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GEOGRAPHY, GEO-SCIENCES, ENVIRONMENTAL SCIENCE & DISASTER  
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## CONTENTS OF THE ISSUE

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- i. Copyright Notice
  - ii. Editorial Board Members
  - iii. Chief Author and Dean
  - iv. Contents of the Issue
- 
1. Reuse of the Boa Vista City Landfill Area through a Municipal Park. *1-10*
  2. Demographic Growth and Environment in Sub- Saharan Africa: An Analysis of the Panel Data on the 1980-2016 Period. *11-20*
  3. Sustainable Tourism for Regional Development in North-East States of India: Trends, Problems and Prospects. *21-34*
  4. Determining Temperature Trends in the Granary Areas of Peninsular Malaysia using Mann- Kendall and Sen's Slope Estimator. *35-53*
  5. The Devastating Effect of Gully Erosion Menace on Urban Infrastructures in Calabar Metropolis, Nigeria. *55-58*
- 
- v. Fellows
  - vi. Auxiliary Memberships
  - vii. Preferred Author Guidelines
  - viii. Index



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## Reuse of the Boa Vista City Landfill Area through a Municipal Park

By Manoel Valverde Pedrosa Silva, Francilene Cardoso Alves Fortes,  
Emerson Lopes De Amorim & Lucas Matos de Souza

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**Abstract-** The works of the Boa Vista city dump, has caused contamination of the its water resources. The objective of this research is offer possible ideas of measures for remediation of landfill area based on legislation, aiming at re-adaptation for the place. The study well founded on Document analysis and it's an exploratory qualitative research. On many literatures about the Boa Vista City landfill was found that lack of life perspective families and your children is low and still is added up with the socio-environmental issues, it makes them seek inadequate or unhealthy environments for their survival. Their only way of survival. This research has concluded that current garbage dump of capital is at a time conducive for having its activities closed and the site treated, because the Ministry of the Environment has implemented on 30th April, 2019, the "Zero Lixão" program, which aims to eradicate landfills and helps cities adjust to PNRS.

**Keywords:** *dump; re-adaptation; remediation; closure.*

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REUSE OF THE BOA VISTA CITY LANDFILL AREA THROUGH A MUNICIPAL PARK

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# Reuse of the Boa Vista City Landfill Area through a Municipal Park

## Reutilização Da Área Do Aterro Sanitário De Boa Vista-Rr Por Meio De Parque Municipal

Manoel Valverde Pedrosa Silva <sup>α</sup>, Francilene Cardoso Alves Fortes <sup>σ</sup>, Emerson Lopes De Amorim <sup>ρ</sup>  
& Lucas Matos de Souza <sup>ω</sup>

**Resumo-** O funcionamento do lixão a céu aberto tem causado a contaminação dos recursos hídricos em Boa Vista/RR. Este trabalho tem como objetivo propor a implantação de medidas para remediação da área do aterro sanitário perante a legislação, visando readequação do local. O estudo teve caráter bibliográfico, é uma pesquisa exploratória e qualitativa. Observou-se nas literaturas pesquisadas sobre o lixão de Boa Vista/RR que à falta de perspectiva de vida das famílias e crianças, somada as questões socioambientais, fazem com que busquem ambientes inadequados ou insalubres a sua sobrevivência, ou seja, idealiza no lixão o único meio de sobrevivência. Conclui-se que o atual depósito de lixo da capital está num momento propício a ter suas atividades encerradas e o local tratado. Visto que o ministério do meio ambiente lançou no dia 30 de abril de 2019 o programa lixão zero, que visa erradicar os lixões e ajuda os municípios a se adequarem PNRS.

**Palavras-chave:** lixões; reutilização; remediação; encerramento.

**Abstract-** The works of the Boa Vista city dump, has caused contamination of the its water resources. The objective of this research is offer possible ideas of measures for remediation of landfill area based on legislation, aiming at re-adaptation for the place. The study well founded on Document analysis and it's an exploratory qualitative research. On many literatures about the Boa Vista City landfill was found that lack of life perspective families and your children is low and still is added up with the socio-environmental issues, it makes them seek inadequate or unhealthy environments for their survival. Their only way of survival. This research has concluded that current garbage dump of capital is at a time conducive for having its activities closed and the site treated, because the Ministry of the Environment has implemented on 30<sup>th</sup> April, 2019, the "Zero Lixão" program, which aims to eradicate landfills and helps cities adjust to PNRS.

**Keywords:** dump; re-adaptation; remediation; closure.

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### I. INTRODUÇÃO

Na capital do Estado de Roraima, Boa Vista, são geradas 30 mil toneladas de lixo por mês segundo Costa (2015), e tais detritos são destinados ao aterro sanitário da cidade. E com base no Plano Municipal de Gestão Integrada de Resíduos Sólidos de Boa Vista - PMGIRS (2016) pode-se dizer que os resíduos depositados no aterro não tem tratamento ou seletividade prévia, isso condiz com Filho, Mendonça e Lopes (2017) que destacou que estas 30.000t de Resíduos Sólidos Urbanos-RSU são "jogadas no aterro sem nenhum cuidado com o meio ambiente, o que equivale a 1000 toneladas/dia".

Pelas condições, "tecnicamente a área não é considerada um aterro sanitário e sim um lixão, por não atender as normas técnica atuais", e ainda é tratado no Plano Municipal De Gestão Integrada De Resíduos Sólidos Da Capital como passivo ambiental (PMGIRS, 2016). Diante disso, uma ação civil pública foi apresentada contra a prefeitura de Boa Vista/RR no site Portal Amazônia (2017), a Construtora Soma Ltda. e a empresa Sanepav Saneamento Ambiental Ltda. requerendo o encerramento das atividades do atual aterro sanitário da capital, o lixão, e a construção do novo aterro sanitário para o município.

A ação foi impetrada pelo Ministério Público Federal (MPF), Ministério Público do Estado de Roraima (MPRR) e Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA). Conforme os termos da ação, as atividades executadas no lixão a céu aberto têm causado a contaminação dos recursos hídricos, superficiais ou subterrâneos na região da margem esquerda da BR-174, sobretudo do lençol freático da região e do igarapé Wai Grande (SANCHES, SOARES, OLIVEIRA JÚNIOR, 2016).

Ainda foi pedido um plano de encerramento para o aterro sanitário existente e a ação requereu que a prefeitura realize e apresente estudos ambientais que deem segurança à instalação de um novo aterro sanitário. Também foi solicitado a condenação dos réus a indenizar o dano material provocado ao meio ambiente, bem como pelo dano moral coletivo

ambiental, com medidas e prazos para a recuperação de toda a área degradada (PORTALAMAZONIA, 2017).

Por causa de problemas como esse, a Política Nacional dos Resíduos Sólidos-PNRS de 2010, determina a responsabilidade compartilhada dos geradores de resíduos e cria metas importantes que irão contribuir para a eliminação dos lixões atualmente em operação. Tais avanços geram, contudo, novos problemas ainda não encabeçados pelos órgãos competentes que é a destinação futura e reuso das áreas de tais aterros controlados e lixões após o seu fechamento.

Diante essa situação foi que surgiu o interesse para o desenvolvimento desta presente pesquisa. Pois, encerrar as atividades do lixão não é suficiente, já que o ambiente afetado deverá ser tratado porque a poluição está intrínseca no solo e sendo lançada ao ar em forma de gases, políticas públicas devem se fazer presente para evitar ocupação precoce do lugar, além de buscar soluções de remediação para tornar possível o uso futuro área.

O objetivo deste trabalho busca propor medidas de remediação do Aterro Sanitário de Boa Vista/RR perante a legislação, visando futuramente tornar possível o uso área, melhorando a qualidade ambiental e a qualidade de vida dos moradores do município. E os objetivos específicos foram pontuar alguns impactos no aterro de Boa Vista/RR e adjacências, apresentar medidas de remediação de acordo com as normas e parâmetros das leis vigentes; além de propor a criação de parque municipal como forma de recuperar o ambiente e trazer futuramente uma área de lazer.

Por fim para mostrar que é possível tal proposta, este estudo traz brevemente alguns projetos implantados pelo mundo que deram certos, mostrando que estudos técnicos de engenharia e arquitetura, têm viabilizado do uso de tais localidades e abrindo um vasto campo de conhecimento em estudos do solo, do ar e água.

#### a) *Aterro sanitário: impactos e desafios*

Segundo a Abrelpe (2018) relata que o Brasil produziu em 2017 de 71,6 milhões de toneladas de lixo e registrou um índice de coleta de 91,2% para todo o país, tal pesquisa mostrou ainda que 6,9 milhões de toneladas de resíduos não foram coletados e possivelmente tiveram destino inadequado.

Infelizmente grande parcela destes números é proveniente da construção civil, pois os desperdícios de resíduos nos canteiros de obras com as demolições durante reformas e a falta de tratamento diferenciado faz com que seja simplesmente descartado nos aterros e lixões ou reutilizados na própria obra sem qualquer estudo prévio, colocando em risco a segurança humana e ambiental.

Em Roraima um estudo realizado por Oliveira, et al. (2013) afirma que o aterro sanitário de Boa Vista/RR foi projetado para ser utilizado por 20 anos, mas com apenas com 10 anos de existência encontrava-se saturado, por receber mais de 600 toneladas de lixo produzidas diariamente pelos 250 mil habitantes do município na época, tornando-se uma fonte de degradação ambiental.

Segundo a Folha web (2017) mesmo depois de uma ação realizada pela Prefeitura de Boa Vista, quando catadores de lixo e seus familiares foram retirados do aterro sanitário da capital, a equipe de reportagem da Folha flagrou cerca de dez pessoas voltando a trabalhar no lixão. E a Secretaria Municipal de Serviços Públicos e Meio Ambiente/RR informou que todas as pessoas que insistem em continuar entrando no aterro sanitário eram retiradas pela empresa responsável do local e levadas para delegacia por descumprimento de mandado judicial. Assim outro desafio dos aterros, seriam suas fases posteriores ao encerramento das atividades, já que em muitos lugares os espaços ficam ociosos, e conforme Oliveira (2017) as pessoas começam a ocupar tais espaços de forma desordenada e para tanto o poder público deve se fazer presente e muito rigoroso, para que se evite exposição de risco.

Nesta perspectiva é que em cumprimento a Lei Federal 12.305/2010 que institui a Política Nacional de Resíduos Sólidos é que se estabelece a implementação do Plano Municipal de Gestão Integrada de Resíduos Sólidos de Boa Vista, trazendo consigo todos os itens obrigatórios para a operacionalização e sistematização dos resíduos gerados dentro dos seus limites geográficos (A2 Gestão Ambiental).

Embora não esteja assim tão cedo, percebe-se que o mundo está acordando para o futuro, e a otimização e ampliação da capacidade do aterro sanitário depende da Implantação do Plano de Gestão Integrada de Resíduos Sólidos Urbanos que preconiza, entre outras coisas, a universalização e a estruturação adequada dos serviços de coleta e a implantação de programas municipais de coleta seletiva, reciclagem, reaproveitamento e educação ambiental.

#### b) *Aterro e contaminação do solo e água*

Sendo assim, Albuquerque (2011) define aterro sanitário como um lugar adequado para a recepção de Resíduos Sólidos Urbanos (RSU) de origem doméstica, varrição de vias públicas e comércios. No entanto Besen (2011) afirma que quando os resíduos não são acondicionados adequados nos aterros sanitários, podem comprometer a qualidade do solo, da água e do ar: degradação do solo, poluição dos corpos de água e mananciais, poluição do ar e induzir a catação em condições insustentáveis nas ruas dos centros urbanos.

A falta de planejamento no uso dessas áreas e a crescente necessidade de deposição de mais resíduos acabam estimulando a proliferações de vetores nos “lixões” que acabam ingressando na cadeia alimentar dos seres humanos, transmitindo inúmeras doenças, tais como: “diarreias infecciosas, parasitoses, amebíase etc. Além de larvas de mosquitos vetores de doenças como a dengue e a leishmaniose” (SANCHES, SOARES, OLIVEIRA JÚNIOR, 2016).

Por fim, aterro sanitário deve ter tratamento em técnicas sanitárias de impermeabilização do solo mais aceitas, sendo a compactação e cobertura diária das células de lixo, coleta e tratamento de gases, bem como tratamento do chorume para que não atinja as águas subterrâneas, dentre outros métodos técnico que afastam os aspectos negativos da deposição final do lixo (FOLHA BOA VISTA, 2015).

c) *Remediação de acordo com as normas e parâmetros das leis vigentes*

Antes de qualquer ação para reutilização da área do aterro, deve se conhecer o local e ter atividades encerradas, depois medidas devem ser tomadas, como: recobrimento do maciço com camada de argila selante, drenagem de chorume e coleta de gases por meio de um controle rigoroso, e monitoramento por longos períodos. Embora para a recuperação destas áreas não existe regulamentação específica nem padrões de segurança na Resolução do CONAMA nº 430 (2011) estabelecem normas e parâmetros de qualidade das concentrações máximas de poluentes e posterior lançamento dos efluentes na natureza.

Para Reis (2015) a remediação mais barata é o reaproveitamento dos materiais que possam ser reutilizados, pois dependendo do tipo de material, este pode ser encaminhado para instalações de tratamento, instalações de reciclagem, ou ambos. O que não pode ser reciclado pode ser tratado e disposto em aterros. Na Alemanha havia 50.000 aterros no país. Hoje, devido às medidas restritivas da geração de RSU e reciclagem, são cerca de 200 aterros, e a meta é até 2020 reciclar 100% do que produz, reduzindo os seus resíduos e eliminando os aterros existentes.

No site Jornal Roraima Hoje (2017) o Sindicato da Construção Civil de Roraima Sinduscon aderiu às discussões da Prefeitura de Boa Vista sobre a implantação do Plano Municipal de Resíduos Sólidos, que propõe a destinação correta do lixo produzido pelo setor. Já que a substituição dos materiais convencionais pelo entulho resulta em economia na aquisição de matéria-prima. E com a reciclagem, há ainda a minimização da poluição causada pelos resíduos, que podem provocar enchentes e o assoreamento de rios e córregos.

d) *Proposta de criação de parque municipal*

Assim, a proposta deste projeto ganhou importância, pois existem estudos e ideias já postos em

prática para reutilização dessas áreas como uma forma de remediação delas por meio de parques verdes na América do Norte, Europa e até Oriente Médio. Acredita-se que o resto do mundo irá tratar seus antigos lixões e aterros para seu posterior reuso, que atualmente acontece por meio das novas ideias de espaços verdes, destinados a preservação e recuperação ambiental, contemplando o bem-estar coletivo e promovendo a qualidade de vida urbana (FERREIRA, 2006).

A área de estudo tem características que atendem a proposta de implantação do parque já que consiste em espaço aberto, comum e que pode servir como modelo para o Estado. Neste sentido, é surge à necessidade de mitigação dos danos ambientais com o encerramento do lixão na cidade de Boa Vista/RR, permitindo subsidiar uma tomada de decisão, acrescido nas normas vigentes.

Além de viabilizar um novo uso desta área com a proposta de intervenção urbana visando seus potenciais com técnicas paisagísticas e urbanísticas em Boa Vista, o planejamento se faz necessário, visto que o aterro não atende a legislação vigente, além de ser considerado lixão a céu aberto segundo a Folha de Boa Vista em 2015.

Pela dimensão desta proposta, torna-se uma alternativa interessante em transformar áreas que abrigavam lixões ou aterros controlados em parques públicos que atendem grande número de usuários, requalificando não apenas o espaço, mas também, a vida de seu público.

Por fim não se deve encarar os custos operacionais do aterro sanitário como prejuízo aos cofres municipais, deve-se pensar nos benefícios socioambientais e sanitários, com investigação detalhada dos riscos de contaminação que colocarão o município em consonância com a Lei nº 12.305/2010.

## II. METODOLOGIA

O presente estudo foi realizado na cidade de Boa Vista-RR, numa área de 5117,9 km<sup>2</sup>, com população estimada pelo IBGE (2018) em 375.374 pessoas. E o município possui um aterro sanitário situado nas coordenadas geográficas N02°44'30.2" e a W60°45'01.9".

O estudo teve caráter bibliográfico, uma pesquisa exploratória e qualitativa. E para a proposta de remediação do local abordado, este trabalho baseou-se em parâmetros de qualidade das normas e resoluções, entretanto vale ressaltar que estudos científicos norteiam o assunto, além da lei federal 12.305/10, com o fim dos lixões.

Assim buscou-se nas literaturas certa convergência com as Resoluções 420/09, e 430/11 do Conselho Nacional do Meio Ambiente- CONAMA que apresentam padrões de qualidades sobre critérios e

valores de qualidade do solo quanto à presença de substâncias químicas, e estabelecem diretrizes para o gerenciamento ambiental de áreas contaminadas por substâncias em geradas em atividades antrópicas e lançamento de efluentes em corpos d'água, bem como alguns parâmetros para criação para aterros sanitários.

Também se baseou no caderno técnico de reabilitação de áreas degradadas por resíduos sólidos urbanos da Fundação Estadual do Meio Ambiente – FEAM (2010), em pesquisas encabeçadas pela Abrelpe em 2017 e 2018 de mesma temática. Outra literatura que se fez de base a este trabalho foi a de Oliveira (2017) acerca de parâmetros jurídicos e técnicos para reutilização de uma área de aterro sanitário no Rio de Janeiro.

Estudos dos autores Falcão et al. (2012) e Filho, Mendonça e Lopes (2017) sobre o tema foram de grande relevância devido às composições químicas e minerais do solo do aterro, ocupações irregulares no Estado, bem como características da produção de RSU em Boa Vista, tratamento de chorume no aterro sanitário municipal e impactos aos arredores dele. E para uma melhor visualização da proposta, foi usado um programa, o REVIT, da empresa Autodesk já na

versão 2019, a mais atual e já disponível em mercado profissional, em busca de apresentar em modelo BIM.

### III. RESULTADOS E DISCUSSÕES

O estudo de Falcão et al. (2012) expôs a fragilidade e vulnerabilidade que o igarapé Wai Grande se submete, pela usabilidade de seus arredores no perímetro de Boa Vista, e por causa do lixão que está a menos de 150m das margens dele. A autora aponta a disposição irregular e de diferentes tipos de RSU, como: lixo domésticos, resíduos oriundos da construção civil e até galhadas jogadas por toda área do lixão que causam diversos impactos ambientais desde aéreo até as águas subterrâneas.

Diante deste contexto, na figura 1 (A) segundo Sanches, Soares, Oliveira Júnior (2016) ocorreu uma ação civil pública ambiental devido aos problemas existentes desde 2001 até os dias de hoje no aterro sanitário de Boa Vista- BV, verdadeiro “lixão ao céu aberto”, figura 1 (B) e aos descumprimentos de premissas das leis federais 6938/81 e 12.305/10 e lei estadual 416/04 da necessidade de construção de novo aterro sanitário.



Fonte: TEXEIRA (2002).



Fonte: SANEPAV (2019).

Figura 1: A - Área do Aterro sanitário 2002; B -Imagem do “aterro sanitário” em 2019.

Observou-se nas literaturas sobre o lixão de Boa Vista à falta de perspectiva de vida para as famílias e crianças, e isto somado as questões socioambientais, fazem com que busquem ambientes inadequados ou insalubres a sua sobrevivência, ou seja, idealiza em locais como o lixão o único meio de sobrevivência. Estes resultados estão em consonância com Lima publicado no G1/RR (2013) que mostram crianças recorrem ao lixão da capital, cerca de 12 km do centro da cidade para ajudar família, e em 2016 o Ministério público de Roraima-MPRR, segundo a Folha de Boa Vista notificou a prefeitura para retirar crianças e adolescentes do lixão. Pois busca no lixão sua fonte de renda.

Outros problemas evidenciados na ação pública de Sanches, Soares, Oliveira Júnior (2016) foram à constatação de focos de “incêndio” no local,

problemática altamente perigosa em face ao acúmulo natural de gás metano decorrente da decomposição que é muito inflamável. Também foi apontada ausência de tampa dos poços de visita da tubulação de concreto armado da drenagem gerando significativos riscos de acidentes, e ainda detectaram a concentração de maior volume da chuva nas tubulações de drenagem e o descarte do lixo domiciliar nas vias de acesso ao local.

Ainda, evidenciaram a inexistência de cobertura de terra ou de cobertura vegetal mínima no talude da célula de lixo domiciliar, circunstância que possibilita a ocorrência de desmoronamento e a presença crescente do número de catadores disputando os subprodutos despejados e que ocupam “praticamente toda a dependência do Aterro Sanitário”.

A fim de responder os objetivos apresentados foram propostas remediações no local do estudo de

acordo com as normas e parâmetros das leis vigentes. Inicialmente foi previsto no PMGIRS (2016), existência de duas possíveis áreas previstas, Figura 2 (A), sendo que a primeira apesar de estar embasada para o uso,

não seria viável, uma vez que é próximo ao atual lixão, e visivelmente imagem 1, próxima ao principal rio do Estado de Roraima, o rio Branco, em situação a jusante.



Fonte: Adaptada pelo autor (2019).

Figura 2: A- Áreas previstas para o novo aterro sanitário de Boa Vista/RR;

Na situação descrita no documento PMGIRS feito em 2016, a melhor proposta é utilização da área 2, que foi selecionada por conta da direção dos ventos, que não propagará odores ou gases em direções da cidade, e outro critério descrito no documento que influenciou na pré-seleção foi que a área é pouco drenável. Isto evitaria novas contaminações de igarapés da região por meio da percolação podendo chegar até o lençol freático, evitaria que detritos fossem parar em locais da vizinhança, causando enchentes e alagamentos no município.

Segundo o G1/RR (2016) havia a presença de pessoas não autorizadas, incluindo crianças e adolescentes, e em visita no dia 14/05/2019, constatou-se que atualmente existem vigias diurnos e noturnos para impedir que pessoas não autorizadas adentrem no espaço, além de cercas de proteção e escavações profundas no solo por fora da cerca para dificultar a entrada, entretanto, alguns indivíduos no período da noite tentam entrar por outros meios em busca principalmente de metais como alumínio (Al) e cobre (Cu). Notou-se durante a visita que a antiga cooperativa USIRENDA está desativa e sem funcionamento, ou seja, todo resíduo chegado ao aterro, não tem seletividade prévia, é apenas aterrado.

Para evitar novas ocorrências, o autor acima relata a necessidade da criação de políticas públicas que permitam melhor qualidade de vida para as famílias, este projeto propõe palestras voltadas a educação ambiental, uso de equipamentos de segurança adequada para o serviço com o intuito de minimizar os impactos em sua saúde, implantação de usinas de reciclagem no novo aterro sanitário para separação e seleção de materiais a serem reutilizados, e para a empresa, incentivo fiscal para implantação destes serviços. Assim, desta forma estariam em um novo ambiente legalizado, fora da nocividade do antigo lixão e construções adequadas.

E para remediação do chorume produzido, já existe uma coleta como consta na Figura 3, esta situação segundo Filho, Mendonça e Lopes (2017) é “propícia para o tratamento biológico devido à localização geográfica e aos fatores climáticos da região, assim como por questões político-econômicas”. Entretanto os autores destacam que o resultado do tratamento atual do lixiviado não atende aos valores estabelecidos pela legislação ambiental brasileira – Resolução N° 357/2005 acerca do lançamento de efluentes líquidos em corpos receptores.



Fonte: Autor (2019).

Figura 3: Estação de coleta atual do chorume produzido no lixão

Os autores acima ainda propõem uma excelente alternativa ao tratamento do chorume são os banhados construídos-wetlands constructed, é um método eco tecnológico de polimento de efluentes de tratamento secundário ou terciário de esgoto doméstico, removendo constituintes orgânicos e inorgânicos. Afirmam que se bem projetado e dimensionado apresenta eficiência de até 80% na remoção de lixiviados.

Portanto ainda é destacado que este sistema é mais bem aproveitado se houver um sistema complementar vindo do processo anaeróbico, e justamente a ETC do aterro sanitário de Boa Vista/RR é composto por uma lagoa anaeróbia. Desta forma,

poderia ser economicamente viável e possível enquadrando assim o seu lançamento no corpo hídrico conforme a Resolução Nº 357/2005 do CONAMA.

Quanto à ausência de tampas nos poços de visita anteriormente citado no processo, durante a visita, foi observado que os poços de visitas estão devidamente tampados como exemplifica a figura 4 (A), entretanto uma readequação no projeto de drenagem de gases e chorume poderiam ser realizadas e implementadas, a fim de identificar os pontos que possam está sem proteção por deterioração e ainda aumentar a capacidade de drenagem dos fluidos do processo de decomposição dos detritos.



