciences, 38, 105-1117.