Fonte: Autor (2019).



Fonte: Autor (2019).

Figura 4: A - Poço de visita devidamente tampado; B - Presença de focos de incêndios.

E em busca de evitar focos de “incêndio” ainda presentes no local como está demonstrado na figura 4 (B), propõe-se implantação de um novo sistema de captação e tratamento dos gases para que por meio de uma usina que produtora de biogás em parceria com centros, universidades, Embrapa e órgãos competentes no município de Boa Vista/RR. Pois Santos (2018) em seus estudos com software Biogás, “estimou que o aterro necessitaria de 35 drenos e instalação das tubulações de acordo com a área total do aterro, estimado em aproximadamente 67.809 m<sup>2</sup> “. E teria uma potência de 3,94 KW, com produção de até 660.000,00 KWh/mês.

Os estudos do autor acima mostraram que o ápice da potência gerada seria em 2022, com um total de até 10.608,00 KW, e com o tempo a geração de gases iria diminuindo tendo seu fim útil de produção em 2034 com produção de 2.367,00 KW. Teria então um custo de investimento inicial de R\$ 2.836.019,43, relativamente baixo considerando que o retorno seria de 1 ano, 1 mês e 17 dias, sendo expressivamente rápido. E tornando um empreendimento bem valorizado com o VPL– Valor Presente Líquido positivo de R\$ 35.089.165,46 conforme suas análises de software e dados do trabalho desenvolvido.

A análise feita por Santos (2018) em que os valores ao final dos 15 anos de sua implantação são

satisfatórios pelo valor do VPL positivo refletiria na população através de uma melhor qualidade de vida, reduzindo a emissão de gases poluentes na atmosfera, cerca de 802.580 mil toneladas de (CO<sub>2</sub>) ao final dos 15 anos de operação da usina.

Diretamente isto minimizaria um grande problema dos gases no lixão e contribuiria com o sistema energético em Boa Vista/RR, pois devido à crise na Venezuela, o Estado de Roraima está gastando cerca de um milhão de litros de diesel por dia segundo Carvalho na folha de Boa Vista (2017), e em poucos dias somam cerca de 70 milhões de reais, a uma taxa de 3,5 mi por dia.

A proposta para inexistência de cobertura de terra ou de cobertura vegetal foi implantar curvas de nível que evitem o carreamento do solo exposto, pela ação da chuva, além de recobrir o maciço. Uma vez tendo o solo tratado, pode-se investir em determinados tipos de plantas e árvores que auxiliam no tratamento do ar e na estética do local. E a FEAM (2010) recomenda que a camada utilizada para o plantio acima da camada dispersora de cargas introduzida nessa proposta, sobre a camada selante argilosa seja suficiente para garantir que as raízes não entrem em contato com os resíduos dispostos, no máximo até a camada de argila da cobertura final. Outra possibilidade seria utilizar o método de fitoremediação: “técnica que

emprega as espécies vegetais e obtém a energia necessária para realizar a remediação proveniente do seu próprio metabolismo quando realiza a fotossíntese” (PEREIRA, 2013).

Já Santos (2018) em seu estudo relata construção de muros de contenções por geocélula, para que não haja desmoronamentos/ deslizamentos do maciço. No site da empresa PRS Geo-technologies encontra-se uma série de estudos sobre os muros com geocélula, que devido sua alta resistência à oxidação, à degradação por calor e radiação UV, além dos aditivos também serem protegidos da lixiviação, proporcionando durabilidade a longo prazo, o que torna o produto propenso para o uso de taludes no aterro sanitário em Boa Vista/RR.

Esta solução também pode ser utilizada em cima da camada de solo para o recobrimento do maciço, e ainda auxiliará mais na impermeabilização das camadas de lixo no interior do maciço, pois requer um preparo de compactação, e uma manta para base da geocélula. Este produto ainda tem a capacidade de ser utilizado em solos locais e materiais reciclados economiza em recursos de agregados, reduz o transporte de caminhões e os trabalhos de terraplenagem no local, que segundo a empresa PRS é uma forma de economizar já que não se utiliza de concreto, rochas e alta taxa de armadura.

Desta forma, resíduos de concreto e alvenaria podem ser empregados em alguns casos com a geocélula, pois esta usa preenchimento granular de baixa qualidade. Já que a solução não está apenas no material de preenchimento, mas no confinamento geocelular na contenção do próprio aterro. Ainda sobre remediação dos resíduos da construção civil existem trabalhos com a reutilização de concreto para fins não estruturais, assim como alvenaria convencional.

Segundo Feam (2010) após o tratamento da área, deve-se pensar no reuso da área em forma de

beneficiar o máximo de pessoas da região, sendo assim o método mais aconselhável é por meio de parques verdes os quais devem conter equipamentos e espaços comunitários como: praças, campos de futebol, ginásticas ao ar livre semelhantes aos já encontrados em algumas praças brasileiras.

Desta forma Oliveira (2017) cita casos de sucesso pelo mundo como: Sang-Am Millennium Park na Coreia do Sul; La Vall d'en Joan na Espanha; Hiriya em Israel. E também um dos mais icônicos, como parque de Fresh kills nos Estados Unidos da América, que foi o maior lixão do mundo até 1990 ano de fechamento, atualmente funciona como um lugar ecológico, tem três vezes o tamanho do Central Park. O qual gera energia através do biogás, além do lazer com trilhas, lagos e espaços verdes.

No Brasil têm-se exemplos bem singelos, como em São Paulo, outros parques foram erguidos sob antigos depósitos de lixo, como é o caso dos parques *Villa Lobos, da Juventude* e Raposo Tavares. Dentre eles o de Várzea Paulista (SP) onde o antigo aterro sanitário da cidade está se transformando no Parque das Orquídeas, com quadras poliesportivas e arborização (NAKAMURA, 2010). Outro exemplo foi trabalho realizado por Freitas et. al (2016) de requalificações de Lixões e Aterros, Proposta de Projeto de um Parque Municipal após Encerramento do Aterro Controlado da Cidade de Santo Ângelo – RS.

Observa-se que com a desativação do lixão demonstrado na Figura 5 (A) pode demorar com a instalação deste projeto no município por se tratar de uma área instável de decomposição de resíduos sólidos. Assim deve-se monitorar para que não ocorram deslizamentos de massa na área do parque.



Fonte: SANEPAV (2019).

Fonte: Autor (2019).

Figura 5: A –Atual Lixão (DJI-0207); B – Implantação do Parque.

Então após as análises dos monitoramentos e com as devidas autorizações ambientais, pode dizer que a implantação de um parque ecológico Figura 6 (A)

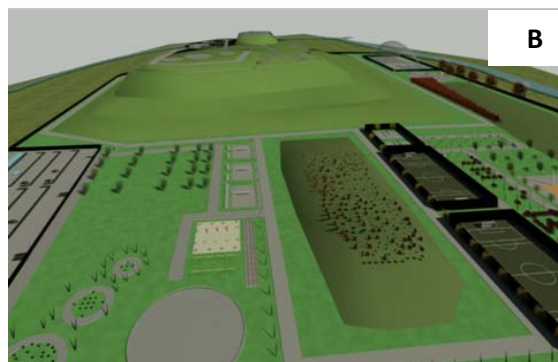
após a finalização do aterro, é a forma mais eficaz de recuperação desta área degradada, pois transforma um problema local em uma benfeitoria municipal, elevando

a satisfação da população da região e do município como um todo, além de atrair o turismo para a cidade. Assim na figura 6 (B) propõem que na área do parque sejam inseridos equipamentos públicos voltados às

carências da comunidade como quadras, pistas de caminhada, campos de futebol e outros que faltam para o lazer, cultura e inserção social na comunidade.



Fonte: Autor (2019).



Fonte: Autor (2019).

**Figura 6:** A – Proposta de modelo de parque, vista lateral espaço aberto; B - Modelo de parque, vista do espaço aberto com calçadas e área esportiva

Espera-se que a presente proposta seja implantada, e que chamem atenção dos órgãos competentes que deverão se atentar as solicitações da população do entorno da área diretamente afetada, pois com procedimentos adequados na execução da nova proposta, emprego de tecnologia visando o controle e monitoramento da qualidade ambiental da região, geração de emprego e renda para a população, possibilitarão o desenvolvimento de boas práticas operacionais e pesquisas científicas que potencializarão outras novas propostas a serem instalados no Estado de Roraima.

#### IV. CONSIDERAÇÕES FINAIS

Conclui-se que o atual depósito de lixo da capital está num momento propício a ter suas atividades encerradas e o local tratado. Visto que o ministério do meio ambiente lançou no dia 30 de abril de 2019 o programa lixão zero, que visa erradicar os lixões e ajuda os municípios a se adequarem PNRS.

Estudos aprofundados precisam ser feitos para implantação da usina de biogás, assim como para estabilização dos taludes no aterro. Bem como, ensaio de toxicidade se faz necessário a fim verificar concentração de metais pesados e outras substâncias que possam afetar a saúde humana. É de grande importância o remanejamento das pessoas que se sustentam do lixão, para usinas de reciclagem e programas sociais, bem como suas crianças, oferecendo educação e cursos profissionalizantes a todos.

A fim de trazer uma nova paisagem à entrada da capital, o presente trabalho trouxe um à proposta bastante interessante, com a implantação de um parque com trabalho paisagístico, locais esportivos,

dentre outros, como mostrado nos anexos de 10 a 12 desta pesquisa.

Neste sentido, este estudo será apresentado aos órgãos competentes para adequações e poderá levar o município a se destacar no ranking do Instituto Trata Brasil, como uma as 20 melhores de capitais saneamento do Brasil.

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## Demographic Growth and Environment in Sub- Saharan Africa: An Analysis of the Panel Data on the 1980-2016 Period

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**Abstract-** The objective of this paper is to determine the impact of the demographic growth on environment in the Sub- Saharan Africa. The data come from the World Bank (Africa Development Indicators, 2017). The study period goes from 1980 to 2016 (37 years) and the sample contains 25 Sub- Saharan Africa countries. The estimate Within/Between method is used to value the parameters of a multiple regression model developed by York and al. (2003). The results show that the demographic growth deteriorate the environmental quality in the Sub-Saharan Africa.

**Keywords:** *demographic growth, environment, sub-saharan africa, panel.*

**GJHSS-B Classification:** *FOR Code: 059999p*



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# Demographic Growth and Environment in Sub-Saharan Africa: An Analysis of the Panel Data on the 1980-2016 Period

## Croissance Démographique Et Environnement En Afrique Subsaharienne: Une Analyse Des Données De Panel Sur La Période 1980-2016

Patrick Geoffroy Nkwenka Nyanda <sup>α</sup> & Yve Daniel Ngassa Nya <sup>ο</sup>

**Résumé-** L'objectif de ce papier est de déterminer l'effet de la croissance démographique sur l'environnement en Afrique Subsaharienne. Les données analysées proviennent de la Banque Mondiale (Africa Development Indicators, 2017). La période d'analyse va de 1980 à 2016 (37 ans) et l'échantillon d'étude est constitué de 25 pays d'Afrique Subsaharienne. La méthode Within/Between a été utilisée pour estimer un modèle de régression multiple inspiré des travaux de York *et al.* (2003). Les résultats montrent que la croissance démographique détériore la qualité de l'environnement en Afrique Subsaharienne.

**Mots clés:** croissance démographique, environnement, Afrique Subsaharienne, panel.

**Abstract-** The objective of this paper is to determine the impact of the demographic growth on environment in the Sub-Saharan Africa. The data come from the World Bank (Africa Development Indicators, 2017). The study period goes from 1980 to 2016 (37 years) and the sample contains 25 Sub-Saharan Africa countries. The estimate Within/Between method is used to value the parameters of a multiple regression model developed by York *and al.* (2003). The results show that the demographic growth deteriorate the environmental quality in the Sub-Saharan Africa.

**Keywords:** demographic growth, environment, sub-saharan africa, panel.

### I. INTRODUCTION

Depuis le début des années 1970, la communauté scientifique internationale s'interroge sur la capacité de la nature à fournir des ressources nécessaires à la poursuite de la croissance économique (Meadows *et al.*, 1972). Selon le PNUD (2009), les progrès techniques ont permis à l'homme de se lancer dans une course effrénée vers la création de richesses en s'attaquant à des ressources naturelles non renouvelables ou dont le rythme de renouvellement est beaucoup plus lent que celui de leur exploitation. D'ailleurs, le Rapport Meadows (1972) énonce que l'épuisement des ressources naturelles, les diverses pollutions dues à l'industrialisation, à l'urbanisation et à la surconsommation des biens constituent les

principaux obstacles à la préservation de l'environnement dans le monde, notamment dans les économies Africaines qui connaissent une amélioration de leurs taux de croissance depuis quelques années (CNUCED, 2013).

Selon la CNUCED (2013), l'économie Africaine a affiché un taux de croissance de plus de 4%, soit plus que l'Amérique Latine et les Caraïbes (3,4%) et l'Europe et l'Asie Centrale (0,2%), entre 2008 et 2011, période de grande incertitude mondiale. Par ailleurs, sur la période allant de 2002 à 2012, l'Afrique a connu un taux de croissance économique (4,9%) supérieur à la moyenne mondiale (2,6%); ce qui lui a permis de se situer au deuxième rang des économies en développement derrière les économies Asiatiques (7,3%). L'Afrique Subsaharienne (ASS) a réalisé sur cette même période un taux de croissance économique (5,3%) supérieur à celui de l'ensemble de l'Afrique (4,9%), des économies émergentes (3,9%) et comparable à celui des économies d'Asie du Sud-Est (5,4%).

Selon la Banque Mondiale (2010), cette croissance de l'économie Africaine a reposé sur une exploitation accrue des ressources naturelles non renouvelables, ce qui s'est traduite par une augmentation des émissions de CO<sub>2</sub> dans ce continent. Le rapport de l'AIE (2012) révèle que les quantités totales de CO<sub>2</sub> émises par l'Afrique ont augmenté de 35%, atteignant environ 930 millions de tonnes métriques en 2010 au cours de la dernière décennie. Entre 1960 et 2016, l'ASS a enregistré une augmentation de 282% de son volume total d'émission de CO<sub>2</sub>, l'Afrique du Sud et le Nigeria étant les premiers contributeurs (Africa Development Indicators, 2017).

La croissance des émissions de CO<sub>2</sub> dans les pays d'ASS exige la mise sur pied des politiques de croissance verte pour atteindre les Objectif de Développement Durable (ODD). La 21<sup>é</sup> Conférence des Nations Unies sur le changement climatique (COP21) tenue à Paris en 2015 s'interroge, entre autres, sur la contribution de la croissance démographique à la dégradation de l'environnement dans les pays en

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développement (ONU, 2016). Cette préoccupation pousse à examiner deux principaux courants théoriques sur la population : les courants malthusien et anti-malthusien. Selon le premier (Malthus, 1798 ; McNamara, 1990 ; Marquette et Bilsborrow, 1997), la croissance démographique dégrade la qualité de l'environnement. Cependant, le second énonce que la croissance démographique, sous certaines conditions, peut améliorer la qualité de l'environnement à long terme (Boserup, 1976).

L'intérêt accordé à l'impact environnemental de la croissance démographique en ASS se justifie par la progression des émissions de CO<sub>2</sub> et le contexte démographique de cette sous-région qui enregistre depuis plusieurs années une augmentation significative de sa population. En ASS, les taux de fécondité sont élevés (environ 6,5%), l'espérance de vie a progressé de 43 à 51 ans depuis 1965 et le taux d'accroissement de la population est de 3% par an (Banque Mondiale, 2010). Par ailleurs, sa population a été multipliée par sept entre les années 1900 et 2000. Elle devrait passer de 750 millions à 1,5 milliards d'habitants entre les années 2000 et 2030. L'ASS aura ainsi à gérer en moyenne un doublement de sa population totale et un triplement de sa population urbaine entre 2000 et 2030 (ONU, 2013). Selon l'ONU (2016), cette croissance rapide de la population affecte l'environnement à travers ses effets sur l'agriculture, la déforestation et l'utilisation des combustibles fossiles.

Les pays Africains ont été responsables de plus de la moitié des pertes de forêts enregistrées dans le monde entre 2000 et 2005 ; et la perte nette de forêts a atteint 3,4 millions d'hectares par an entre 2000 et 2010 (FAO, 2011). Sur dix des pays qui ont connu les taux de déboisement les plus élevés dans le monde, sept<sup>1</sup> se trouvent en Afrique dont 6 en ASS (Unmubig et Cramer, 2008). Par ailleurs, la plupart des habitants d'ASS dépendent de la terre pour vivre (McNamara, 1990). Les activités agricoles qui émettent du méthane et de l'oxyde nitreux, ainsi que le déboisement qui réduit les puits de carbone sont plus intenses dans les pays en développement, notamment en ASS (Nyong, 2008).

Les pays en développement en général et ceux d'ASS en particulier sont interpellés au terme de la COP21 à participer aux efforts de réduction des émissions de CO<sub>2</sub>. Par ailleurs, le 13<sup>é</sup> ODD recommande la lutte contre le changement climatique et ses impacts. Dans ce contexte, comment peut-on concilier la croissance démographique et la préservation de l'environnement afin de promouvoir une croissance durable ? L'objectif de ce papier est de déterminer l'effet de la croissance démographique sur l'environnement en ASS.

Le reste du papier comprend 4 sections: une revue de la littérature (II), la méthodologie utilisée (III), les résultats obtenus (IV) et la conclusion (V).

## II. REVUE DE LA LITTÉRATURE

### a) Littérature théorique

#### i. Les pessimistes

- Malthus
 

Il y a deux siècles, Malthus publiait son célèbre ouvrage intitulé « Essai sur le principe de la population » (Malthus, 1798). Le but de l'ouvrage était d'analyser le principe de la population et son influence sur les progrès futurs de la société. Dans cet ouvrage majeur de l'économie classique de la fin du dix-huitième siècle, Malthus présente la population comme un danger pour la croissance économique et la production agricole.

- Les néomalthusiens

Si les travaux de Malthus portent sur la production agricole et n'abordent pas directement les questions environnementales, les néomalthusiens ont étendu ses travaux à l'environnement. La théorie néomalthusienne énonce qu'une population trop importante dégrade l'environnement et les moyens de sa production agricole (comme les sols).

Selon Meadows *et al.* (1972), les ressources naturelles seront épuisées dans un siècle si la croissance démographique ne s'arrête pas. La destruction écologique de la planète dépend du nombre absolu d'individus qui y vivent. En 1969, Ehrlich qualifie la population de « bombe-population » (Ehrlich et Ehrlich, 1969). Hardin (1968) postule qu'un monde fini ne peut supporter qu'une population finie : quand la population augmente, les biens, les ressources ou les produits alimentaires par habitant diminuent jusqu'à s'annuler.

La « capacité de charge » se définit comme la population maximale que peut supporter indéfiniment un écosystème donné sans dégrader les ressources renouvelables (Keyfitz, 1991). Le concept de capacité de charge a conduit à des nombreuses études de projection et de modélisation sur le nombre d'humains que peut supporter indéfiniment la planète Terre (Ramade, 1987). Les faits montrent un dépassement de la taille de population supportable : les humains dilapideraient les ressources et détruiraient la planète (Marquette et Bilsborrow, 1997). L'arrêt de la croissance démographique serait alors urgent. Les néomalthusiens préconisent donc des mesures de limitation des naissances, en particulier dans les pays en développement.

#### ii. Les optimistes

Pour les optimistes, l'accroissement démographique n'est pas un danger pour l'environnement. Depuis le seizième siècle, de nombreux économistes ont eu une approche optimiste de la croissance démographique en montrant qu'elle

<sup>1</sup> Comores, Burundi, Togo, Mauritanie, Nigéria, Bénin et Ouganda.

entraînait le progrès économique et qu'une population démographiquement stable stagnait culturellement et économiquement (Hutchinson, 1967).

Simon (1981) a développé une théorie en contradiction avec les propos néo-malthusiens. Selon lui, l'observation de l'histoire humaine montre que les niveaux de vie se sont élevés en même temps que la population augmentait. La principale cause de cette richesse grandissante est l'accroissement démographique. Plus de personnes signifie des marchés plus grands, des communications plus faciles, des économies d'échelles possibles, des gains de productivité. Selon Simon (1981), l'invention et l'innovation, en tant que produits de l'intelligence humaine, augmentent avec la taille de la population. Plus une population est nombreuse, plus il lui sera facile d'inventer une solution à ses problèmes (Simon, 1990).

En cas de pénurie de ressources ou de menace environnementale, la recherche de solutions techniques est stimulée (des produits de substitution ou une technologie propre par exemple). Les pénuries sont donc temporaires et les nouvelles solutions sont meilleures (moins chères et plus respectueuses de l'environnement) que les précédentes (Boserup, 1983).

#### b) Littérature empirique

Birdsall (1992) met en évidence les mécanismes par lesquels l'augmentation de la population entraîne un accroissement du taux d'émission de CO<sub>2</sub>. Il soutient qu'une forte population favorise un fort taux d'industrialisation et donc un accroissement de la demande des ressources énergétiques non renouvelables. Pour lui, l'utilisation extensive des forêts est causée par la forte demande des produits manufacturiers due à la croissance démographique. Cela contribue significativement aux émissions de CO<sub>2</sub>.

Dietz et Rosa (1997) ont fait une régression entre le logarithme de la population et le logarithme des émissions de CO<sub>2</sub>. Ils ont trouvé que lorsque la taille de la population est grande, son impact sur le volume des émissions de CO<sub>2</sub> est plus que proportionnel. Il en résulte de leur étude qu'une augmentation de 1% de la taille de la population entraîne une augmentation de 1,15% du volume de CO<sub>2</sub> émis.

Meyerson (1998) a étudié le lien entre la croissance démographique et le taux d'émission de CO<sub>2</sub>. Il a trouvé que depuis 1970, le taux de croissance des émissions de CO<sub>2</sub> et celui de la population évoluent au même rythme. Il a donc conclu que la cause majeure de l'augmentation des émissions de CO<sub>2</sub> dans l'atmosphère est la croissance démographique.

York *et al.* (2003) ont montré qu'il existe une corrélation positive entre la part de la population vivant en ville et les émissions de CO<sub>2</sub>. Leurs analyses sont focalisées sur 86 pays et sont étendues sur la période allant de 1975 à 1998.

Shi (2003) a trouvé un rapport direct entre les changements démographiques et les émissions d'anhydride carbonique de 93 pays au cours de la période 1975-1996. Pour cet auteur, tout individu fait une demande d'énergie pour satisfaire ses besoins vitaux tels que la nourriture, le logement, les vêtements, etc. Plus le nombre de personnes augmente, plus la demande d'énergie s'accroît. Il déclare qu'un taux de croissance démographique élevé crée des pressions socioéconomiques qui empêchent la société de s'y adapter. En conséquence, il s'en suit l'utilisation intensive des ressources naturelles non renouvelables et la hausse du taux d'émission de CO<sub>2</sub> dans l'atmosphère.

Cole et Neumayer (2004), considérant 86 pays sur la période 1975-1998, ont examiné le lien entre la taille de la population, les autres facteurs démographiques et la pollution. Ils se sont intéressés à deux polluants (CO<sub>2</sub> et SO<sub>2</sub>). Leurs résultats indiquent un lien positif entre les émissions de CO<sub>2</sub> et un ensemble de variables explicatives comprenant le taux d'accroissement de la population, le taux d'urbanisation, la consommation d'énergie et les ménages de petite taille.

Wei *et al.* (2006) ont considéré différents groupes de pays classés en fonction de leur niveau de PIB par tête. Ils ont trouvé que la proportion de la population dont l'âge est compris entre 15 et 64 ans exerce un effet négatif sur les émissions de CO<sub>2</sub> dans les pays à revenu faible alors que cet effet est positif dans les autres groupes de pays.

Alam *et al.* (2007) ont utilisé les séries chronologiques pour évaluer l'impact de l'urbanisation sur le taux d'émission de CO<sub>2</sub> au Pakistan. Leurs résultats montrent qu'il existe une relation positive entre le degré d'urbanisation et le taux d'émission de CO<sub>2</sub>.

Liddle et Lung (2010) ont classé la population en trois catégories d'âge (20-34, 35-49 et 50-64 ans) et ont montré que la structure de la population doit être prise en compte dans les études analysant l'impact de la population sur l'environnement. Pour eux, l'impact de la population sur la qualité de l'environnement varie en fonction des différentes classes d'âge. Leurs résultats ont montré que la population dont l'âge est compris entre 50 et 64 ans exerce une influence négative sur l'environnement, ce qui est contraire aux résultats empiriques antérieurs. En outre, ils soutiennent que l'urbanisation est positivement corrélée à la consommation d'énergie dans les pays en développement. Les jeunes conduisent longuement leur automobile que les adultes. Par conséquent, la quantité de CO<sub>2</sub> produite par les jeunes est plus abondante que celle des adultes. En outre, un pays avec une forte population jeune en âge de conduire un véhicule verra son taux d'émission de CO<sub>2</sub> supérieur à celui d'un pays ayant le même nombre d'habitant que le

premier mais avec une faible proportion de jeunes en âge de conduire.

Poumanyong et Kaneko (2010) ont cherché à savoir si l'urbanisation conduit à une utilisation minimale d'énergie et par conséquent réduit les émissions de CO<sub>2</sub>. En estimant un modèle de panel sur 99 pays de 1975 à 2005, ils concluent que l'urbanisation diminue la consommation d'énergie dans les pays à revenu faible alors qu'elle l'accroît dans les pays à revenu intermédiaire et élevé. Ils ont également trouvé que l'urbanisation influence positivement les émissions de CO<sub>2</sub> pour tous les groupes de pays mais que l'impact est plus prononcé dans les pays à revenu intermédiaire que dans les autres groupes de pays.

Sharma (2011) a analysé les déterminants des émissions de CO<sub>2</sub> dans 69 pays. Il a trouvé des résultats allant dans le même sens que ceux évoqués ci-dessus. Il soutient que l'impact de l'urbanisation est fonction de la classification des pays en fonction de leur niveau de PIB par tête. Il découle de ses résultats que l'urbanisation a un effet positif sur le taux d'émission de CO<sub>2</sub> dans les pays à revenu élevé ainsi que ceux à revenu intermédiaire.

Martinez-Zarzoso et Maruotti (2011) ont utilisé un panel de pays en voie de développement pour montrer que la relation entre le logarithme de la part de la population urbaine dans la population totale et le logarithme des émissions de CO<sub>2</sub> pourrait ne pas être linéaire et avoir une forme en U-inversé.

Feng et al. (2011) soutiennent que la consommation d'énergie et les émissions de CO<sub>2</sub> augmentent rapidement chez les ménages en milieu urbain que chez les ménages en milieu rural.

Menz et Welsch (2012) ont analysé la structure de la population et les émissions de CO<sub>2</sub> dans les pays de l'OCDE. Il ressort de leur analyse que le changement de la structure de l'âge et de la composition de la population a fortement contribué à l'augmentation du taux d'émission de CO<sub>2</sub> dans les pays de l'OCDE.

Zhu et Peng (2012) ont évalué l'effet du changement de la structure de l'âge de la population sur les émissions de CO<sub>2</sub> en Chine sur la période allant de 1978 à 2008. Ils ont trouvé que plus la population est jeune plus le taux d'émission de CO<sub>2</sub> augmente.

Au regard des travaux suscités, l'hypothèse suivante est formulée : *la croissance démographique détériorerait la qualité de l'environnement en ASS.*

### III. METHODOLOGIE

#### a) Nature et source des données

Les données utilisées pour ce papier sont quantitatives et annuelles. Elles s'étalent sur la période allant de 1980 à 2016. Elles sont secondaires et proviennent de la base de données de la Banque Mondiale (Africa Development Indicators, 2017). La disponibilité des données a conduit à considérer un

échantillon de 25 pays d'ASS. Cet échantillon est constituée des 14 pays de la Communauté des Etats de l'Afrique de l'Ouest (CEDEAO), des 6 pays de la Communauté Economique et Monétaire de l'Afrique Centrale (CEMAC) et des 5 pays de la Communauté d'Afrique de l'Est (CAE).

#### b) Modèles économétriques

##### i. Variable expliquée

La variable expliquée dont l'indicateur est « CO » représente le logarithme du volume des émissions totales de CO<sub>2</sub> (en tonnes métriques). Les émissions de CO<sub>2</sub> considérées dans ce papier sont celles qui émanent de la combustion des combustibles fossiles et de la production de ciment.

Cette variable mesure la qualité de l'environnement pour trois raisons : premièrement, les données sur les émissions de CO<sub>2</sub> en ASS sont disponibles ; deuxièmement, le CO<sub>2</sub> est le principal gaz à effet de serre ; et troisièmement, la communauté scientifique internationale attache une attention particulière à la réduction des émissions de CO<sub>2</sub> dans le cadre de la lutte contre le changement climatique.

##### ii. Variables explicatives

##### ➤ Population : DEMO

DEMO est considérée comme la variable d'intérêt dans ce papier. Elle est représentée par le logarithme de la taille (ou effectif) de la population. Dans les pays en développement, l'explosion démographique exerce une pression sur l'environnement à travers la déforestation, l'utilisation des combustibles fossiles, etc. (Cropper et Griffiths, 1994) ; ce qui entraînent une augmentation des émissions de CO<sub>2</sub> (Koop et Tole, 1999).

Les autres variables ci-dessous décrites sont considérées comme des variables de contrôle. Il s'agit de IDE, PIB, PIB<sup>2</sup>, SCO, DEPEDUC, IDO, OUV, INDUS, DPRU.

##### ➤ Investissements Directs Etrangers : IDE

Cette variable est représentée par le logarithme du volume des IDE entrants en pourcentage du PIB. Certains travaux indiquent que l'incidence des IDE sur les émissions de CO<sub>2</sub> peut être différente dans les pays développés et les pays en développement ; les premiers enregistrant une amélioration de la qualité de l'environnement et les seconds, une détérioration (Managi et al., 2008).

##### ➤ PIB/habitant : PIB

Représentée par le logarithme du PIB<sup>2</sup> réel par habitant, PIB est utilisé pour mesurer l'impact, à court et moyen termes, de la croissance économique sur les émissions de CO<sub>2</sub> (Kuznets, 1955). L'ASS étant constituée en majorité des pays en développement, le faible niveau de revenu par habitant amènerait les

<sup>2</sup> Exprimé à prix constant 2000.

individus à rechercher leur bien-être sans se soucier de la préservation de l’environnement à court terme.

➤ Carré du PIB/habitant : PIB<sup>2</sup>

Représentée par le logarithme du PIB réel par habitant élevé au carré, PIB<sup>2</sup> est utilisée pour mesurer l’impact, à long terme, de la croissance économique sur les émissions de CO<sub>2</sub> (Kuznets, 1955). Le transfert de technologies propres des pays développés vers les pays en développement et l’existence des normes environnementales strictes auront pour conséquence une diminution des émissions de CO<sub>2</sub> à long terme.

➤ Capital humain : SCO et DEPEDUC

Cette variable est représentée par le logarithme du taux brut de scolarisation au secondaire d’une part, et le logarithme des dépenses publiques d’éducation par élève au secondaire (exprimées en pourcentage du PIB/habitant) d’autre part. L’éducation est observée dans la littérature comme un facteur d’amélioration de la qualité de l’environnement. En effet, les individus éduqués sont suffisamment avisés des inconvénients de la dégradation de l’environnement. Ils sont par conséquent susceptibles d’adopter des comportements propres. En outre, l’éducation permet l’amélioration de la qualité de vie à travers l’amélioration des revenus des individus. Ce faisant, l’éducation peut permettre aux individus d’effectuer des investissements propres dans le strict respect de l’environnement.

➤ Investissement domestique : IDO

Cette variable est représentée par le logarithme de la Formation Brute de Capital Fixe en pourcentage du PIB. Les pays en développement, soumis à des réglementations environnementales souples, abritent le plus souvent des investissements qui ne respectent pas les normes environnementales. Dans ces conditions, l’investissement domestique pourrait altérer la qualité de

l’environnement en favorisant l’augmentation des émissions de CO<sub>2</sub>.

➤ Degré d’ouverture : OUV

Cette variable est représentée par le logarithme du ratio de la somme des exportations et des importations par rapport au PIB. Le faible niveau de revenu par habitant couplé à l’absence d’une réglementation environnementale forte, font des pays d’ASS des potentiels havres de pollution, ce qui pourrait accroître leurs émissions de CO<sub>2</sub>.

➤ Industrie : INDUS

Cette variable est représentée par le logarithme du PIB industriel<sup>3</sup>. Elle permet de prendre en compte l’impact des activités industrielles sur la qualité de l’environnement. Compte tenu de la nature des industries et de l’absence d’une réglementation environnementale stricte dans les pays en développement, on s’attend à une incidence négative des activités industrielles sur les émissions de CO<sub>2</sub>.

➤ Consommation de carburant fossile : CCARB

Cette variable est représentée par le logarithme de la consommation d’énergie fossile en pourcentage de la consommation d’énergie totale. Elle renvoie à l’utilisation du charbon, du pétrole, d’huile de roche et des gaz naturels comme source d’énergie. En ASS, la consommation d’énergie fossile dans les activités anthropiques contribue majoritairement aux émissions de CO<sub>2</sub> (Africa Development Indicators, 2017).

➤ La désertification : DPRU

Cette variable est représentée par le logarithme de la densité<sup>4</sup> de la population rurale comme dans les travaux de Cropper et Griffiths (1994). Selon ces derniers, la désertification à grande échelle détériore l’environnement et favorise l’augmentation des émissions de CO<sub>2</sub>.

Les signes attendus des variables explicatives sont résumés dans le tableau suivant :

Tableau 1: Récapitulatif des signes attendus

Variables	DEMO	IDE	PIB	PIB <sup>2</sup>	SCO	DEPEDUC	IDO	OUV	INDUS	CCARB	DPRU
Signes attendus	+	+	-	+	-	-	+	+	+	+	+

Source: Auteur, d’après la littérature

iii. Spécification du modèle

Le modèle économétrique d’impact environnemental retenu dans le présent papier est inspiré des travaux de York *et al.* (2003). L’équation à estimer se présente ainsi :

$$CO_{it} = \beta_0 + \beta_1 DEMO_{it} + \beta_2 PIB_{it} + \beta_3 PIB_{it}^2 + \beta_4 IDE_{it} + \beta_5 IDO_{it} + \beta_6 DEPEDUC_{it} + \beta_7 SCO_{it} + \beta_8 OUV_{it} + \beta_9 INDUS_{it} + \beta_{10} CCARB_{it} + \beta_{11} DPRU_{it} + \varepsilon'_{it} \dots \dots \dots (1)$$

$\beta_0$  est une constante,  $\beta_j$  ( $j = 1, \dots, 11$ ) sont les élasticités respectives des variables et  $\varepsilon'_{it}$  est l’erreur de spécification.  $i$  ( $i = 1, \dots, 25$ ) et  $t$  ( $t = 1, \dots, 37$ ) représentent respectivement l’indice du pays et l’indice de l’année.

<sup>3</sup> Le PIB industriel est la valeur ajoutée du secteur secondaire en pourcentage du PIB au terme d’une année.

<sup>4</sup> La densité de la population rurale est la population rurale divisée par la surface de terres arables (cultivables).





c) *Méthode d'estimation*

i. *Description de la méthode d'estimation Within/Between*

Ce papier privilégie la prise en compte de l'hétérogénéité du panel à travers l'usage de la méthode d'estimation Within/Between du modèle de panel à effets individuels. Le recours à cette méthode est nécessaire dans la mesure où les émissions de CO<sub>2</sub> s'expliqueraient par des facteurs structurels et conjoncturels propres à chaque pays d'ASS.

En fixant un individu observé (un pays), la série chronologique ou coupe longitudinale le concernant est obtenue. Si c'est la période examinée qui est fixée, une coupe transversale ou instantanée pour l'ensemble des individus est obtenue.

Un modèle à effets individuels fixes est estimé. L'hypothèse de base de ce modèle est que l'hétérogénéité des comportements est modélisée par un effet individuel. Il s'agit donc d'un modèle avec une variable muette individuelle. Par conséquent, ce modèle ressort la variabilité intra-individuelle (estimation Within). Si les perturbations aléatoires croisées satisfont aux hypothèses classiques des Moindres Carrés Ordinaires (MCO), c'est-à-dire centrées, homoscédastiques, indépendantes et normales, alors l'estimation par les MCO est optimale (Sevestre, 2002).

Ensuite, un modèle à effets individuels aléatoires est estimé. Ici, l'effet individuel n'est plus un paramètre fixe à estimer mais une variable aléatoire non observable. Ce modèle ressort la variabilité inter-individuelle (estimation Between). L'estimation du modèle procède ici par deux étapes : la première consiste à estimer les composantes de la variance de l'aléa et la deuxième consiste à utiliser ces estimations pour estimer le modèle par la méthode des Moindres

➤ *Résultats des tests préliminaires*

Carrés Généralisés (MCG), la structure de la variance des résidus étant approximativement connue.

ii. *Tests préalables à l'estimation*

Le recours aux estimations Within/Between exige que soient effectués au préalable les tests préliminaires, suivis des tests de validation du modèle.

*Tests préliminaires :*

Il s'agit du test de multi-colinéarité des variables et du test de présence des effets individuels de Fisher.

➤ *Test de multi-colinéarité des variables*

En cas de problème de multi-colinéarité, il n'est pas possible de déterminer l'effet propre d'une variable explicative particulière sur la variable expliquée. Un coefficient de corrélation entre deux variables explicatives supérieur à + 0,7 ou inférieur à - 0,7 indique l'existence de potentiels problèmes liés à la multi-colinéarité.

➤ *Test de présence des effets individuels de Fisher*

Le test de présence des effets individuels de Fisher est utilisé pour discriminer le modèle à effet individu et le modèle sans effet individu. Concrètement, l'objectif est de déterminer si le modèle théorique étudié est parfaitement identique pour tous les pays, ou au contraire s'il existe des spécificités propres à chaque pays.

Le logiciel STATA 12 permet de calculer deux statistiques de Fisher. La première teste la significativité conjointe des variables explicatives tandis que la seconde teste la significativité conjointe des effets individuels fixes introduits.

Si la p-value est inférieure au seuil de signification  $\alpha$  (5%), on est en présence d'effets individuels spécifiques. Dans le cas contraire, il y a absence d'effets individuels spécifiques.

*Tableau 2: Résultats du test de multi-colinéarité des variables*

	CCARB	DEMO	DEPEDUC	DPRU	I D E	I D O	INDUS	O U V	P I B	P I B 2	S C O
C C A R B	1.0000										
D E M O	0.4006	1.0000									
D E P E D U C	0.2484	0.2682	1.0000								
D P R U	-0.1659	0.1000	0.3749	1.0000							
I D E	0.0828	-0.2114	0.1521	-0.1046	1.0000						
I D O	-0.0280	-0.2904	-0.1087	-0.0749	0.2197	1.0000					
I N D U S	0.0221	-0.3880	-0.0862	-0.1925	0.2619	0.4340	1.0000				
O U V	-0.0249	-0.3689	0.0620	-0.1233	0.3812	0.4782	0.4577	1.0000			
P I B	0.0622	-0.3815	-0.1287	-0.2436	0.3194	0.4181	0.4838	0.5353	1.0000		
P I B 2	0.0671	-0.3980	-0.1432	-0.2444	0.3225	0.4187	0.4747	0.5233	0.5950	1.0000	
S C O	0.2907	-0.0068	0.2992	0.0573	0.2615	0.2685	0.3602	0.4205	0.5064	0.4843	1.0000

Source: Auteur, à partir d'Eviews 5.0

Tableau 3: Résultats du test de présence des effets individuels

T e s t	O b s e r v a t i o n s	C o n c l u s i o n
Test de détection des effets individuels	p - v a l u e = 0 , 0 0 0 0 < 5 %	Il y a présence des effets individuels

Source: Auteur, à partir de STATA 12

Il ressort du tableau 2 que tous les coefficients de corrélation entre les variables ont une valeur absolue inférieure à + 0,7. Ce qui traduit l'absence de problème de multi-colinéarité. Par ailleurs, le tableau 3 présente une p-value inférieure à 5% (les effets individuels introduits ne sont pas tous nuls). Le modèle de panel est donc hétérogène. Il existe en ASS des effets individuels propres à chaque pays qui expliquent leurs émissions de CO<sub>2</sub>.

Tests de validation du modèle :

Il s'agit du test d'hétéroscédasticité de Breusch-Pagan, du test d'autocorrélation de Wooldridge et du test d'Hausman.

➤ Test d'hétéroscédasticité de Breusch-Pagan

Le test de Breusch-Pagan est utilisé pour détecter la présence d'hétéroscédasticité. L'hypothèse nulle (H<sub>0</sub>) est celle de l'homoscédasticité, tandis que l'hypothèse alternative (H<sub>1</sub>) est celle de l'hétéroscédasticité. Si la p-value est inférieure au seuil de signification α (5%), on rejette H<sub>0</sub> et il y a hétéroscédasticité.

➤ Test d'autocorrélation de Wooldridge

Le test d'autocorrélation de Wooldridge permet de détecter la présence d'autocorrélation des résidus. Les hypothèses à tester sont :

➤ Résultats des tests de validation

– H<sub>0</sub> : il n'y a pas d'autocorrélation des résidus,

– H<sub>1</sub> : il y'a autocorrélation des résidus.

Si la p-value est inférieure au seuil de signification α (5%), on accepte H<sub>1</sub>.

➤ Test d'Hausman

Le test d'Hausman permet de choisir entre le modèle à effets individuels fixes et le modèle à effets individuels aléatoires. Ce test permet de déterminer si les coefficients des deux estimations (Within et Between) sont statistiquement différents. Les hypothèses à tester sont les suivantes:

• H<sub>0</sub> : les coefficients des deux estimations ne sont pas statistiquement différents,

• H<sub>1</sub> : les coefficients des deux estimations sont statistiquement différents.

Si la p-value est supérieure au seuil de signification α (5%), on accepte l'hypothèse nulle (H<sub>0</sub>). Le modèle à effets individuels aléatoires est donc le plus approprié. Dans le cas contraire, le modèle à effets individuels fixes est plus adapté.

Ces trois tests permettent de vérifier si les conditions statistiques d'estimation des paramètres des modèles par la méthode choisie sont remplies.

Tableau 4: Synthèse des résultats des tests de validation

T e s t	O b s e r v a t i o n s	C o n c l u s i o n
Test de Wooldridge	p - v a l u e = 0 , 0 0 0 0 < 5 %	Les erreurs sont autocorrélées
Test de Breusch-Pagan	p - v a l u e = 0 , 0 0 0 0 < 5 %	Les erreurs sont hétéroscédastiques
Tests de Hausman	p - v a l u e = 0 , 9 0 5 4 > 5 %	Le modèle à effets individuels aléatoires est approprié

Source: Auteur, à partir de STATA 12

Le tableau 4 montre que les modèles à effets individuels fixes et aléatoires souffrent des problèmes d'autocorrélation et d'hétéroscédasticité des erreurs. En

plus, le modèle à effets individuels aléatoires est plus approprié. L'estimation dudit modèle se fera donc par la méthode des MCG.

#### IV. RESULTATS

Tableau 5: Résultats de l'estimation de l'équation 1

Variables explicatives	Variable expliquée : CO	
	Coefficient (β)	P - v a l u e
D E M O	0 , 1 4 1 4 * *	0 , 0 0 0
I D E	0 , 0 1 1 2 * *	0 , 0 6 4
P I B	- 1 , 5 5 2 8 * * *	0 , 0 0 0
P I B <sup>2</sup>	0 , 1 8 0 8 * * *	0 , 0 0 0
I D O	- 0 , 0 5 2 2	0 , 1 9 3
D E P E D U C	- 0 , 0 1 1 7	0 , 8 2 8
S C O	0 , 1 7 8 3 * * *	0 , 0 0 1
O U V	- 0 , 0 3 4 8	0 , 5 1 3

I N D U S	0 , 1 5 3 4 * * *	0 , 0 0 8
C C A R B	0 , 2 1 6 8 * * *	0 , 0 0 0
D P R U	0 , 3 0 4 7 * *	0 , 0 1 8
R <sup>2</sup> b e t w e e n	0 , 3 4	0 4
R <sup>2</sup> w i t h i n	0 , 5 8	7 1
R <sup>2</sup> o v e r a l l	0 , 3 7	9 1
P - v a l u e	0 , 0 0	0 0

\*, \*\* et \*\*\* correspondent respectivement à la significativité à 10%, 5% et 1%.

Source: Auteurs, à partir de STATA 12

Le modèle est expliqué à 34,04% par les effets fixes. La variation intra-individuelle de la variable dépendante est expliquée à 58.71%. Par ailleurs, le modèle est globalement bien spécifié puisque le test de Fisher révèle dans chaque échantillon une p-value (0,0000) inférieure à 5%. Le modèle peut donc être utilisé pour les prévisions économiques.

La population affecte négativement (0,1414) et significativement (5%) les émissions totales de CO<sub>2</sub>. Au regard de ces résultats, conformes aux prédictions théoriques Malthusiennes, il ressort que la population stimule les émissions de CO<sub>2</sub> et contribue à la dégradation de l'environnement en ASS.

Les IDE affectent négativement (0,0112) et significativement (5%) les émissions totales de CO<sub>2</sub>. En ASS, les IDE favorisent les émissions totales de CO<sub>2</sub>. Conforme à la théorie, ce résultat va dans le même sens que ceux de McCarney et Adamowicz (2005).

L'impact du PIB par habitant est positif (-1,5528) et significatif (1%) sur les émissions totales de CO<sub>2</sub>. Aussi, le PIB par habitant au carré influence négativement (0,1808) et significativement (1%) les émissions totales de CO<sub>2</sub>. Ces résultats sont contraires aux attentes théoriques mais corrobore toutefois avec les résultats de Kaufmann *et al.* (1998).

Le taux de scolarisation affecte négativement (0,1783) et significativement (1%) les émissions totales de CO<sub>2</sub>. Ce résultat est contraire aux prévisions théoriques mais va dans le même sens que ceux de Roberts et Grimes (1997).

Les effets non significatifs des dépenses d'éducation, de l'investissement domestique et du degré d'ouverture sur les émissions totales de CO<sub>2</sub> ne sauraient être appréciés

L'effet des activités industrielles sur les émissions totales de CO<sub>2</sub> est négatif (0,1534) et significatif (1%). L'expansion des activités industrielles favorise la dégradation de l'environnement en ASS. Conforme à la théorie, ce résultat conforte les allégations de Kaffo (2013).

Cependant, l'effet de la consommation de carburant fossile sur les émissions totales de CO<sub>2</sub> est négatif (0,2168) et significatif (1%). La consommation de carburant fossile provoque la détérioration de l'environnement en ASS. Conforme aux prédictions théoriques, ce résultat conforte les allégations de Halicioglu (2008), Sharma (2010) et Odhiambo (2011).

L'effet de la désertification sur les émissions totales de CO<sub>2</sub> est négatif (0,3047) et significatif (5%). La désertification provoque donc les émissions de CO<sub>2</sub> en ASS. Ce résultat conforte les allégations de Malthus (1798).

## V. CONCLUSION

L'objectif de ce papier était de déterminer l'effet de la croissance démographique sur la qualité de l'environnement en ASS. L'atteinte de cet objectif a donné lieu à l'estimation d'un modèle de régression multiple (modèle d'impact environnemental). Pour estimer ce modèle, ce papier a privilégié la prise en compte de l'hétérogénéité du panel à travers l'usage de la méthode d'estimation Within/Between du modèle de panel à effets individuels. La méthode des Moindres Carrés Généralisés a été retenue au regard des résultats des tests de validation du modèle. Il apparaît que la croissance démographique détériore la qualité de l'environnement en ASS. Cette situation montre la nécessité pour les pays d'ASS de solliciter un soutien technologique et financier des pays développés pour leur permettre de s'adapter aux méfaits du changement climatique à court terme et d'atténuer les émissions de CO<sub>2</sub> à long terme. Ce soutien doit être orienté vers la densification d'une éducation relative à l'environnement afin de favoriser, à long terme, le développement des technologies propres. Ce dernier nécessite un cadre institutionnel propice. Ceci interpelle le renforcement des capacités opérationnelles des administrations chargées de la mise en œuvre des programmes de gestion durable des ressources environnementales dans les pays d'ASS.

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## Sustainable Tourism for Regional Development in North-East States of India: Trends, Problems and Prospects

By Dr. Sherap Bhutia

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**GJHSS-B Classification:** FOR Code: 059999p



*Strictly as per the compliance and regulations of:*



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## I. INTRODUCTION

North East India, called the land of the seven sisters and one brother, is a region which can be best described as virgin, wild and untouched from the modernizations taking elsewhere in the world. It is a region guarded by mountains, the only passage being a narrow stretch of land some 40 km wide, called the Siliguri Corridor. Beyond this corridor lies the seven sister states of North-Eastern India, each state more beautiful than the other, each with its own cultures and beliefs, each having its own charm. Because of the regions inaccessibility from the rest of world, it has been lucky enough to maintain most of its natural diversity.

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Northeastern part of India comprises the states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura which possesses great physical and human diversities to project it as one of the most potential areas of the country in respect of tourism promotion. As a zone of convergence of diverse ethnic stocks, the region is undoubtedly a showcase of cultural diversity. Considering the significance of the tourism sector as a catalyst for regional development, an attempt has been made in this article to visualize the present scenario and trends of the tourism sector in North-East Region and focus on the problems and prospects regarding sustainable tourism.

## II. GEOGRAPHICAL BACKGROUND OF NORTH-EAST INDIA

North-East India, popularly known as North-East Region (NER), comprises of the eight States of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim and geographically situated in the North-East corner of India, at Latitude 21.57°N - 29.30°N and Longitude 88°E - 97.30°E with an area of 26.2 million Sq. Km. It comprises 7.8% of the land area of the country. The North-East Region shares the international boundaries of India with China to the North, Bangladesh to the South West, Bhutan, and Nepal to the North West and Myanmar to the East. This region is connected with the rest of India only through a narrow corridor in North Bengal, known as Chicken Neck, having an approximate width of 33 km on the eastern side and 21 km on the western side.

About 70% of North-East is the hilly region, and the topography varies within each state. Mountains and hills cover most of Arunachal Pradesh, Mizoram, Nagaland, Meghalaya and about half of Tripura, 20% of Assam, 90% of Manipur and almost entire Sikkim. The plains of the region are mainly made up of separate landmasses - the Brahmaputra Valley and the Barak Valley in Assam and the Tripura plains in the South. In Manipur, the valley is small, comprising only about 10% of the total area of the State. The topography of the hills is generally rugged and vast areas are inaccessible. The flora and fauna of this region is numerous and varied. North-East is regarded as one of the 7 most bio-diverse

regions of the world (hottest hotspots). Many endangered species of fauna like the one-horned-Asiatic rhino, white winged- wood duck, and Golden Langur can be spotted in the reserved forests and National Parks of NER. The North-East States possesses more than 550 varieties of orchids, which is said to be almost 70% of the total orchid species identified so far.

The North-East Region is the home to extraordinarily diverse mosaic of ethnic groups having distinctive social, cultural and economic identity, more akin to their South Asia neighbours than main land India. All the eight states in total occupy an area of 262, 179 sq.km which is 7.9% of the total area of the country. The

largest state in terms of the area is Arunachal Pradesh which occupies an area of 837,43 sq. km followed by Assam which occupies an area of 78,438 sq. kms. The smallest of all the 8 states is Sikkim which has an area of 7,096 sq. kms. The density of the region varies widely due to complex geographical and cultural composition. With a total population of 45.48 million (2011 census) the North-Eastern Region is relatively sparsely populated compared too much of the rest of India. However, population density varies widely among the northeastern states. Assam and Tripura are the most densely populated States with over 350 persons/sq. km, while Arunachal Pradesh is the least densely populated with 17 persons/sq. km.

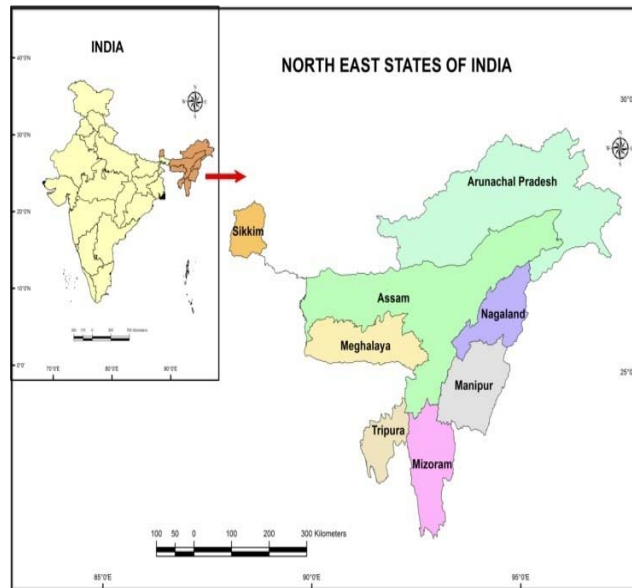


Figure 1: Location Map of North-East States of India

North-East region is a virgin unexplored terrain with vast tourism potential in the form of wildlife sanctuaries, adventure tourism assets, diverse cultural heritage, multi faceted fairs & festivals, world famous

Buddhist Monasteries etc. The primitive culture of at least the Neolithic age now co-exists with the modern and post-modern lifestyle.

Table 1: Area, Population & Density of Population in North-East States of India, 2011

NE States	Area in Sq. Km	Population (2011)			Population Density	% Decadal Growth (2001-2011)
		Persons	Males	Females		
Arunachal Pradesh	83,743	1,383,727	713,912	669,815	17	26.0
Assam	78438	31,205,576	15,939,443	15,266,133	398	17.1
Manipur	22,327	2,570,390	1,290,171	1,280,219	115	18.6
Meghalaya	22,429	2,966,889	1,491,832	1,475,057	132	27.9
Mizoram	21,081	1,097,206	555,339	541,867	52	23.5
Nagaland	16,579	1,978,502	1,024,649	953,853	119	-0.6
Sikkim	7,096	610,577	323,070	287,507	86	12.9
Tripura	10,486	3,673,917	1,874,376	1,799,541	350	14.8
NER	262,179	45,486,784	23,212,792	22,273,992	158	14.2

Source: Census of India, 2011



### III. ECONOMY OF NORTH-EAST STATES

There are differences among the eight States in the North-Eastern region concerning their resource endowments, level of industrialization as well as infrastructural facilities. The industrial sector has mainly grown around tea, petroleum [crude], natural gas, mining, saw mills and steel fabrication units in other parts of the region. The economy of the region is still primarily agrarian but its full potential is yet to be exploited. The contribution of agriculture to State domestic income is much higher in this region, except for Meghalaya and Nagaland. Mining in the case of Meghalaya and forestry and logging in the case of Arunachal Pradesh and Nagaland are important contributors to NSDP (Net State Domestic Product). The contribution of construction is also high in this region. The region's economy is generally characterized by low per-capita income, low capital formation, in-adequate infrastructure facilities, geographical isolation and communication bottleneck, inadequate exploitation of natural resources like mineral resources, hydro-power potential, forests etc., low progress in the industrial field, lack of private and foreign direct investment and high unemployment rate among the relatively high literate people.

Tourism in India is a growing industry, and as per World Tourism Organisation predictions, India will be a leader in using tourism as an employment generator. North-East India must be placed in a strategic position to take advantage of this growth. Tourism being a multi-sectoral activity can stimulate different sectors of the economy. It is evident from highly developed states and countries that tourism opens up immense opportunities for economic development, poverty alleviation and income generation. Being labour intensive, it opens avenues for a host of employment opportunities. Tourism can also make a positive impact on conserving the environment, cultural enrichment, development of rural areas and empowerment of women. Tourism has emerged as one of the prospective sectors of industry in the Northeast. The economic development of NER has been greatly influenced by tourism. The growth of tourism industry over the years has nourished and stimulated the development process. The tourism industry has also been able to generate large scale employment opportunities and the development of the region as a whole. The rich natural beauty, serenity and exotic flora and fauna of North-East region are invaluable resources for the development of eco-tourism.

With the increasing intensity of the emergency in the North-East, there is a deep need to devise long-term, sustainable solutions for the region. A large part of the emergence arises from economic need, and hence the solution lies in economic (and social) development of the region. However, for economic development to

take place, several key players need to step up and take the initiative in the region. In recent years, various strategies for the development of the NER-special development packages, the New Industrial Policy including incentives for the development of industry, investment in communications, earmarked funds for the NER, etc. -formulated by the Government and under public pressure have stirred the economy of the North-East. However, concerted measures are needed to inject greater dynamism into the development process so that the region can make up for a lost time and catch up with the rest of the country.

### IV. TOURISM RESOURCES IN NORTH-EAST STATES

The North-East States of India is a region rich in varied tourism attractions, some of which are unmatched in terms of attractiveness and pull factor. However because of remoteness, accessibility concerns, high travel time taken, security concerns and a lot of other factors, these barring few have not become established tourism destinations at a national level. Most of the other sites have medium level attractiveness, however not strong enough to become big tourism drivers in themselves. They presently lack the potential to attract tourists at the national and international level. There are many National parks, wildlife resources and other nature tourism sites in this part of India. But the development around National Parks and Wildlife Sanctuaries is minimal, not properly planned or not well regulated. This region is blessed with rich biodiversity, huge forest wealth, fruits and vegetables, flowers, herbs and aromatic plants, rare and rich flora and fauna, India's largest perennial water system, the River Brahmaputra and its tributaries, horticultural products/ plantation crops/vegetables/spices and rare forest products. Some sites would appeal to special interest tourists. Thus it is important to develop tourism circuits, so that these medium level destinations also get tourist attraction and develop.

With more than 220 ethnic groups with an equal number of dialects makes it hugely diverse region. The North-East India is rich in biological diversity and contains more than one-third of the country's total biodiversity. The region has at least 7500 flowering plants, 700 orchids, 58 bamboos, 64 citrus, 28 conifers, 500 mosses, 700 ferns and 728 lichen species. The region is equally rich in faunal diversity. An estimated 3624 species of insects, 50 mollusks, 236 fishes, 64 amphibians, 137 reptiles, 541 birds and 160 mammalian species have been identified so far. The region is also rich in terms of genetic and ecosystem diversity. Some of the important gene pools of citrus, banana and rice are reported to have originated from this region. A wide variety of man-modified ecosystems such as jhum (one way of shifting Cultivation) agro-ecosystem, wet rice

agro-ecosystem and alder based agro-ecosystem contribute towards the rich ecosystem diversity.

The North-East Region has a variety of tourism resources such as heritage, historical, cultural, natural etc. This region is extremely rich in tribal culture and particularly international tourists use to visit to see this. Many tribal communities are residing in North-East India keeping their culture and traditions intact. In Arunachal Pradesh only there are 26 major tribal groups with numerous sub groups. The entire region is extremely rich when it comes to Crafts- particularly handlooms which vary between States, bamboo products etc. The present scenario of tourism does not consider local arts and crafts as a prime tourism resource. However, nationally and internationally, there has been increasing

tourist interest in this. Fair & Festivals are very big colourful attractions and really reflect the strong cultural heritage of the States of North-Eastern Region. At present, Hornbill festival is conducted with full spirit and lot of tourists visit during the time. The region offers almost all kind of tourist activities, Trekking, Mountaineering, Jungle Safari Trails, Adventure Activities, Ornithological Tour Programmes, Buddhist Circuit Tours, Cultural Tours, Exquisite Sea Beaches, Pilgrimage Tours, Tea Tour, and many other options which can lure tourist. These resources are the major differentiators compared to tourism of other regions and hence needs to be protected and properly addressed, in controlled manner.

Table 2: States-wise Tourists Circuits & Destinations in North-East India

State	Tourist Circuits	Tourist Spots	
<b>Arunachal Pradesh</b>	<ol style="list-style-type: none"> <li>1. Bhalukpong- Bomdila-Tawang</li> <li>2. Itanagar-Ziro-Daporijo-Along-Pasighat</li> <li>3. Tinsukhia-Parasuram Kund</li> <li>4. Miao-Namdapha</li> <li>5. Dibrugarh-Roing-Anini</li> <li>6. Dibrugarh-Tezu-Hayuliang</li> <li>7. Pasighat-Yingkiong</li> </ol>	<ol style="list-style-type: none"> <li>1. Itanagar</li> <li>2. Tezpur</li> <li>3. Bomdila</li> <li>4. Ziro</li> <li>5. Tawang</li> <li>6. Pasighat</li> </ol>	<ol style="list-style-type: none"> <li>1. Namdapha Wildlife Sanctuary</li> <li>2. Parasuram Kund</li> </ol>
<b>Assam</b>	<ol style="list-style-type: none"> <li>1. Guwahati-Phulbari/Jakhalabandha-Kaziranga-Sibsagar</li> <li>2. Guwahati-Barbeta-Baroma-Manas</li> </ol>	<ol style="list-style-type: none"> <li>1. Kamakhya Temple</li> <li>2. Bashista Ashram</li> <li>3. Nabagraha Temple</li> <li>4. Ugratara Temple</li> <li>5. Dirgheshwari Temple</li> <li>6. Ashvklanta Temple</li> <li>7. River Cruise on Brahmaputra</li> <li>8. Sualkuchi</li> <li>9. Hajo</li> <li>10. Tezpur</li> <li>11. Bhalukpong</li> </ol>	<ol style="list-style-type: none"> <li>1. Sibsagar</li> <li>2. Haflong</li> <li>3. Majuli Island</li> <li>4. Kaziranga National Park</li> <li>5. Manas National Park</li> <li>6. Nameri National Park</li> <li>7. Orang National Park</li> <li>8. Pabitora Sanctuary</li> </ol>
<b>Manipur</b>	<ol style="list-style-type: none"> <li>1. Imphal-Moirang-Loktak-Lake-Keibul Lamjao National Park</li> <li>2. Imphal-Ukhrul-Imphal</li> </ol>	<ol style="list-style-type: none"> <li>1. Imphal</li> <li>2. Shri Govindaji Temple</li> <li>3. Khwairamband Bazar</li> <li>4. Shaheed Minar</li> <li>5. War Cemeteries</li> <li>6. Langthabal</li> <li>7. Kangchup</li> <li>8. Waithou</li> <li>9. Kaina</li> <li>10. Khongjom</li> </ol>	<ol style="list-style-type: none"> <li>1. Tengnoupel</li> <li>2. Moirang</li> <li>3. Loktak Lake</li> <li>4. Sendra Island</li> <li>5. Bishnupur</li> <li>6. Ukhrul</li> <li>7. Central Khonghampat Orchidarium</li> <li>8. Manipur Zoological Garden</li> </ol>
<b>Meghalaya</b>	<ol style="list-style-type: none"> <li>1. Kaziranga-Guwahati-Cherrapunjee-Shillong</li> <li>2. Shillong-Mawphlang-Weilloi-Mawsynram-Shillong</li> <li>3. Shillong-Smit-Nartiang-Thadlaskein-Jowai-Thlu Umwi-Shillong</li> <li>4. Guwahati-Dudnai-Bajengdoba-Anoggre-Tura Barengapara-Baghmara-Siju-Balpakram-Shillong</li> </ol>	<ol style="list-style-type: none"> <li>1. Shillong Peak</li> <li>2. Ward's Lake</li> <li>3. Lady Hydari Park</li> <li>4. Lewduh Market</li> <li>5. Sohpetbney Peak</li> <li>6. Spread Eagle Falls</li> <li>7. Sweet Falls</li> <li>8. Bishop Falls</li> <li>9. Beadon Falls</li> <li>10. Elephant Falls</li> </ol>	<ol style="list-style-type: none"> <li>1. All Saint Church</li> <li>2. Umiam Lake</li> <li>3. Cherrapunjee</li> <li>4. Mawsynram</li> <li>5. Mawphlang</li> <li>6. Ranikor</li> <li>7. Tura</li> <li>8. Nartiang</li> <li>9. Thadlaskein Lake</li> <li>10. And many Caves</li> </ol>

Mizoram	1. Aizwal & excursions in and around the areas	1. Aizwal 2. Durtlang 3. Bung 4. Paikhai 5. Tamdil 6. Vantawang	1. Champhai 2. Phawngpul 3. Saiha 4. Palakdil 5. Dampa Sanctuary
Nagaland	1. Dimapur-Kohima-Wokha-Mokokchung-Tuensang-Mokokchung-Zunheboto-Kohima	1. Kohima 2. World War II Memorial 3. State Museum 4. Kohima War Cemetery 5. Barra Basti 6. Khonoma	1. Dimapur 2. Mokokchung 3. Wokha 4. Phet 5. Zunheboto 6. Intanki Wildlife Sanctuary
Sikkim	1. Pemayongtse-Yuksam-Kewzing-Ravangla-Timitarku-Gangtok-Singtam-Rangpo-Teesta-Siliguri 2. Namchi-Nayabazar-Chakung-Soreng-Buriakhop-Varse-Hilley-Uttarey-Dentam-Burmiok-Legship-Tatopani-Sikip-Namchi	1. Gangtok 2. Mt. Kanchendzonga View 3. Tashi namgyal Institute of Tibetology 4. Tsomgo lake 5. Himalayan Zoological Park	1. Nathu-La Pass 2. Bakkhim 3. Dzongri 4. Pemayangtse 5. Yuksam 6. And many Monasteries
Tripura	1. Agartala-Sipahijala-Neermahal-Udaipur-Matabari-Pilak-Mahamuni 2. Agartala-Dumboor Lake-Unakooti-Jampui Hills	1. Agartala 2. Ujjayanta Palace 3. Kamalagar 4. Udaipur-Neermahal 5. Bhubaneswari Temple 6. Matabari	1. Pitak 2. Mahamuni 3. Dumboor Lake 4. Jampui Hills 5. Unakoti

Source: Compiled from various publications of Tourism Department.

The Region is endowed with diverse tourist attractions and each State has its own distinct features. The attractions are scattered over the entire region and are largely located in remote areas within highly fragile environments. These attractions and the people of the Region constitute the tourism resources at large. All the Eight States of North-East have ample tourist destination, which is given in Table 2. Table 2 shows the various tourist circuits and tourist destination which can be explored by the tourists in this part of the country. Among the eight States, Arunachal Pradesh has 07 tourist circuits, Meghalaya 04 tourist circuits, Assam, Manipur, Sikkim and Tripura had 02 tourist circuits each and Mizoram and Nagaland have 01 tourist circuits each. Likewise, various tourist spots available in this region are also shown in this table. The cultural products for tourism in the region include the visual and performing arts, crafts, traditional ceremonies and costumes, fairs and festivals, oral literature, life and lifestyle, dietary habit, etc. Various fairs and festivals are being organized in respective States, which are major attraction for the tourists and each has its unique special message to the travelers who passes from one State to another. All these festivals highlight the region's rich indigenous culture combined with folk songs, tribal dances, cuisines and handicrafts.

## V. TRENDS AND PRESENT SCENARIO OF SUSTAINABLE TOURISM

Travel and tourism is the largest service industry in India. This industry provides heritage, cultural,

medical, business and sports tourism. It is expected that the tourism sector's contribution to the country's gross domestic product (GDP) will grow at the rate of 7.8 per cent yearly in the period 2013-2023. The Indian tourism sector has been flourishing in recent years due to the improved connectivity to and from the country. Also, a better lodging facility at the tourist destinations has been a factor which has contributed to increase in foreign tourist. The Ministry of Tourism, Government of India has played a very active role in promoting tourism in India. With the foreign tourists arrivals at 7.68 millions in 2014 and India having 0.64% of the world tourists arrivals, India has huge potential to expand its tourism.

Tourism, as an instrument of economic development, will steadily assume an even greater importance in the future. There are grounds for optimism about what sustainable tourism development can mean for developing nations in the 21<sup>st</sup> century. Sustainability carries the idea of self-regulating societies in which economic and social changes are broadly accommodated. Spread over an area of 262,179 sq. kms, the North-East India has an ecology and lifestyle, and economy that have been shaped by the major rivers of the region - the Brahmaputra and the Barak, ranges of mountains and thick tracks of jungles and heavy monsoons. The North-East of India is a reservoir of rich natural resources & biodiversity and, the amalgamation of different tribes and cultures. This region is a melting pot of variegated cultural mosaic of people and races, an ethnic tapestry of many hues and shades. The folk culture is still vital in this region. Well integrated with life

and nature, the folk artworks have a common element of tune and tone.

The tourist arrivals in the North-East from 2005-2014 are presented in Table-3. The table further shows that there has been an increase in tourist arrivals in the NE Region and the rate of growth has been consistent.

It also indicates that tourist arrival in the NE has increased tremendously from 2006. There were a total of 3,553,172 tourists to the North-Eastern States in 2005 with the figure going up to 6,762,100 in 2013. That number further increased to 7,008,467 in 2014. (Figure-2).

Table 3: Tourist Arrivals in North-East Region, 2005-2014

Year	Tourist in Number			Growth Rate in %		
	Domestic	Foreign	Total	Domestic	Foreign	Total
2005	3515792	37380	3553172	-	-	-
2006	4454266	38496	4492762	26.69	02.99	26.44
2007	4727854	43665	4771519	06.14	13.43	06.20
2008	5212654	47761	5260415	10.25	09.38	10.25
2009	5708878	47595	5756473	09.52	-00.35	09.43
2010	6166269	50950	6217219	08.01	07.05	08.00
2011	6374254	58920	6433174	03.37	15.64	03.47
2012	6663933	66302	6730235	04.54	12.53	04.62
2013	6677280	84820	6762100	00.20	27.93	00.47
2014	6889915	118552	7008467	03.18	39.77	03.64

Source: Tourism Departments, North-Eastern States of India.

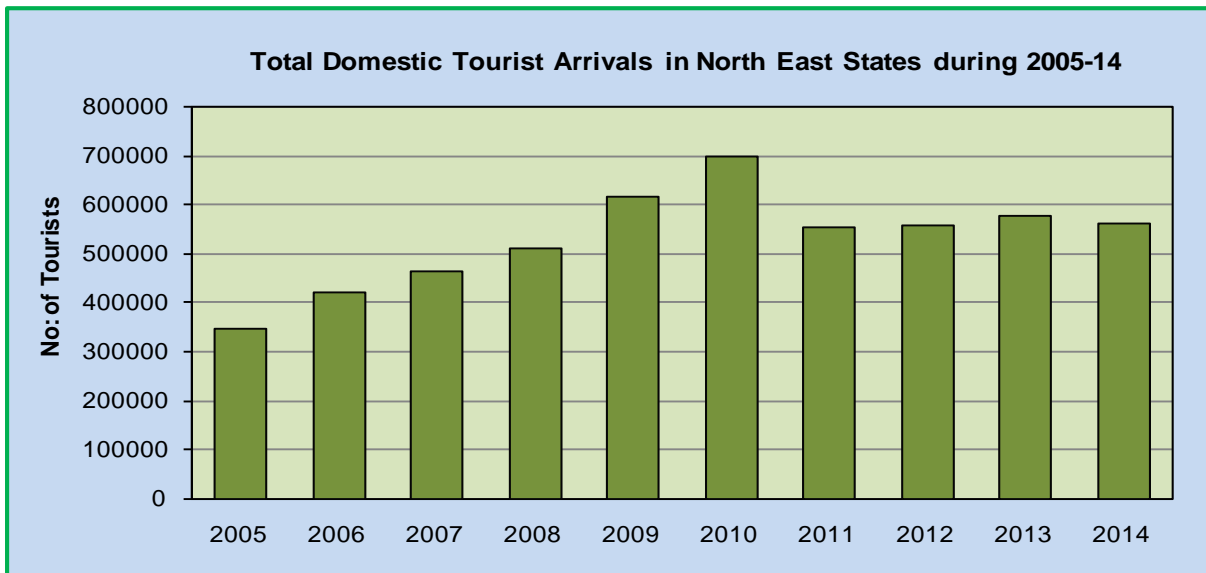


Figure 1: Bar Diagram Showing Domestic Tourist Arrivals in North-East Region

Among the North-East States, Assam attracts the largest numbers of tourists with 4,848,239 (4,826,702 of domestic tourist and 21,537 of foreign tourist) as shown in Figure-3, mainly because of famous Kamakhya temple and Kaziranga National Park. Almost all major centers of both private and Government are available in Assam. Furthermore, since, to go to the other States of North-East Region excluding Sikkim, Assam is the doorstep, it has grasp all the opportunities of tourism and maximum inflows of tourists are concentrated here. Besides Assam, Meghalaya and

Sikkim also attract tourists. Nagaland has been found as the least visited States with lowest tourists' inflows.

State-wise classification of domestic & foreign tourist arrivals is given in Table-4. The figure shows that Assam's contribution in terms of domestic tourist flows outweighs other States. Sikkim has been a destination of preference for foreign tourists followed by Assam. Meghalaya & Arunachal Pradesh have started showing signs of growth, both in terms of domestic and foreign tourists. The domestic tourist visits to North-East have raised from 3,515,792 tourists in 2005 to 6,889,915

tourists in 2014 (Figure-3). It further reveals that Assam was at the first place with 4,826,702 number of domestic tourist arrivals during 2014. It was followed by Meghalaya with 716,469 tourist and Sikkim with 562,418

tourists and the least number of domestic tourist arrivals is recorded in Nagaland with only 58,413 domestic tourists.

Table 4: State-wise Inflow & Growth of Domestic & Foreign Tourist in North-East Region

NE States	2013			2014			Growth Rate in %		
	Domestic	Foreign	Total	Domestic	Foreign	Total	(2013-14)		
							Domestic	Foreign	Total
Arunachal Pradesh	125461	10846	136307	180964	5204	186168	44.24	-52.02	36.58
Assam	4684527	17638	4702165	4826702	21537	4848239	3.03	22.11	3.11
Manipur	140673	1908	142581	115499	2769	118268	-17.9	45.13	-17.05
Meghalaya	691269	6773	698042	716469	8664	725133	3.65	27.92	3.88
Mizoram	63377	800	64177	68203	836	69039	7.61	4.5	7.58
Nagaland	35638	3304	38942	58413	3679	62092	63.91	11.35	59.45
Sikkim	576749	31698	608447	562418	49175	611593	-2.48	55.14	0.52
Tripura	359586	11853	371439	361247	26688	387935	0.46	125.16	4.44

Source: Tourism Departments, North-Eastern States of India.

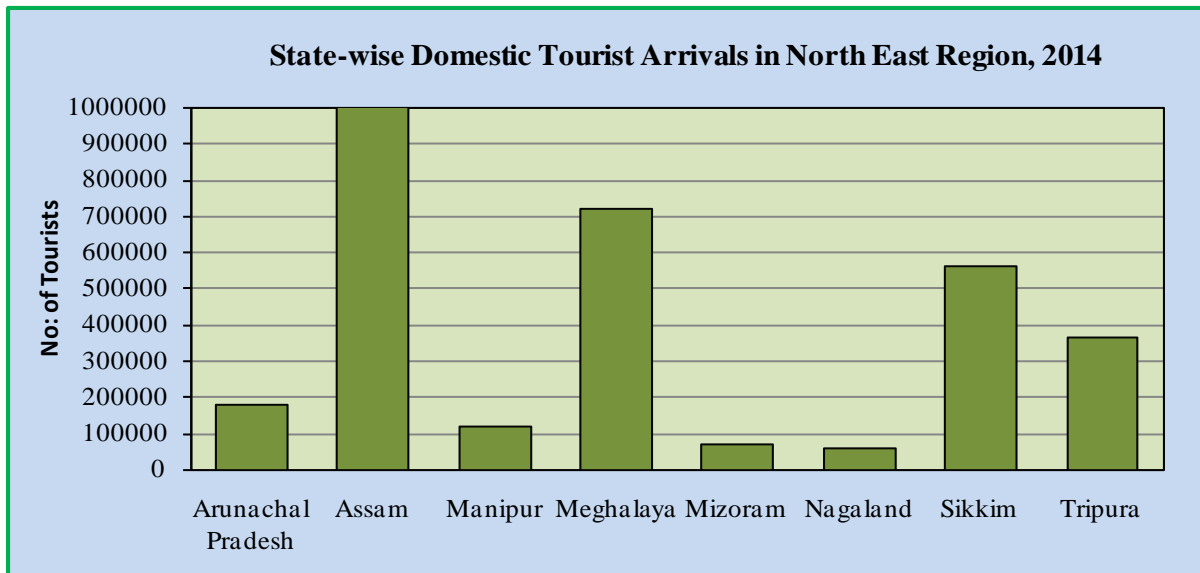


Figure 2: Bar Diagram Showing State-wise Domestic Tourist Arrival in North-East Region

The foreign tourist arrival in North-East has increased from 37,380 persons in 2005 to 118,552 in 2014 (Figure-4). The foreign tourist arrival as per States-wise in the North-East Region is not much satisfactorily. It is the State of Sikkim where the maximum number of foreign tourist use to visit in compares to other States of this region. The Figure-5 depicts that during 2014, Sikkim drew about 49,175 of foreign tourist arrivals followed by Tripura with 26,688, Assam with 21,537, and Meghalaya with 8,664 foreign tourist and rest of the States drew below 6000 tourists. The region has potentiality to become the most favorite tourism destination for International tourist, as it enjoys pollution

free, moderate and pleasant weather throughout the year. But due to mis-information and perception about the situation of North-East, the region is viewed as a highly unsafe region for travel, so the foreign tourist are discouraged to travel in North-East India. This perception need to be changed in order to increase the foreign tourist in North-East region. Besides the old news in social media regarding the abnormal situation in North-East are being circulated discouraging the tourist from visiting the region without knowing the actual ground truth and present scenario.

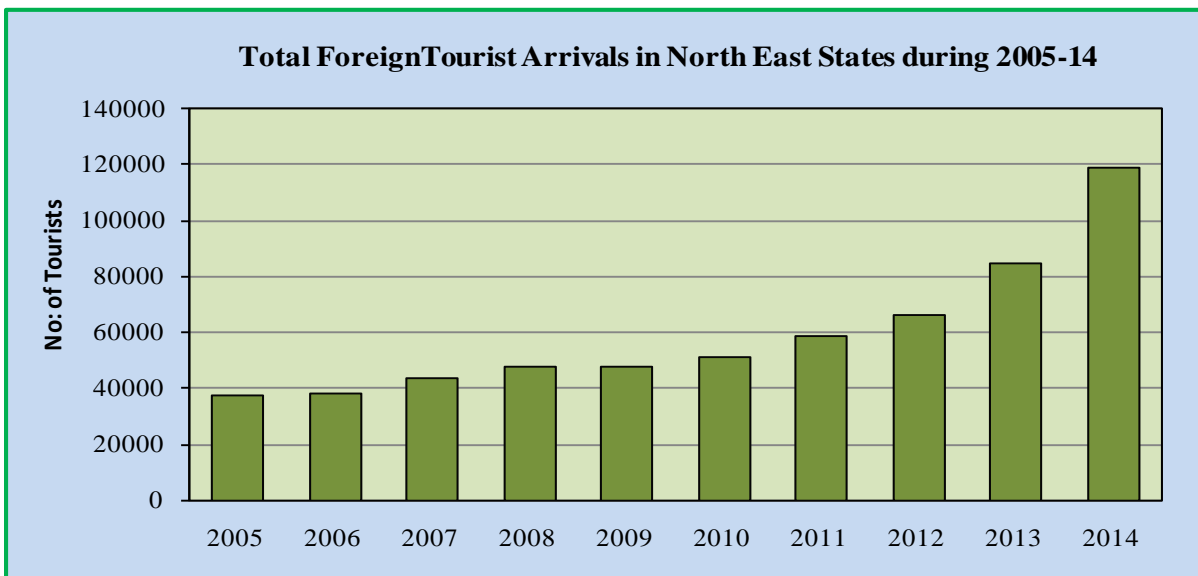


Figure 3: Bar Diagram Showing Foreign Tourist Arrivals in North-East Region

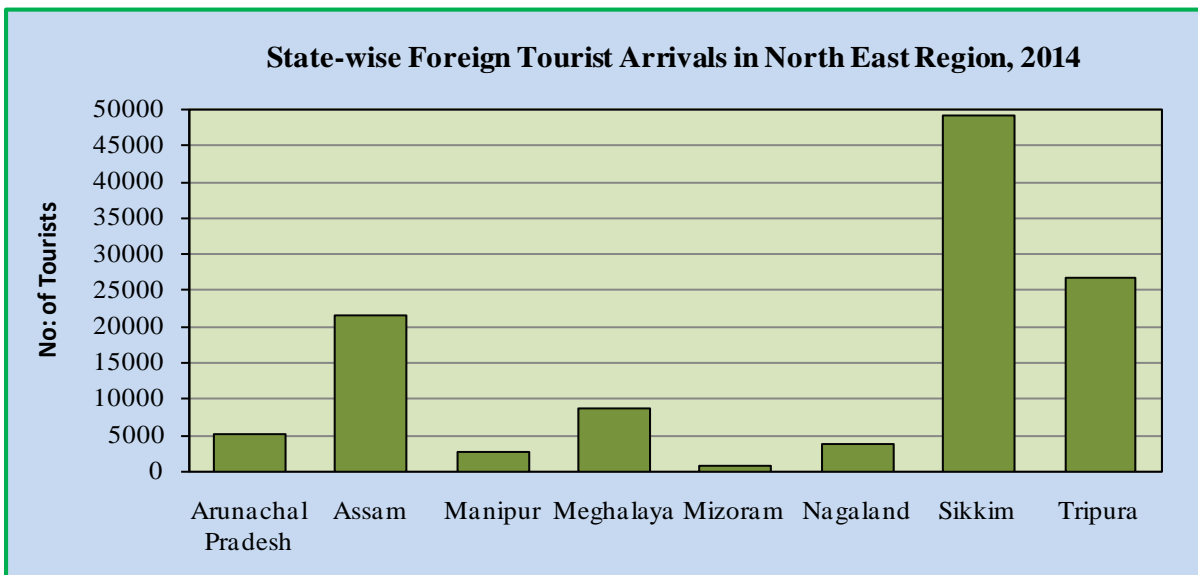


Figure 4: Bar Diagram Showing State-wise Foreign Tourist Arrivals in North-East Region

As per the average annual growth rate of tourists' inflow, the picture is quite different. The overall growth rate of tourist (both domestic and foreign) in North-East was as high as 26.44% during 2005-06 and now this growth rate has decreased as low as 3.64% during 2013-14 as shown in Figure-6. A high and positive growth of 12.53% was registered in foreign tourist visits to North-East States of India during 2012 from 2011, which further rose by more than 100% to register a growth of 27.93% during 2013 from 2012. Foreign tourist arrivals in North-East witnessed a growth of 39.77% during 2014 from 2013, according to data provided from the Ministry of Tourism, Government of India. The North-East of India is finally turning a new leaf in tourism, as the number of *foreign tourists* has more than doubled in 2014 compared to the previous year.

Among the Eight States of North-East, there is a sudden growth in the flow of foreign tourists to Tripura with 125% growth rate during 2013-14, followed by Sikkim with 55.14% and Manipur with 45.13% and the least was Arunachal Pradesh where there is decline of Foreign Tourist was recorded with -52.02% (Figure-7). Whereas, the total number of domestic tourist inflow to Nagaland increased by 63.91%, followed by Arunachal Pradesh by 42.24%, Mizoram with 7.61%, Assam, Meghalaya, and Tripura with below 5% growth rate whereas Sikkim and Manipur experience the negative growth rate of -2.48% and -17.90% respectively.

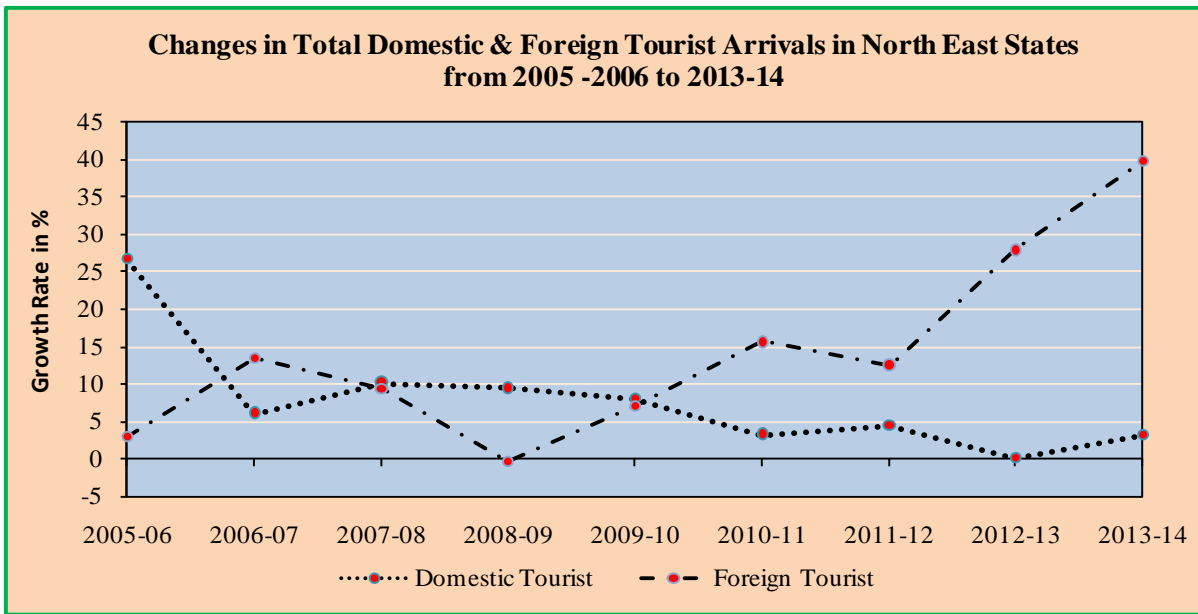


Figure 5: Diagram Showing Growth Rate in Domestic & Foreign Tourist in NER

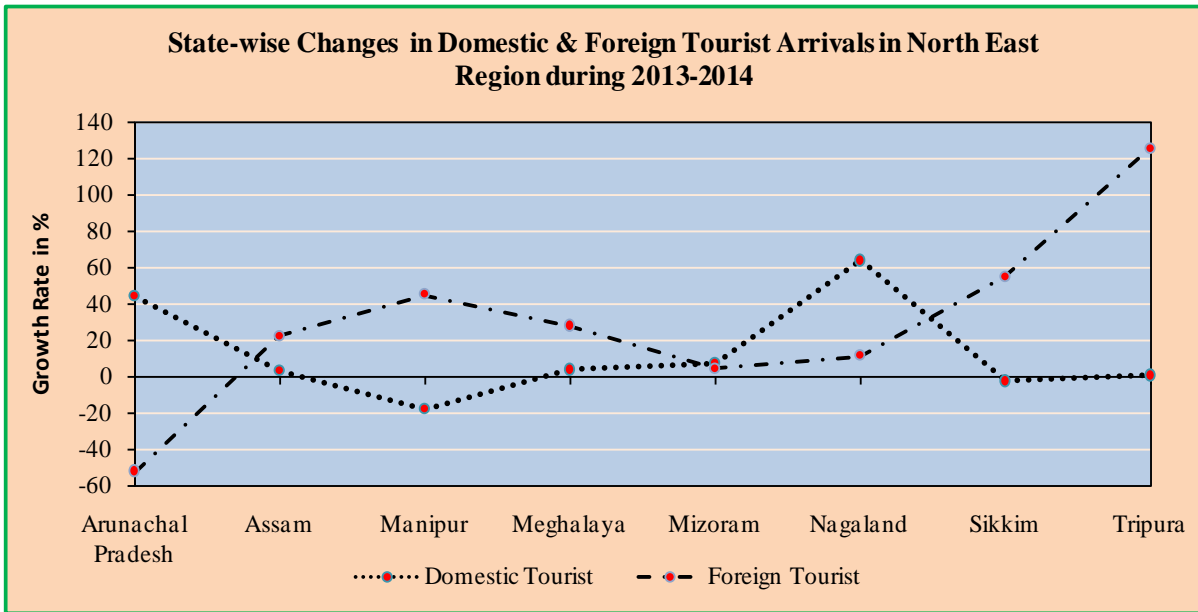


Figure 6: Diagram Showing State-wise Growth Rate of Tourist Arrivals in NER

Despite its vast tourism resources, the North-East Region could not attract only 0.54% of the domestic tourist flow of the whole country in 2014. Even within the North-East Region, around 88% of the domestic tourist arrivals are in the States of Assam, Meghalaya and Sikkim only. The percentage of foreign tourist arrivals in the North-East Region is 0.52% to the total tourists which is negligible in comparison to arrivals in the country. The major constraints for less foreign tourist arrivals in this region is its connectivity to other circuits, less tourism marketing of this region in comparison to the other circuits of the country and perception of safety in the region.

## VI. PROBLEMS OF TOURISM IN NORTH-EAST

The North-East India is plagued by multiple problems, from poverty to insurgency, which have rendered it poorer and less connected than the rest of the country. These realities, have thus far, prevented the North-East from realizing its full tourism potential. The region is characterized by limited tourism infrastructure facilities, particularly in terms of quality and experiential/interpretational, and site services in certain circuit and mostly nil elsewhere.

The main problems that are facing for tourism development in the North-East States of India are self-explanatory which can be identified as under:-

*Security Threats/Perceptions:* The region is viewed as a highly unsafe region for travel. There are reality situations at some parts, but overall there is an image deficit. The North-East is situated in a geographically vulnerable zone. Almost 98% of the North-Eastern borders are international ones – connected to Bangladesh, Bhutan, China and Myanmar. A major risk associated with this unique geo-political location is that of cross-border human trafficking. Adding to the vulnerability are factors of unemployment, gender-based violence, armed conflicts and oppressive social structures. The insurgency problems have repelled many people from entering North-East Region. In some states like Sikkim, Arunachal Pradesh, Mizoram, etc., issues of insurgency don't come up, but these states are also marred by a generalization and superficial knowledge of the North-East Region. Because of security concerns in certain circuits/sub-regions/sites, the potential tourists outside generally feel whole area is unsafe, this perception needs to be changed through different measures.

*Accessibility & Transportation:* Accessibility is the single biggest problem of North-East Region. Railways is the major primary mode of transport for far off destinations by domestic tourists. Railways network is abnormally poor in the region. Railways connectivity is non-existent for most States/sub-regions. Unless railway plans are implemented, it will not lead to large volumes of tourist inflow. Air connectivity is also limited. Roads, which are now the main form of connectivity between States and destinations are in varying grades across. Assam has very good road connectivity in general, hill areas suffer in terms of poor road connectivity and condition. . The distances, hilly roads and the condition of the roads result in high travel time. Accessibility needs to be first addressed not only from tourism perspective, but also for improving security situation and access to markets.

*Accommodation Facility:* The present accommodation capacity, is extremely lacking both in terms of numbers and quality. Existing lodging facilities are insufficient to cope with increasing demand as well as do not cater to high spending tourists, and quality is very poor. Except in few cities and main destinations, standard quality accommodation is not available elsewhere. There is a need to develop accommodation facilities at most destinations/hubs/nodes, regularise, augment the facility, to become a quality destination and meet the requirements of increased tourist traffic after development of the circuit. There is requirement of professionalism in North-Eastern Region's hotel industry.

*Hygienic Food:* Standard & hygienic food restaurants and hotels are lacking in North-East Region. To attract quality tourists, hygienic food joints are one of the foremost requirements. Restaurants are required on roads connecting major destinations. The food habits of

North-East are quite different, though this would become an additional interest point for some tourists, standard Indian food is required at all destinations/key circuit routes.

*Tourist Amenities:* The wayside amenities including toilets, dustbins, drinking water, filling stations, vehicle repair shops etc. are inadequate/non-existent at sites and enroute. Tourist spots/destinations are spread over large distances with no proper wayside amenities. Other tourist's facilities like guide, map, foreign exchange, ATMs, Cyber cafe, signage etc. are also lacking and need to be addressed. There are inadequate entertainment facilities such as, exhibition centres, cultural theatres, shopping haats etc. for tourists. These facilities will increase stay of tourists in North-East Region and their expenditure to the economy.

*Tourist Information System:* There is need of tourist information system at most of the circuits in the region and outside. A full-scale publicity drive is crucial for making tourists aware of what in worth seeing in the region and the local community to care for proper marketing of its landscape, heritage and skills. Tourist Information offices existing in North-East Region do provide some information on some tourist destinations. However, the information system needs to be strengthened and means diversified by giving information related to tour operators in NER, skilled and authorised guides, places of interest etc.

*Brand Image and Exposure:* Regional spread of resources is not uniform- there are few attractions which can sell as stand-alone destinations, however there are many attractions which are medium level, however approached as independent attractions, rather than in circuit manner. There is lack of exposure in tourism products which can generate markets in all the destinations and place of attractions. No proper marketing strategy has been implemented so far in the region. Hence there is no distribution network in place; none of the tour operators sell region's tourism products. There is a lack of a brand identity for the region. Ideally, a brand image should be developed for the region, which should be integrated into the highly successful "Incredible India" campaign.

*Permit System:* Tourists are not allowed to visit some restricted area where the Inner-Line Permits is necessary to be obtained from the respective authority. Ethnic issues as well as the sensitive nature and proximity to the borders of China, Bhutan, and Myanmar deems this permit necessary. This permit is compulsory for both the foreign tourist as well as the domestic tourist. This type of permit system in some states makes it difficult for the independent travellers to make self arrangements for travel or have to travel to certain cities for issue of permits. The present system of issuing permits from few locations is an impediment to tourist travel. Also the manual system is Government office time based. Thus,



it is proposed that permits be converted to an online permit system.

The above mentioned problems of tourism are the underlying foundations for the entire economic development of the North-East Region. To overcome the above constraints and problems, some immediate as well as long-term measures are to be adopted. A strong political will have to be set with extensive leadership for restoration of peacefulness and political stability. The infrastructure required by tourism like transport, communications, water supply and health services etc. are also benefits local communities and can be used for other activities like speeding disaster relief, providing for the local population and fuelling the overall development of the region. Although there are several measures being taken by the State and the Centre to upgrade tourism potential of the North-East but it still remains one of the least preferred choice as a tourist destination. Image improvement, infrastructure upgradation, and administrative and security concerns need to be handled for tourism to flourish as a development industry with community participation.

## VII. PROSPECTS OF SUSTAINABLE TOURISM FOR REGIONAL DEVELOPMENT IN NORTH-EAST

In the context of a globally growing sector like tourism, North-East India with both physical and human diversities is one of the most promising regions of the country in respect of tourism. The North-Eastern states of India are lesser explored as compared to the rest of the country, despite their scenic beauty. The tourism potential of the North-East has not been fully exploited. The Ministry of Tourism calls the region a '*paradise unexplored*'. Global tourism has been booming and future projections show that this trend will continue. The new generations of travellers who are 'money rich and time poor' are increasingly looking for unique experiences. More and more people are looking at tourism as less of a journey and more of an experience – a phenomenon being called the emergence of the 'experience economy'. Tourism being a multi-dimensional activity, depends on the involvement of many other agencies for its success. Other departments like roads, culture, forest and so on, can play an important role in the development of the total tourism product. For achieving maximum coordination, institutional arrangements should be put in place.

For these new and growing breed of tourists the North-East with its variety and uniqueness holds immense attraction. The rich natural beauty and its diversity, exotic cultural and ethnic mosaic, flora and fauna and the serenity of the virgin, unexplored ecosystems provides possibilities of a totally different experience for the tourists. The rationale for a trade led growth strategy for the North-East integrated to the 'look

east' policy has been well explained. The landlocked North-East, it is explained, is ideally placed to link India with ASEAN both in a geographical and commercial sense. The North-East also has strong cultural and historical linkages with the East, which could be exploited to forge economic cooperation. Unfortunately, despite its comparative advantage in this area, tourism is not perceived as an important economic activity. The first task of the governments should be to create awareness about the place of tourism in general and of sustainable tourism in particular, in the socio-economic planning of the region. But such awareness creation efforts can start only when the governments themselves are convinced of tourism's importance and provide it due priority in the planning process.

Most of tourism planning in the region appears to be ad hoc. It is essential to move away from such an ad hoc approach to draw up definite plans of action, charting out the future directions clearly. Every state must bring out a pragmatic tourism policy, not couched in general terms but clearly defining an implementable action plan. It should indicate the government's commitment to sustainable tourism, the place assigned to tourism in broad development planning, the role of government and other key players. The policy should identify the organizational pattern to implement the policy and a system of monitoring and accountability. Tourism planning for the North-East States, whether aimed at the domestic or the foreign tourist, would be most attractive and cost effective if based on an integrated NE perspective. The attractions of the different States, rather than competing, should supplement each other and enhance the total attraction of the region. If tourism development is not taken up with some urgency and in a planned manner it is quite possible that instead of tourism providing an economic push, in a liberalized atmosphere, the region may suffer from a reverse flow. In tourism, as elsewhere, if the goods cannot meet the competition, the outflow may overtake inflow.

Though North-East States of India is a very backward region in the whole country, yet it has the greatest potentiality to develop the region into a potent force through tourism industry. North-East India is well blessed by Nature and it lays at the centre of one of the world's richest bio-geographic areas. It is the treasure house of various economic resources. Tourism has the greatest potential for generating income and employment opportunities in North-East Indian States because NE is not only characterized by the blending of flora and fauna it is also exceptionally rich in bio-diversity. Tourism development of a region endorses overall economic progress and a crucial boost for local entrepreneurial activities. As such, entrepreneurship in tourism is generally considered as means of local business development under sustainable tourism paradigm. Tourism provides direct benefits to the local

community and businesses. It has a multiplier effect on other economic activities, providing jobs and incomes to those serving tourists through the supply chain and also as it is a labour intensive industry.

The North-East handicrafts especially bamboo/cane based and textiles are well known and exclusive. Promotion of these handicrafts would directly benefit the local artisans who are involved in production. Handlooms are a rich village industry in most of the States in the region. This in most of the cases is a hereditary occupation. Some of the handloom products, which are known for their excellent craftsmanship are - carpets of Arunachal Pradesh, Muga silk products of Assam, Lashingphee of Manipur, Shawls of Nagaland and Mizoram. Other common handloom products such as Bed Sheets, Scurf, Jackets are produced in almost all the States of the region. Thus, these products, emerging from a tradition of arts and crafts, have less value within the region, as compared to the rest of the country and for that matter, the world. To allow local entrepreneurs to reach such emerging markets, there needs to be a significant thrust towards the development of a relationship between the rest of the country and people from this region. Such a long-term relationship will not only lead to the creation of a dependable marketplace for local artisans and entrepreneurs but will also help in creating employment opportunities among the masses.

For the formulation of a sustainable tourism strategy in the North-East States of India, tourism planners may need to concentrate on some key areas like -

- (i) Conservation and neo interpretation of natural, archaeological/historical and cultural tourism products,
- (ii) Seasonality aspects of tourism operation,
- (iii) Enhancement of tourist facilities and services (transportation, accommodation etc),
- (iv) Public health and safety,
- (v) Promotion of tourism infrastructure,
- (vi) Focus on community involvement,
- (vii) Allocating/zoning spaces for recreational land use,
- (viii) Extending efforts on need-based tourism education and training,
- (ix) Tourism financing,
- (x) Prioritization of domestic tourism sector and
- (xi) Evolving strategies for better management of the sector.

These strategies take advantage of the developmental opportunities, and try to remove the constraints to develop North-East Region as a tourist destination. As there are lot of tourist destinations within the region and nearby, potential of developing circuits within and with North-East Region needs to be explored. This would help in attracting more tourists to North-East Region and increasing their duration of stay. Circuit(s)

should be developed in a way that tourists can choose the circuits they want to visit depending on the duration of their stay. It is very important to have local community involved-actively engaging the local community in tourism economic activities which will also help in easing out the internal conflicts and lead to safer and more hospitable environment. To generate awareness and commitment of all stakeholders in the industry that a pristine and unspoiled environment is an important resource that provides a rationale for generating sustainable tourism arrivals for the future.

## VIII. CONCLUSION

The sustainable tourism development advocates for proper exploitation and explanation of touristic resources and the direction of development should be as per the need but not only of the present but also of the future. The successful development and operation of tourism sector in this region requires better management at the local government level to guide, facilitate and coordinate the process, so that tourism ventures can sustain in the local socio-economic situation and contribute meaningfully in the areas concerned. The North-Eastern Region of India has failed to attract domestic and foreign tourists. The majority of the region is naturally rich but more or less politically disturbed, climatically attractive but geographically tough, culturally diversified but economically unsound.

The present study concludes that the tourism industry in North-East Region is developing but not as expected. Though the Government of India is providing some special care for the North-East Region, it is still the backward part of the India territory because of many constraints. As per the growth in tourists inflows is concerned, Nagaland is higher in average growth in tourists' inflows in 2013-14 as compare to other States of North-East. This growth in the rate of inflows shows a significant improvement in the tourism industry. The major constraints of tourism development in North-East Region are inadequate fund, insufficient transportation facilities, managerial inefficiency, and safety issues, permit issue and so on. It may therefore conclude that the main problem facing the tourism industry in the North-East is the lack of adequate and reliable tourism infrastructure. If tourist amenities, conservation and maintenance not taken care of immediately, North-East Region will never be able to catch up with tourism development as in other areas.

## IX. RECOMMENDATIONS

Inspite of many problems for the sustainable tourism development in North-East States of India, the following measures can be made for the future prospects and sustainable development of tourism in North-East Region.

- To increase the growth of tourism and its shares in the regional economy the proper steps should be taken by the Government and all the stakeholders for the development of the tourism industry in the region.
  - The conservation and sustainable use of natural, social and cultural resources is crucial. Therefore, tourism should be planned and managed within environmental limits and with due regard for the long term appropriate use of natural and human resources.
  - The major cities of the North-eastern states should be connected with each other by the means of adequate transportation system and effective communication.
  - Proper campaigning of the region's wide variety of physical and cultural products (the hidden substances for developing tourism) can bring a dramatic change to the present socio-economic situation of the region.
  - The Government should review the policies on issuing Restricted Area Permit (RAP) and Inner Line Permit (ILP) in the region for creating a favourable atmosphere to tourists.
  - The security measures for the tourists should be improved in all States of NER.
  - Tourism exchange programme within North-East States can be conducted for the betterment and promotion of tourism among the States.
  - Tourism infrastructure and amenities should be improved as the present condition is not good.
  - A strong political will is of excessive in need for the restoration of peace and political stability in the area with a whole hearted efforts including political dialogue with the various insurgent groups working in NE India should be made to redress their grievances within the framework of Indian constitution in a democratic manner.
  - Restoration of peace and tranquility to attract the foreign tourists is of utmost importance for the development of trade and tourism in NE India.
  - Government should make huge investment to break the geographical isolation and remove communication-bottlenecks from NE Indian States.
  - Proper tourism development policy is the need of the hour and for this Government should make a thorough survey in the whole NE region.
  - Planned, sustained and well-thought long term efforts are to be made by the Government and the stakeholder to improve the socio-economic and political set up of NE India.
  - All stakeholders within tourism should be educated about the need to develop more sustainable forms of tourism. This includes staff training and raising awareness, through education and marketing tourism responsibly, of sustainability issues amongst host communities and tourists themselves.
- Seminars, conference and workshops, should be conducted to discuss the problems and prospects of tourism and development at the local, national and international level.

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## Determining Temperature Trends in the Granary Areas of Peninsular Malaysia using Mann- Kendall and Sen's Slope Estimator

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**Abstract-** The spatiotemporal dynamics of temperature as well as rainfall have received greater attention from the scientific communities. This study analysed temperature variability in the three granary areas of Peninsular Malaysia using descriptive statistics, parametric (least square regression) and non-parametric (Mann- Kendall and Sen's slope estimator). The study identified significant warming trend in the annual mean maximum temperature in two of the study areas, i.e. Subang Jaya and Kota Bharu. Also significant warming trend was detected in the annual minimum temperature and significant increasing trend in some of the monthly maximum and minimum temperatures for all the three stations. Also the result reveals spatial and temporal variation in both the maximum and minimum temperature at annual, monthly and seasonal scales. For the annual scale maximum temperature, this study identified a warming trend for the two stations with about 0.014oC per year (1.4oC per 100 years).

**Keywords:** temperature trends, mann- kendall, sen's slope estimator, peninsular malaysia.

**GJHSS-B Classification:** FOR Code: 059999p



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# Determining Temperature Trends in the Granary Areas of Peninsular Malaysia using Mann-Kendall and Sen's Slope Estimator

Danladi Yusuf Gumel <sup>α</sup>, Ahmad Makmom Bn Abdullah <sup>σ</sup>, Rasheeda E. Elhadi <sup>ρ</sup> & Da'u Abba Umar <sup>ω</sup>

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## I. INTRODUCTION

There has been a growing concern from scientific communities across the globe on analyzing spatiotemporal dynamics of rainfall and temperatures. As these two critical weather elements exerts overriding influence on agriculture and other aspects of human society, triggered by the increase in anthropogenic greenhouse gas emission causing the warming of the globe (IPCC, 2007). The global warming phenomenon creates series of feedback mechanisms affecting the natural processes of the hydrologic cycles which alters rainfall patterns in terms of intensity, duration, frequency, and onset and cessation. Although the issue of climate change has become a global issue, yet its impacts are rather deterministic in nature and depends on the specific region of concern (Amirabadizadeh, Huang, & Shui Lee, 2015). Global temperature studies have clearly reported on the recent

long-term warming of the global around the middle of 1970 to 2013 with an average global trend of 0.2 °C per decade (Rohde et al., 2013; Turco, Palazzi, Hardenberg, & Provenzale, 2015).

Though, in recent times the global temperature trends all over the world have either declined or lacks statistical significance in a lot of regional series around the globe around 1997 (Kaufmann, Kauppi, Mann, & Stock, 2011), although temperatures have consistently hovers above the long-term averages (Campra & Morales 2016). Recent observations and global averages show a significant decrease in the warming trend from 0.12 °C per decades between 1951-2012 to 0.05 °C per decades between 1998 to 2012 (Hartmann et al., 2013). Moreover, surface air temperatures exhibits greater spatial and temporal variability (Lovejoy, 2014; Steinman, Mann, & Miller, 2015; Turco et al., 2015).

Previous studies conducted to analyse the trends in the temperature and rainfall used Mann – Kendall statistics and Theil Sen's slope mainly due to the simplicity and versatility of the approach (Mustapha, 2013). For instance studies in India, by Jain and Kumar (2012) studied trends in rainfall, rainy days and temperature over India using Sen's non-parametric estimator and Mann–Kendall test. Their findings showed inconsistent rainfall trends amongst the stations under their study, 15 basins indicated decreasing trend with only one station showing statistically significant trend at 95% confidence level, while the mean maximum temperature series showed a rising trend for most of the stations; it showed a falling trend at some stations. The mean minimum temperature showed a rising as well as a falling trend. Also in the north-eastern United States, (Karmeshu, 2012) similarly used Mann- Kendall test on annual temperature and precipitation for the nine states, their findings revealed statistically significant increasing trend in temperatures for seven out of the nine states with annual linear trend ranging from 0.0006 to 0.02°F per annum.

In a more recent studies, Chakraborty et al. (2017) studied changes in mean air temperature in the parts of eastern Himalaya, in the northeast Indian states. They observed spatial variability in trends with statistically significant increase in annual mean temperature for most of their stations. Despite the spatial variability, the overall range of increase in mean

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temperature is 0.2 °C to 1.6 °C per decade across the study region. Significant rise in average temperature during the winter is experienced by five out of seven places. While in Austria Herath and Sarukkali (2017) using binning technique have reported variation of rainfall- temperature scaling with location and reported increasing trend for more extreme short span precipitation and a decreasing trend in the average long span precipitation incidences. The Fifth Assessment Report (AR5) of the intergovernmental panel on climate change (IPCC) revealed that the period 2016 to 2035 will witness increase in the mean temperature around the globe (Stocker et al., 2013). As such the need for the determination of local as well sub- regional trends and variability for a better understanding of the pattern of changes in the world climate has been reiterated (Campra & Morales 2016).

In spite of this growing concern and the prevalence of the trends associated with a number of climatic variables all over the world, studies of this nature in Malaysia are limited in number (Amirabadizadeh et al., 2015). A study by Wai, Camerlengo, Khairi, and Wahab (2005) reported an upward trend in the average yearly temperature. Their studies predicted temperature changes ranging from 0.99° C to 3.44°C for the next one hundred years. They also reported upward warming trend for all their stations for the past three decades. Tangang, Juneng, and Ahmad (2007), also reported a warming trend of 2.7 – 4.0°C per 100 years for all regions in Peninsular Malaysia and the northern Borneo. Studies by (Suhaila, Deni, Zin, & Jemain, 2010; Varikoden, Preethi, Samah, & Babu, 2011; Zin, Jamaludin, Deni, & Jemain, 2010) have equally demonstrated the variability and occurrence of extreme events signalling changes in the pattern of climate in some parts of the country with its attendant consequences on the environment and other activities.

Similarly, the study by Amirabadizadeh et al. (2015) reported a warming trend of minimum and maximum temperatures ranging from 3.5°C to 4.0°C per 100 years (0.035°C to 0.04°C per annum) over the Langat River Basin in Malaysia. Suhaila and Yusop (2017) used Pettit and sequential Mann-Kendall (SQ-MK) tests to examine the annual and seasonal trends, and change point detection associated with the mean, maximum and minimum temperature data series in Peninsular Malaysia. Their findings detected abrupt changes in the data series and observed significant increasing trends in the annual and seasonal mean, maximum and minimum temperatures in over the country ranging from 2 to 5 °C per 100 years during the last 32 years. They detected large increase in magnitudes of the minimum temperature trend greater than that of the maximum temperatures for most the stations under study.

A number of possible factors governing spatial and temporal variability of surface temperature warming in a particular region or continental area have been highlighted in the literature. They include those related variability arising from atmosphere-ocean interface. For example North Atlantic Oscillation (NAO), the Pacific Decadal Oscillation (PDO), the Indian Ocean Dipole (IOD) and the El Ni-no– Southern Oscillation (ENSO).

The variability of inter-annual temperatures perhaps have largely been ascribed to the effects of El Ni-no -Southern Oscillation (ENSO) and El- Nina (Suhaila and Yusop (2017). In parts of Southeast Asia recent study by Malik et al. (2012) visualized the pattern of extreme events in the rainfall- fields revealed the variability in the moisture sinks over the region. These natural variabilities are believed to have caused both inter-annual and decadal variations of temperatures in some part of the globe and may influence the long term warming trend in any part of the world (Tangang et al., 2007), as well rainfall variability(Tan, Ibrahim, Cracknell, & Yusop, 2017).

Beside these, other anthropogenic ally induced variability, such as the consequences of the Urban Heat Island (UHI) (Li, Zhang, Liu, & Huang, 2004; Philandras, Metaxas, & Nastos, 1999), and deforestation effects (Voldoire & Royer, 2004) are capable of causing variation in the local patterns of temperatures. But in the case of Malaysia and perhaps major part of Southeast Asian sub-region studies have demonstrated continuous changes in the inter-annual rainfall variability and other anomalies (Juneng & Tangang, 2005; Tangang et al., 2007). Furthermore, Tangang et al. (2007) averred that Malaysia being located amid the Indian and the Pacific Ocean which is the origin of the expanding Walker cell, it is probable that the IOD might have an effect on the country's temperature and rainfall variation. Hence the need for more studies on the rainfall behaviour especially at the micro levels to effectively comprehend the significance of the climatic changes has also been stressed (Suhaila et al., 2010).

This study analyzed and examined the trend in the changes associated with minimum and maximum annual, monthly and seasonal scale temperatures specific to the granary areas of MADA, Kedah, IADA, Barat Laut Selangor, and KADA, Kelantan in the Peninsular Malaysia. The study however employed Theil-Sen's Slope and measured the rate of changes of these variables temporally.

## II. MATERIALS AND METHODS

### a) Data Sources

Time series data for mean monthly values of temperature for the period of 34 years (1981 to 2014) from three principal meteorological stations Subang with (elevation of 63m; Latitude 3° 21' N; Longitude 101°56'

E); Alor Setar (elevation 2m; Latitude 6° 12' N; Longitude 100°24' E) and Kota Bharu (elevation 10m; Latitude 6° 12' N; Longitude 100°24' E) were obtained from Malaysia Meteorological Department (MMD).

The selection of the stations to represent the areas was based on data accessibility, homogeneity and completeness of the records and proximity of the

chosen stations to the study areas. The locations of the stations are shown in Figure 1 indicating Alor Setar station representing Muda Agricultural Development Area (MADA), Subang Station representing Integrated Agricultural Development Area, Barat Laut Selangor (IADA- BLS) and Kota Bharu station representing Kemubu Agricultural Development Area (KADA).

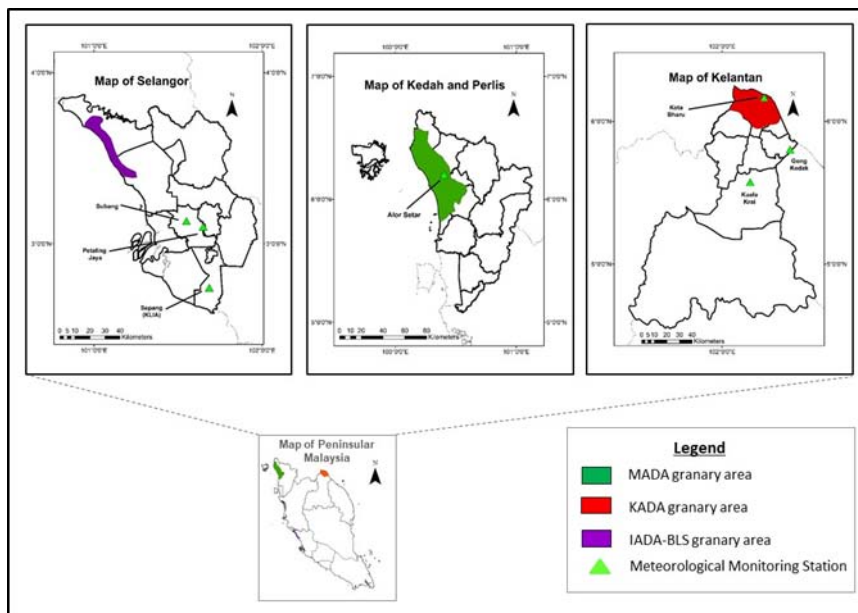


Figure 1: Maps of the Study Areas Showing the Meteorological Stations

b) Data Quality and Treatment

Among the three stations records used only Alor Setar has about nineteen missing values in relation to the total data of the station representing less than 10%. Mostly the missing values were recorded as either not available or amount were “trace” which is conceived to be insignificant. As such the missing values were substituted with corresponding monthly average values following (Muñoz-Díaz & Rodrigo, 2006; Río, Herrero, Fraile, & Penas, 2011; Rodriguez-Puebla, Encinas, Nieto, & Garmendia, 1998).

Generally, the need to identify outliers is one of the significant step in the data quality control (González-Rouco, Jiménez, Quesada, & Valero, 2001). Outliers could be error in measurement or might be accurate extreme values. In the context of this dataset, the concern was not identification of erroneous observations especially with the regards to using hydrological parameters, but to reduce the size of the distribution tails (González-Rouco et al., 2001). In this study, possible outliers were examined using Q-Q plots of the individual data sets, the identified possible outliers were corrected by trimming the extreme values relative to the mean value. In this case outliers were considered as those values above a maximum threshold for each of the time series (González-Rouco et al., 2001; Trenberth & Paolino Jr, 1980) this is defined by;

$$P_{out} = q_{0.75} + 3IQR \quad (2.1)$$

Where  $q_{0.75}$  is the third quartile and IQR the interquartile range. IQR is normally used in climate data quality control (Eischeid, Bruce Baker, Karl, & Diaz, 1995) as it is resistant to outliers. Values over  $P_{out}$  were replaced by this limit (González-Rouco et al. (2001).

c) Normality Test

A Shapiro- Wilk’s test ( $p>0.5$ ) (Razali & Wah, 2011; Shapiro & Wilk, 1965) as well as visual interpretation of their histograms, normal Q-Q plots and box plots showed that all the data series were approximately normally distributed for all the temperatures with Skewness coefficients -0.63 to 0.291 (SE=0.365) and a Kurtosis coefficients of -1.195 to 0.984 (SE = 0.788) (Cramer & Howitt, 2004; Doane & Seward, 2011).

d) Homogeneity Test

In this study the test of inhomogeneity of datasets (temperature series) was performed by applying four techniques of the standard normal homogeneity test, Buishand range test, Pettitt test, and Von Neumann ratio tests. The results showed that the data series obtained from the three stations were found to be homogeneous at  $\alpha = 0.05$ .

e) Linear Regression Test

Simple linear regression is considered as a conventional approach and one of the simplest methods used in detecting changes in the time series of





meteorological variables (Campra & Morales 2016). Simple linear regression was applied to the temperature and rainfall data series. Trends and their 95% CIs were estimated by least squares linear regression. Linear trends were estimated in every series from the slopes of the fit using values of monthly, annual and seasonal averages of Tmax, Tmin (Rimi, Rahman, Karmakar, & Hussain, 2009)) calculated from monthly means provided by MMD. The ordinary least square regression model is linear for each sample  $n$  the value  $y_n$  is represented in the equation;

$$Y = a + bx \tag{2.2}$$

Where  $X_s$  are the  $K$  explanatory variables (years) and  $y$  is the dependent variable (maximum temperature, minimum temperature). The slope line is  $b$ , and  $a$  is the intercept (value of  $y$  when  $x = 0$ ). The slope of regression describes the trend whether positive or negative. Linear regression works with the assumption of normal distribution. In this instance, the null hypothesis is that the slope of the line is zero or there is no trend in the temperature data. The significance of the slope shows the probability value (p-value). Microsoft excel was therefore, employed in the plotting of the trend lines and the XLstat was used in the determination of the statistical values of the linear regression analysis. The P-value from the regression analysis was tested at the significance level  $\alpha = 0.05$ . The  $R^2$  value or the square of the correlation from regression is used to indicate the strength of association and relationship between the variables  $X$  and  $Y$ . It has ratio between 0 and 1.0.  $R^2$  value of 1.0 indicates stronger correlation and it means all points lie linearly. Whereas when  $R^2$  is 0.0 it means no correlation or linear relation between variables  $X$  and  $Y$ .

*f) Mann Kendall Trend Test*

In this study Mann Kendall test was used to examine the performance of a class of non-parametric trend test and the relative magnitude of the data rather than their measured values (Juahir et al., 2010; Kendall 1975). In this context the method was used to detect long term trend of the meteorological variables (i.e. temperature) in the respective study areas.

Monthly and annual series were determined for each of the station using the seasonal Mann Kendall Trend Test (Juahir et al., 2010; Río et al., 2011). XLSTAT software was used in the graphical presentation of the data sets. Moreover, XLSTAT and MAKESEN software were also used to calculate the statistical significance and estimation of trend using Sen Slope estimator for the variability and trend detection (Río et al., 2011).

The underlying principle of this model was based on the statistic (S) which is considered to be zero (0) meaning there was no trend. Each pair of observed values  $y_i, y_j (i > j)$  of the random variable was examined to find out whether  $y_i > y_j$  or  $y_i < y_j$ . The test statistic for the Mann- Kendall test was given as;

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^n \text{sgn}(x_j - x_k) \tag{2.3}$$

The sequential data values and  $j > k$ ,  $n$  is the length of the data set and;

Where;

$$\text{Sign}(x_j - x_k) = \begin{cases} 1 & \text{if } x_j - x_k = 0 \\ 0 & \text{if } x_j - x_k = 0 \\ -1 & \text{if } x_j - x_k = 0 \end{cases} \tag{2.4}$$

This means that the number of positive differences minus the number of negative differences. Variance of  $s$  is therefore computed by;

$$\text{Var}(s) = [n(n-1)(2n+5) - \sum_i (t_i-1)(2t_i+5)]/18 \tag{2.5}$$

In a situation where  $n$  is greater than 10, the standard normal variate  $z$  is computed by using the following equation (Douglas, Vogel, & Kroll, 2000).

$$Z = \begin{cases} \frac{s-1}{\sqrt{\text{var}(s)}} & \text{if } s > 0 \\ 0 & \text{if } s = 0 \\ \frac{s+1}{\sqrt{\text{var}(s)}} & \text{if } s < 0 \end{cases} \tag{2.6}$$

Therefore, the presence of a statistical trend is assessed using  $z$  value. A positive or negative  $z$  value is an indication of upward or downward trend. This study used Sen Slope estimator which is a non-parametric test procedure discovered by Sen (Sen 1968) and advanced by (Gilbert, 1987) to measure the actual slope in Mann – Kendall trend tests. It estimates the degree of any significant monotonic increase or decrease in trends examined in the Mann – Kendall S tests. The estimator Sen Slope was used where trend identified in the time series data is considered to be linear, illustrating the measure of the change per unit time (Mustapha, 2013; Tabari & Talae, 2011). The Sen Slope estimator method is not sensitive to single data error or outliers. It is represented in the following equation;

$$Q = \frac{x_j}{j} - \frac{x_k}{k} \tag{2.7}$$

Where  $Q$  represents the value of Sen in slope estimator;  $x_j$  and  $x_k$  are data values at time  $j$  and  $k$ . If there are  $n$  values of  $x_j$  in the time series, the Sen Slope estimator is the median of  $n(n-1)/2$  pairwise slopes, hence the Sen Slope estimator can be determined using;

$$Q = Q\left(\frac{N+1}{2}\right) \text{if } N \text{ is odd} \tag{2.8}$$

$$Q = \frac{1}{2} (Q\left(\frac{N}{2}\right) + Q\left(\frac{N+2}{2}\right)) \text{if } N \text{ is even} \tag{2.9}$$

### III. RESULTS & DISCUSSIONS

*a) Descriptive Statistical Analysis*

Table 1 provides a simple descriptive statistics of the annual values for the three variables used in this

study from 1981 to 2014 obtained from MMD, such as the measures of centrality in terms of the Minimum values, Maximum values, the Mean and the measures of

dispersion of the data about the Mean, including the standard deviation and coefficient of variation (CV).

*Table 1:* Descriptive Statistics of the Annual Temperatures and Rainfall

Granary	Variables	Min	Max	Mean	SD	CV
Alor Setar	Tmax (°C)	34.4	35.0	34.4	0.39	0.011
	Tmin(°C)	22.2	23.2	22.5	0.25	0.011
	R/Fall(mm)	1575.2	2626.4	2016.7	249.3	0.123
Subang Jaya	Tmax (°C)	34.5	35.1	34.5	0.45	0.013
	Tmin(°C)	22.3	23.8	22.4	0.66	0.029
	R/Fall(mm)	1944.8	3210.3	2551.8	328.3	0.017
Kota Bharu	Tmax (°C)	32.9	33.6	32.9	0.32	0.010
	Tmin(°C)	22.1	24.2	22.3	0.65	0.029
	R/Fall(mm)	1540.5	3734.5	2576.5	595.8	0.231

*Data source: Malaysia Meteorological Department*

From the mean temperature records (Table 1), it is evident that Subang Jaya station recorded the highest mean maximum temperature of 34.5°C, followed by Alor Setar (34.4°C) and Kota Bharu station observed the lowest mean maximum temperature (32.9°C). For the Mean minimum temperature values, Subang Jaya observed the highest mean followed by Alor Setar and Kota Bharu recorded the lowest mean. Alor Setar and Subang Jaya observed average maximum temperature slightly higher than the Malaysia average (33°C), while Kota Bharu station exhibited average maximum temperature almost the same with that of Malaysia. Similarly, all the three stations observed slightly higher average minimum temperature than the mean minimum temperature value of 22.0°C for Malaysia (Chee-Wan & Meng-Chang, 2012).

The values of the standard deviation further revealed the absolute variability of the temperatures. Subang Jaya station observed the highest absolute variability as indicated by the coefficients of standard deviation of 0.45 and 0.66 for both minimum and maximum temperatures respectively. Alor Setar recorded second highest standard deviation of 0.39 for the maximum temperature. Kota Bharu station observed the lowest standard deviation of 0.32 for the maximum temperature, but observed higher standard deviation of minimum temperature next to Subang Jaya. The coefficient of variability (CV) relatively indicated that Subang Jaya had the highest coefficient of variation of 0.013 in annual maximum temperature, Alor Setar observed second highest coefficient of variability (0.011) for maximum temperature. While Subang Jaya and Kota Bharu observed highest minimum temperature coefficient of variation of 0.029 each.

Table 2 indicates the pattern of the temperature variability when the temperature variables were constructed into 10 year intervals to examine their possible changes in the mean, standard deviation and the coefficient of variability over time. In Alor Setar station the changes in mean annual maximum

temperature and the mean annual minimum temperature were first steady, and between the periods 2001 to 2010 the mean annual maximum temperature and the mean annual minimum temperature appreciated with about 1.5% and 0.9% respectively with the decreasing variability.

For the Subang Jaya station, the mean annual maximum temperature decreased with about 6% within the 30 years period, while the mean annual minimum temperature increased by about 2.8% within the periods, but there were general increased in the temperature variability. At Kota Bharu station both the mean annual maximum and mean annual minimum temperatures increased by 0.3% and 2.8% respectively, with 1.1% relative variability.



Table 2: Decadal Variability in the Mean Temp and R/fall in the Study Areas 1981- 2010

Station	Period	1981 - 1990			1991 - 2000			2001 - 2010			
		Statistics	Tmax (°C)	Tmin (°C)	R/F (mm)	Tmax (°C)	Tmin (°C)	R/F (mm)	Tmax (°C)	Tmin (°C)	R/F (mm)
Alor Setar	Lowest		33.9	22.3	1615.3	33.9	22.2	1473.5	34.5	22.3	1928
	Highest		34.8	22.7	2469.5	34.8	22.6	2183.9	35.0	22.9	2573.5
	Mean		34.2	22.4	1989.8	34.2	22.4	1911.6	34.7	22.6	2248.8
	SD		0.327	0.131	284.2	0.327	0.141	193.4	0.162	0.164	193.5
	CV		0.010	0.006	0.143	0.010	0.006	0.101	0.005	0.007	0.086
Subang Jaya	Lowest		34.0	21.3	1971.3	34.3	21.8	2419.0	34.1	22.2	2292.4
	Highest		34.8	22.1	3331.4	34.8	23.0	2811.5	35.2	23.3	3455.2
	Mean		34.3	21.6	2390.9	34.5	22.3	2646.5	34.1	22.6	2908.1
	SD		0.241	0.287	405.5	0.171	0.323	126.1	0.359	0.294	320.7
	CV		0.07	0.013	0.170	0.005	0.014	0.048	0.010	0.013	0.110
Kota Bharu	Min		32.4	21.7	1540.5	32.7	21.9	1689.0	32.7	22.0	1928.6
	Max		33.3	22.2	2859.3	33.6	22.9	3734.5	33.3	22.8	3566.2
	Mean		32.8	21.8	2240.6	33.1	22.3	2886.2	32.9	22.4	2547.1
	SD		0.342	0.147	469.9	0.273	0.329	671.2	0.231	0.238	494.0
	CV		0.010	0.007	0.210	0.008	0.015	0.233	0.007	0.011	0.194

Data Source: Malaysia Meteorological Department

Figure 2 and 3 presents the mean monthly and mean annual maximum temperature, minimum temperature for Alor Setar respectively. Figure 1 shows Alor Setar station recorded mean annual maximum temperatures of 34.4°C. The months of August, September, October and February records the highest

maximum temperature. February recorded the highest mean maximum temperature of 36.2°C and highest mean minimum temperature (23.1°C) as well. Moreover, the month of September recorded the lowest maximum temperature (35.0°C), as well as the lowest mean minimum temperature (22.7°C) (Figure 2).

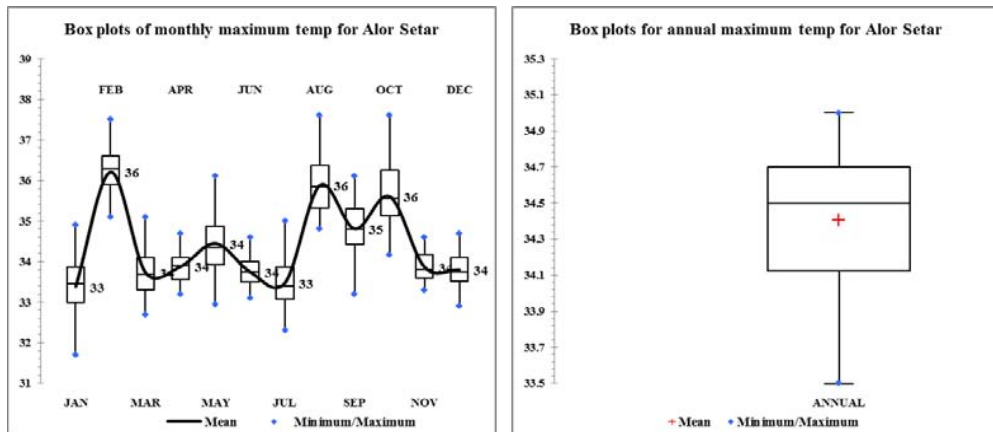


Figure 2: Box Plots of Monthly & Annual Mean Max. Temp for Alor Setar 1981- 201

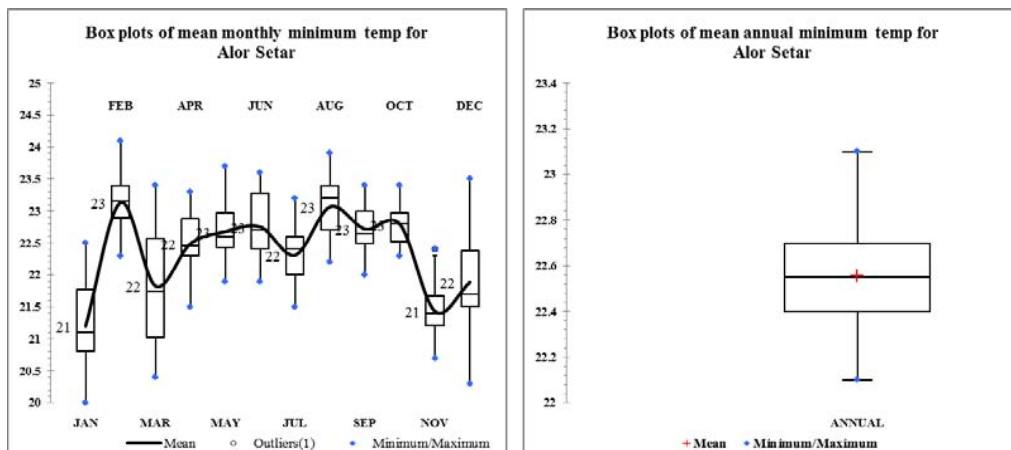


Figure 3: Box Plots of Monthly & Annual Mean Minimum Temp for Alor Setar 1981--2014

Figure 3 and 4 presents the box plots for monthly and annual maximum temperature, minimum temperature, and monthly and annual rainfall for Subang Jaya station respectively. The annual mean maximum temperature over the periods was 34.45°C From January to August the mean monthly maximum

temperature records were constantly high and April was the warmest month (34.8°C). Whereas, the lowest mean maximum temperature was recorded in the month of November (33.9°C). While the annual minimum temperature recorded was 22.3°C, with fairly uniform distribution.

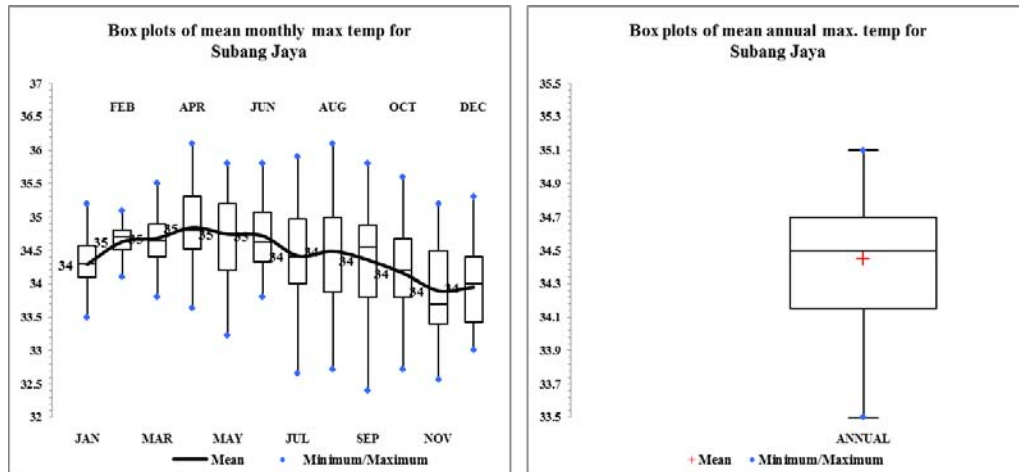


Figure 4: Box Plots of Mean Monthly & Mean Annual Max Temp for Subang (1981- 2014)

The highest mean monthly minimum temperature also coincided with the month of February (Figure 4).

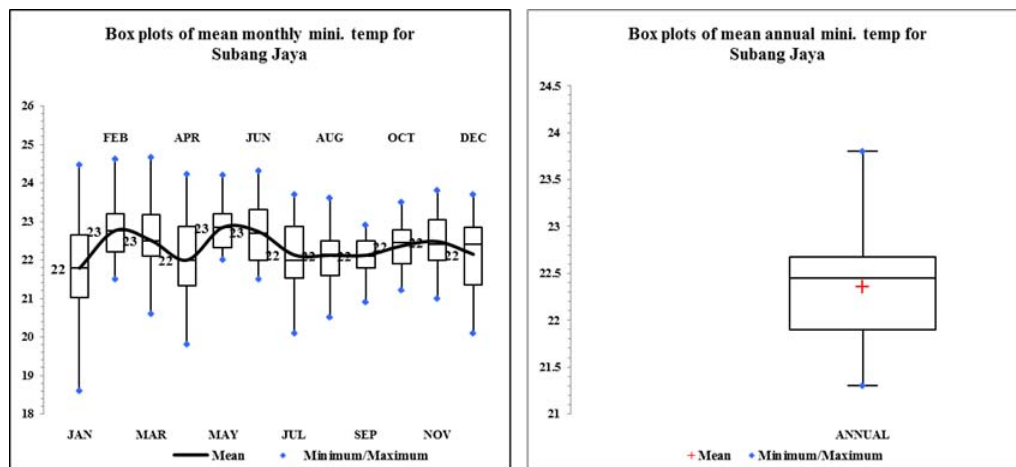


Figure 5: Box Plots of Mean Monthly & Mean Annual Mini Temp for Subang (1981- 2014)

In Kota Bharu station (Figure 6), there is little variation in the mean monthly maximum temperature throughout the year, yet the month of May was the warmest (34.4°C) followed by the month of June (34.3°C) and the lowest mean maximum temperature corresponded with the month of December (30.6°C). Also, average minimum temperature in this station indicates little variability (Figure 6). Characteristically the average minimum values peaked correspondingly along with the months of higher average monthly maximum temperature, which is April with 23°C; but, the months of January through February were noted to be less warm (Figure 7).

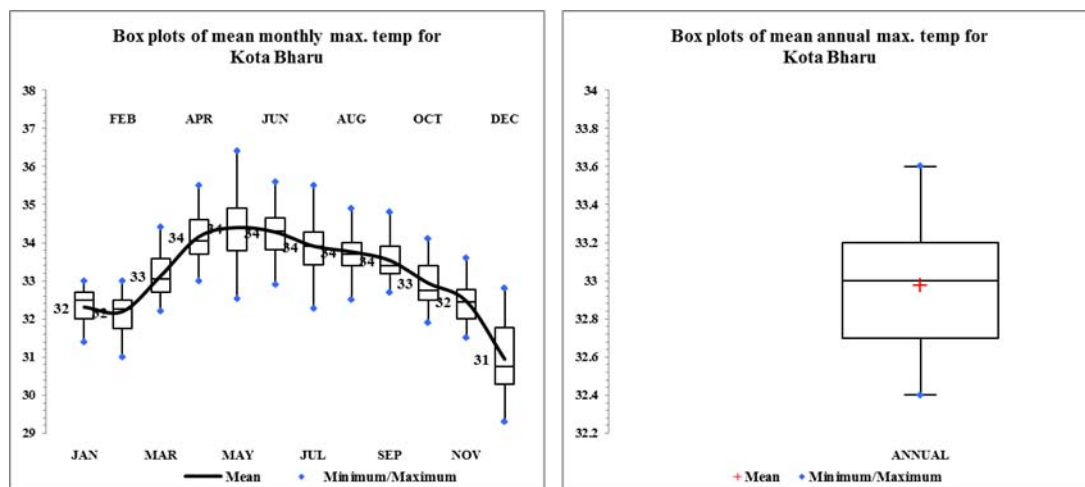


Figure 6: Box Plots of Mean Monthly & Mean Annual Maximum Temp for Kota Bharu (1981- 2014)

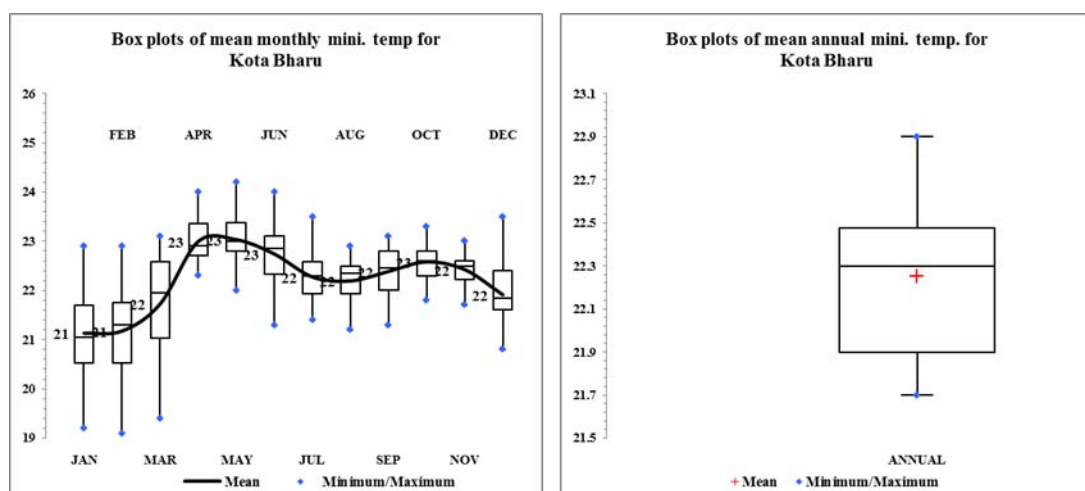


Figure 7: Box Plots of Mean Monthly and Mean Annual Minimum Temp for Kota Bharu (1981- 2014)

Based on the seasonal time scale, the surface climate in Malaysia is influenced by two monsoonal seasons, that is, the southwest monsoon (SW) as well as the northeast monsoon (NE) arrangements. The SW monsoon season is under the dominance of the low level south-westerly winds which begins in May and lasted through August. Alternatively, the NE monsoon season is dominated by the north-easterly wind which begins in November and ended around March of the succeeding year (Amirabadizadeh et al., 2015; Suhaila et al., 2010). Consequently, the seasonal values of TMax and T Min were computed for the average values over the seasons.

Monthly values were averaged to obtain the NE monsoon (winter) and SW monsoon (summer) temperature for each of the three stations. The Northeast monsoon in Malaysia is characterized by steady easterly or north easterly winds of 10-20 knots. This season is considered as the main rainy season which sometimes results in the severe flooding as a result of heavy rainfall, the period last between November and March. This season is succeeded by a short break of an inter-monsoon season in the month of

April. The dominant wind flow normally from south-westerly of light, below 15 knots is the characteristics of the South-west Monsoon. The South-west Monsoon is moderately drier seasons as compared to the Northeast monsoon season throughout the country (Suhaila et al., 2010). This coincided between the months of May and lasted until September. It is also succeeded by an inter-monsoonal break in October. During the two inter monsoonal seasons, the wind are generally light and variable (Suhaila et al., 2010; Wan, 2010).

For the purpose of this study, the seasonal variability in terms of temperature were analysed based on the two paddy growing seasons, i.e. the main season is considered as the period when paddy is grown without supply of water from irrigation. Though varies usually from August/September to February/Mach the following year. The off season is regarded as the dry period when paddy planting normally depends on an irrigation system, the time mostly span from February/March until July/August (DOA, 2014). In this respect, Figures 7- 8 presents the descriptive statistics of the seasonal temperatures for the period 1981 to 2014 in the study areas.

From Figure 8 the mean temperature for the main season was generally lower than the off season temperatures, probably due to the moderating effect of the relatively high amount of rainfall received during the main season. Comparatively, MADA and IADA recorded high mean maximum temperature of 34.2°C each, while KADA had the lowest mean maximum value (32.3°C).

During the off season (Figure 9), Subang Jaya station representing IADA recorded the highest mean

maximum temperature (34.6°C) followed by Alor Setar representing MADA (34.4°C) and Kota Bharu station representing KADA also had the lowest mean. There was higher maximum temperature variability in IADA during the main season, in the MADA area showing less variability (Figure 8).

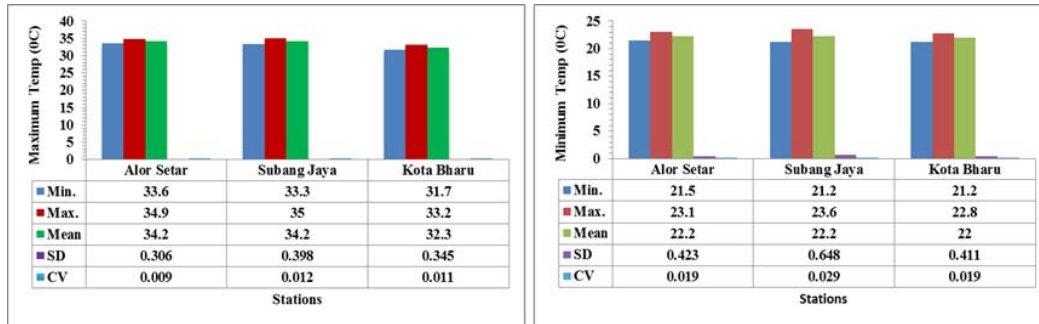


Figure 8: Main Season Maximum & Minimum Temp for Study Areas (1981- 2014)

But, in Figure 9, during the off-season the maximum temperature is more variable at IADA and KADA than at MADA. The minimum temperature shows greater variability more than the maximum temperature for all the seasons in the three areas. Comparatively, the main season minimum temperature for IADA is more

variable than in MADA and KADA (Figure 9). But, minimum temperature for KADA was the least variable during the off- season compared to MADA and the highest variability of minimum temperature was observed in IADA during this season (Figure 9).

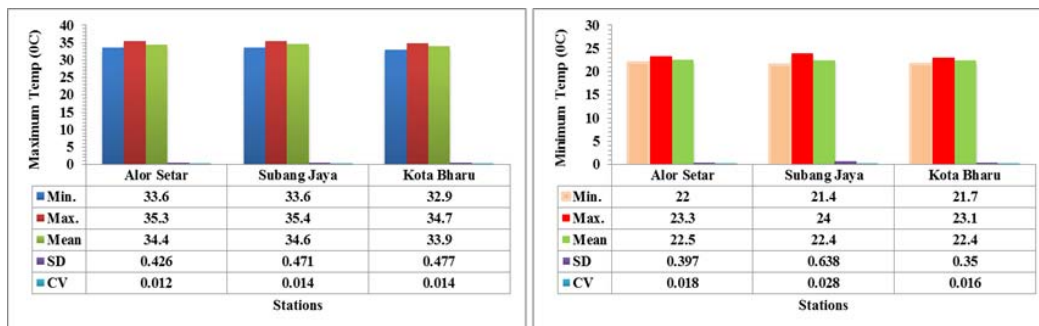


Figure 9: Off Season Maximum & Minimum Temp for the Study Areas (1981- 2014)

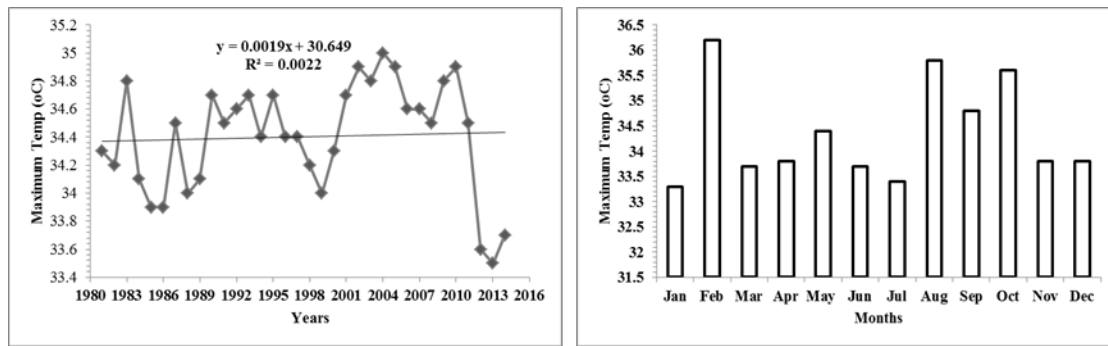
b) Ordinary Linear Regression Trend Analysis

The result of the linear regression of the annual, monthly and seasonal maximum temperature, minimum temperature and rainfall trend analysis for the three study areas are calculated for the 34 years independently.

c) Maximum Temperature Regression Analysis

The maximum temperature linear regression analysis for Alor Setar was conducted on the annual and monthly values, in Alor Setar, the linear trend line of the annual mean maximum temperature shows increasing trend, although there was a weak relationship between the maximum temperature changes and year ( $R^2 = .002$ ) as illustrated in Figure 10a. Higher mean maximum temp is recorded in the months of February,

August and October (Figure 10b). As for the monthly maximum temperature trend, the months of March, April, May, July and November showed decreasing trend, but the other months demonstrated an increasing trend.



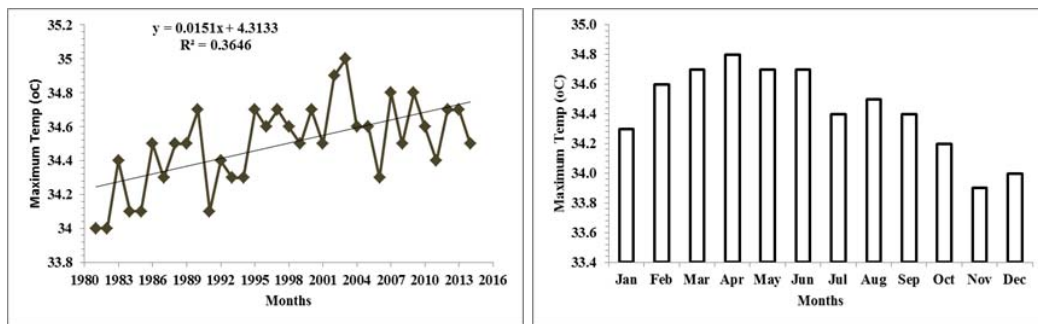
a) Linear trend line of annual mean max Temp For Alor Setar (1981 – 2014)      b) Mean monthly Temp pattern for Alor Setar (1981 – 2014)

Figure 10: Annual Maximum Temperatures Trend & Monthly Pattern for Alor Setar

From the probability value ( $p$ - value) of the regression analyses, the coefficients of the monthly and annual trend lines were greater than 95% confidence level ( $\alpha=0.05$ ), the null hypothesis (that there is no significant trend in the annual and monthly maximum temperature is therefore retained). This means that the annual and monthly maximum temperature exhibited no statistically significant trend, except for the months of January and February. The regression result also shows that more warming was recorded in the month of February with coefficient of  $.045^{\circ}\text{C}$  with a unit change in the year.

Figure 11a shows the annual maximum temperature increasing linear trend with a moderate

relationship between maximum temperature changes and the year ( $R^2= .365$ ), while Figure 11b illustrates the monthly maximum temperature pattern for Subang Jaya over the years. The maximum temperature linear regression analysis was further conducted on the annual and monthly values. The result showed that both annual and monthly maximum temperature demonstrated increasing trend. Only the months of January, February and March revealed statistically significant upward trend. There was no statistically significant increasing trend for the rest of months at 95% confidence level. The maximum temperature for the month of March revealed more significant warming trend with the coefficient of  $.046^{\circ}\text{C}$  for every unit increase in the year ( $p = 0.000$ ).

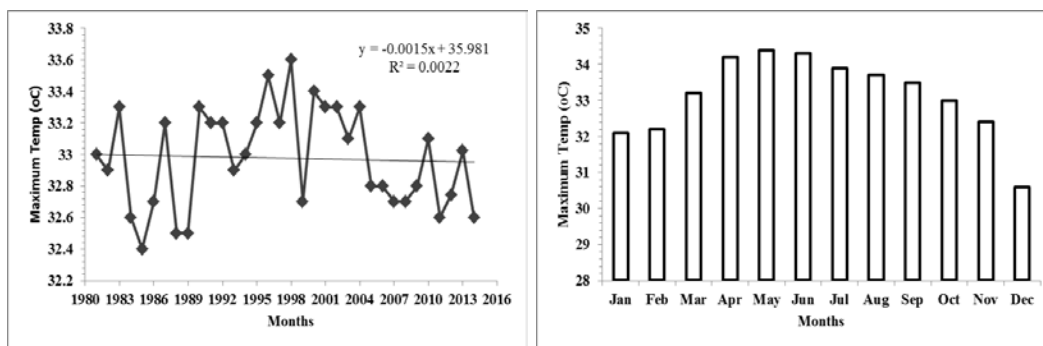


a) Linear trend line of annual mean max Temp For Subang Jaya (1981 – 2014)      b) Mean monthly Temp pattern for Subang Jaya (1981 – 2014)

Figure 11: Annual Maximum Temperatures Trend & Monthly Pattern for Subang Jaya

Figure 12 a illustrates the downward trend in the annual maximum temperature while Figure 12b reveals the monthly pattern of the maximum temperatures for Kota Bharu. From the regression analysis of the monthly temperatures shows downward trend in the months of January, February, September and November while the rest of the months recorded increasing trend. The annual mean and the month of February mean maximum temperatures showed statistically significant downward trend with coefficient  $-.015(P=.016)$  and  $-.027 (p =.047)$  respectively. Similarly, only the months of March, April, December maximum temperature revealed

statistically significant upward trend. The rest of the months revealed no statistically significant trend, this is evident from the respective  $p$ - values of the linear regression analyse for these months are greater than the confidence level ( $\alpha =0.05$ ). The  $R^2$  also shows a very weak relationship between maximum temperature and changes in the year.

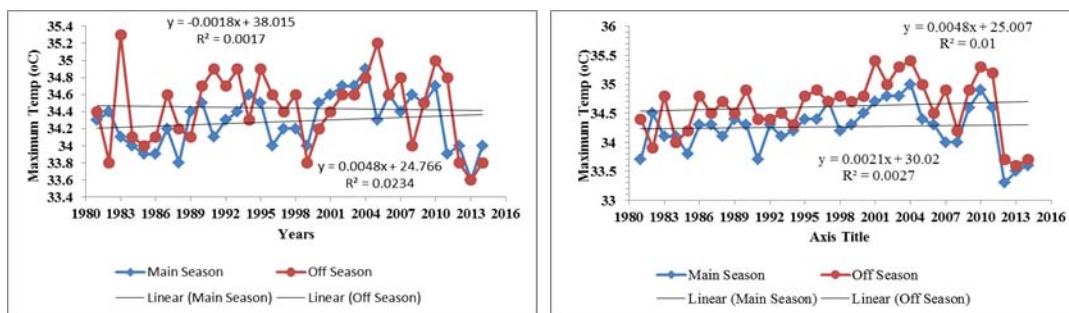


a) Linear trend line of annual mean max Temp for Kota Bharu (1981 – 2014)      b) Mean monthly Temp pattern for Kota Bharu (1981 – 2014)

Figure 12: Annual Maximum Temperatures Trend & Monthly Pattern for Kota Bharu

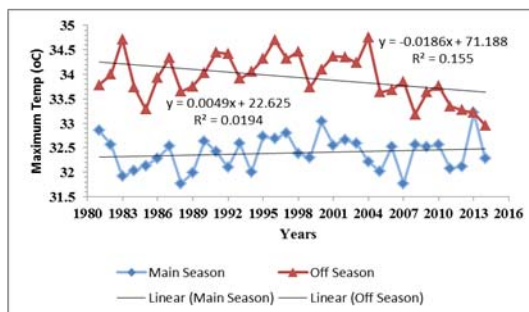
Figure 13 shows the seasonal mean maximum temperature trends for the three study areas. The off seasons maximum temperature for Alor Setar and Kota Bharu showed decreasing trend, while the maximum temperature for all the seasons in Subang Jaya and main season in Alor Star and Kota Bharu showed increasing trend. All the  $R^2$  shows a weak relationship between seasonal maximum temperature changes and the changes in the year.

The result for the linear regression indicated that only main season maximum temperature at Subang Jaya representing IADA showed statistically significant upward trend for the period with a coefficient of .016 ( $p = .002$ ). Also the off seasons, mean maximum temperatures for Alor Setar representing MADA and Kota Bharu representing KADA revealed statistically significant downward trend with the coefficient of -.031 ( $p = .004$ ) and -.022 ( $p = .033$ ) respectively.



Alor Setar

Subang Jaya



Kota Bharu

Figure 13: Seasonal Mean Maximum Temperatures Trend (1981 – 2014)

d) Minimum Temperature Regression Analysis

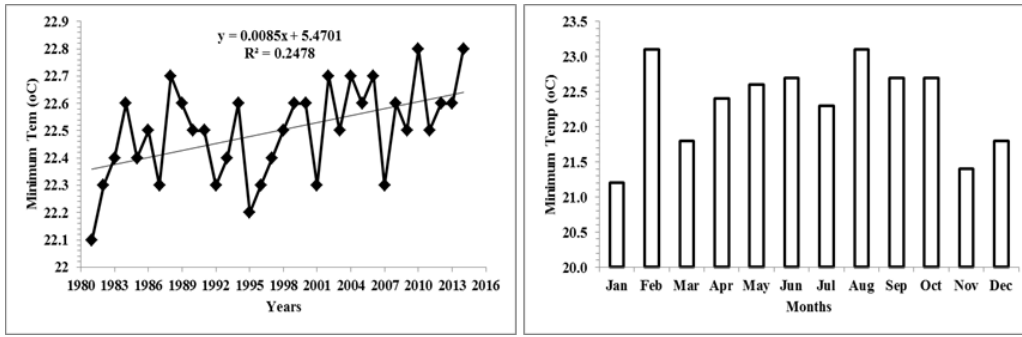
Figure 14a shows the linear trend of the annual minimum temperatures while Figure 14b shows the mean monthly minimum temperature pattern. The result from the regression analysis on the mean annual minimum temperature and mean monthly minimum temperature for Alor Setar showed increasing trends for all the months as well as the mean annual minimum

temperature. But only the minimum temperature for the months of February and July were shown to have no statistically significant trend at 95% confidence level ( $\alpha = .050$ ). From the coefficients of the regression analyses, the minimum temperature for the month of March recorded highest increasing trend within the period with the coefficient of .054°C ( $p = .000$ ). The lowest increasing trend was recorded in the month of



October with coefficient of  $.014^{\circ}\text{C}$  ( $p = .000$ ). The monthly increasing minimum temperature trend for the month of March surpasses the annual increasing trend

over the years with coefficient of  $.018^{\circ}\text{C}$  ( $p = .000$ ).  $R^2$  shows a weak relationship between annual minimum temperature changes and the year.

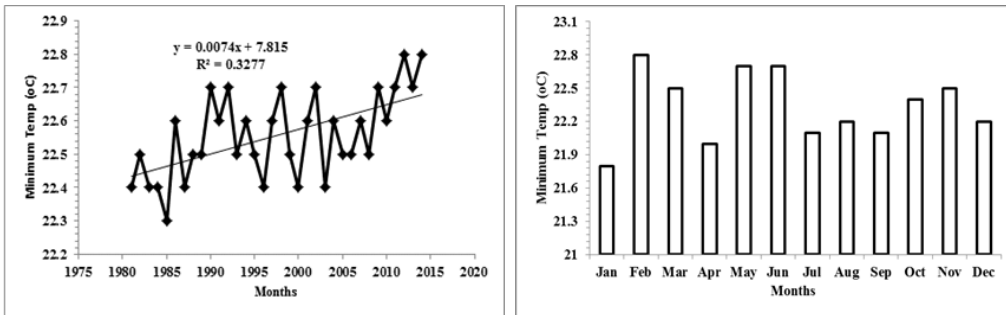


a) Linear trend line of annual mean min Temp for Alor Setar (1981 – 2014)      b) Mean monthly min Temp for Alor Setar (1981 – 2014)

Figure 14: Annual Minimum Temperatures Trend & Mean Monthly Pattern for Alor Setar

Figure 15 a shows the annual linear trend for the mean minimum temperature for Subang Jaya with moderate relationship between annual minimum temperature changes and the year ( $R^2 = .328$ ), while Figure 15b shows the pattern of the mean monthly temperatures. From the linear regression analysis, the result shows statistically significant upward trend for all

the monthly and annual mean monthly minimum temperature for this station. The linear trend coefficient for the mean monthly minimum temperature ranges from  $.037^{\circ}\text{C}$  to  $.063^{\circ}\text{C}$ . The highest increasing trend was recorded in the month of March, while the months of June and July were the lowest increasing trend.

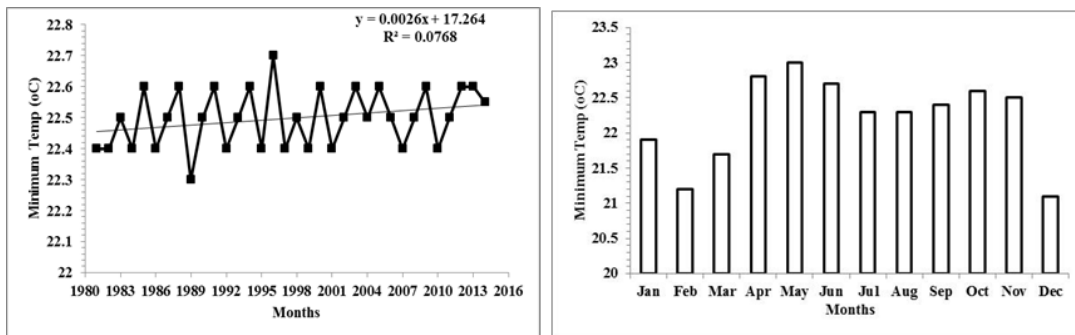


a) Linear trend line of annual mean min Temp for Subang Jaya (1981 – 2014)      b) Mean monthly min Temp pattern for Subang Jaya (1981 – 2014)

Figure 15: Annual Minimum Temperatures Trend & Mean Monthly Pattern for Subang Jaya

Figure 16 a presents annual trend of the mean minimum temperatures, indicating a weak relationship between minimum temperature changes and year ( $R^2 = .077$ ). Figure 16b illustrates the mean monthly minimum temperature patterns for Kota Bharu station.

From the coefficients of the linear trends of all the mean monthly minimum temperature and the annual values showed revealed increasing trend. However, only the minimum temperatures for the months of May and June exhibited no statistically significant increasing trend.



a) Linear trend line of mean annual min Temp for Kota Bharu (1981 – 2014)      b) Mean monthly min Temp pattern for Kota Bharu (1981 – 2014)

Figure 16: Annual Minimum Temperatures Trend & Mean Monthly Pattern for Kota Bharu

Figure 17 shows linear trends of seasonal mean minimum temperature trends for both main and off seasons for the three stations. The regression result for the seasonal changes in the mean minimum temperatures (Appendix F) showed statistically significant increasing trends for all the seasons. Subang Jaya recorded higher upward trend for all the season

with the coefficient of .058 ( $p = .000$ ) each. Alor Setar recorded lowest trend during the main season, while during the off- season Kota Bharu station recorded the lowest seasonal minimum temperature trend. All the  $R^2$  values show that substantial changes in the seasonal temperatures were determined by the changes in the time (year).

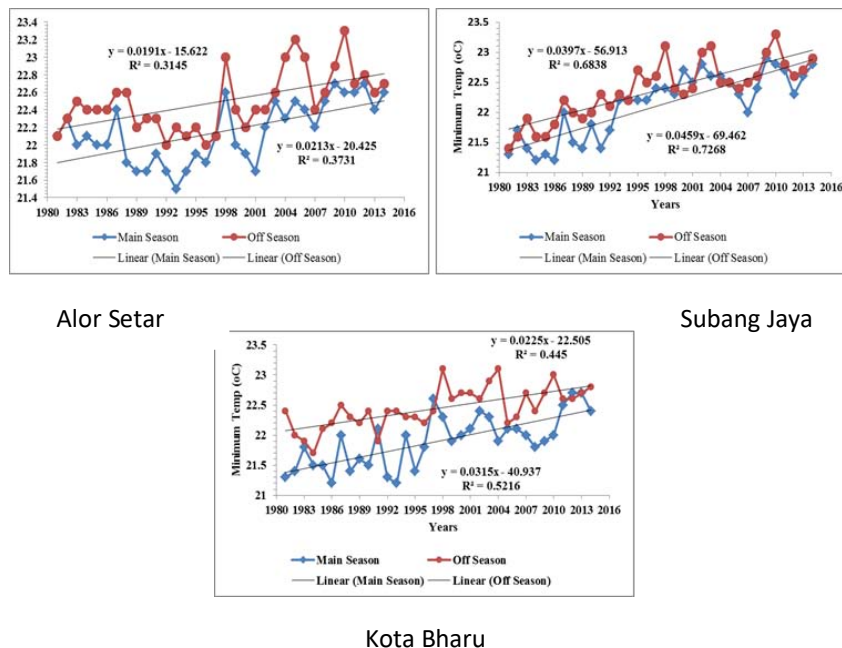


Figure 17: Seasonal Mean Minimum Temperatures Trend (1981 – 2014)

e) MK Test for the Maximum Temperature

In Table 3 present the results of Mann- Kendall and Sen's slope estimator for the mean annual and mean monthly maximum temperatures for Alor Setar. Based on this result the maximum annual temperature indicated a statistically not significant increasing trend in the data series. The MK test confirmed the result of the regression analysis which shows no statistically significant increase in the annual maximum temperature. Mann- Kendall trend revealed similar pattern of upward and downward trends. Similar to the linear regression

analysis, the months of March, April and November have negative sign signifying decreasing trend in the monthly maximum temperature. While the months of May, July and October indicated no trend in their monthly maximum temperature, the rest of the months showed positive sign indicating increasing trend. From the result only the mean maximum temperature for the months of January, August and September shows statistically significant increasing trend. Highest warming was indicated during the months of January ( $Z = 2.69$ ;  $Q = 0.05$ ).

Table 3: Mann- Kendall & Sen's Slope Estimator Result of Annual and Monthly T max for Alor Setar (1981- 2014)

Month	n	Z- Value	Theil Sen's Slope (Q)	Trends	Kendall's Tau	P- Value
Jan	34	2.69	0.05	Increasing	0.329	<b>0.007</b>
Feb	34	1.25	0.025	No Trend	0.155	0.211
Mar	34	-1.13	-0.014	No Trend	-0.139	0.259
April	34	-1.05	-0.02	No Trend	-0.130	0.291
May	34	0.03	0.0	No trend	0.005	0.976
Jun	34	0.78	0.005	No Trend	0.098	0.438
Jul	34	0.22	0.0	No trend	0.029	0.823
Aug	34	2.41	0.029	Increasing	0.297	<b>0.016</b>
Sep	34	2.12	0.033	Increasing	0.260	<b>0.034</b>
Oct	34	0.43	0.0	No trend	0.056	0.665

Nov	34	-1.21	-0.008	No Trend	-0.151	0.228
Dec	34	1.67	0.012	No Trend	0.209	0.095
<b>Annual</b>	<b>34</b>	1.06	0.008	No Trend	0.132	0.291

Table 4 presents the result from the Mann-Kendall and Sen's slope estimator for the annual and monthly maximum temperature for Subang Jaya station. All the monthly and annual maximum temperature for this station revealed increasing trend with the exception of the months of October and November exhibiting no trend and decreasing trend in the maximum temperature respectively. Only the months of February, March, April,

September, and the annual maximum temperature for this station revealed statistical significant increasing trends. The MK trend test result confirmed the regression analysis where both the two tests revealed increasing trends in all the monthly maximum temperature except for the October maximum temperature.

Table 4: Mann-Kendall & Sen's Slope Estimator Result for Annual and Monthly T max for Subang Jaya (1981- 2014)

Month	n	Z- Value	Theil Sen's Slope (Q)	Trends	Kendall's Tau	P- Value
Jan	34	1.16	0.025	No Trend	0.198	0.108
Feb	34	3.27	0.033	Increasing	0.405	<b>0.001</b>
Mar	34	3.20	0.050	Increasing	0.392	<b>0.001</b>
April	34	2.08	0.029	Increasing	0.255	<b>0.050</b>
May	34	1.53	0.024	No Trend	0.190	0.125
Jun	34	1.30	0.014	No Trend	0.161	0.195
Jul	34	1.38	0.020	No trend	0.170	0.167
Aug	34	1.32	0.030	No Trend	0.162	0.186
Sep	34	2.44	0.050	Increasing	0.300	<b>0.015</b>
Oct	34	2.48	0.039	Increasing	0.304	<b>0.013</b>
Nov	34	-0.85	-0.009	No Trend	-0.106	0.396
Dec	34	1.40	0.013	No Trend	0.173	0.162
<b>Annual</b>	<b>34</b>	2.18	0.014	Increasing	0.275	<b>0.029</b>

Table 5 shows the result of the Mann- Kendall trend test and Sen's slope estimator for the annual and monthly maximum temperature for Kota Bharu station. The result shows a downward trend in the months of January, February, September and November maximum temperature, while the maximum temperature for the

month of June showed no trend. All other months including the annual maximum temperature showed increasing trend. There were no statistically significant trends for all the months except for July, December and the annual maximum temperature at 95% confidence level ( $\alpha = .05$ ).

Table 5: Mann- Kendall & Sen's Slope Estimator Result for Annual and Monthly T max for Kota Bharu (1981- 2014)

Month	n	Z- Value	Theil Sen's Slope (Q)	Trends	Kendall's Tau	P- Value
Jan	34	-1.04	-0.025	No Trend	-0.129	0.298
Feb	34	-1.86	-0.03	No Trend	-0.229	0.063
Mar	34	1.65	0.021	No Trend	0.203	0.099
April	34	1.81	0.025	No Trend	0.223	0.070
May	34	1.11	0.007	No Trend	0.139	0.268
Jun	34	0.30	0.0	No trend	0.038	0.766
Jul	34	2.34	0.028	Increasing	0.288	0.020
Aug	34	1.25	0.013	No Trend	0.155	0.211
Sep	34	-1.01	-0.009	No Trend	-0.127	0.311
Oct	34	1.26	0.013	No Trend	0.156	0.206
Nov	34	-1.41	-0.016	No Trend	-0.175	0.158
Dec	34	2.69	0.038	Increasing	0.331	0.007
<b>Annual</b>	<b>34</b>	2.16	0.014	Increasing	0.270	0.031

Table 6 presents the result of Mann- Kendall trend test and Sen's slope estimator for the seasonal maximum temperature for the three stations. The result shows increasing trend in the maximum temperature for all the seasons in all the three study areas. Moreover, only the off- season maximum temperature in all the

three areas showed statistically significant increasing trend. More warming is observed during the off- season in Alor Setar ( $Z= 2.38$ ;  $Q= .032$ ) higher than all the other areas. The MK test result is similar to the regression analysis for seasonal maximum temperatures.

**Table 6:** Mann- Kendall & Sen's Slope Estimator Result of seasonal T max for the study Areas (1981- 2014)

Max. Temperature	n	Z- value	Theil Sen's Slope(Q)	Trends	Kendall's Tau	P- value
Alor Setar_MS	34	1.36	0.008	No Trend	0.170	0.175
Alor Setar_OS	34	2.38	0.032	Increasing	0.294	<b>0.017</b>
Kota Bharu_MS	34	0.69	0.004	No Trend	0.087	0.492
Kota Bharu_OS	34	2.11	0.025	Increasing	0.259	<b>0.035</b>
Subang Jaya_MS	34	3.02	0.016	Increasing	0.377	<b>0.003</b>
Subang Jaya_OS	34	1.65	0.017	No Trend	0.206	0.098

**f) MK Test for Minimum Temperature**

Table 7 revealed statistically significant upward trends in minimum temperature records for all the months as well as for the annual values over the periods in Alor Setar, except for the months of February and July. The rising minimum temperature was observed to

be significantly higher in the month of March ( $Z =3.73$ ;  $Q = 0.056$ ), whereas lowest significant increasing trend in the monthly minimum temperature was noticed in the month of October ( $Z= 2.15$ ;  $Q=.0014$ ). The MK trend statistics confirmed the regression result of the minimum temperature for this station.

**Table 7:** Result of Mann- Kendall & Sen's Slope Estimator of Annual and Monthly Tmin for Alor Setar (1981- 2014)

Month	n	Z- Value	Theil Sen's Slope (Q)	Trends	Kendall's Tau	P- Value
Jan	34	2.56	0.033	Increasing	0.313	0.011
Feb	34	1.31	0.013	No Trend	0.163	0.190
Mar	34	3.73	0.056	Increasing	0.455	0.000
April	34	3.36	0.027	Increasing	0.417	0.001
May	34	4.29	0.031	Increasing	0.532	0.000
Jun	34	2.13	0.022	Increasing	0.264	0.033
Jul	34	1.71	0.012	No Trend	0.214	0.088
Aug	34	2.67	0.022	Increasing	0.333	0.008
Sep	34	3.02	0.024	Increasing	0.377	0.003
Oct	34	2.15	0.014	Increasing	0.267	0.032
Nov	34	3.64	0.027	Increasing	0.453	0.000
Dec	34	3.44	0.042	Increasing	0.425	0.001
Annual	34	4.16	0.018	Increasing	0.524	0.000

Table 8 shows the result of Mann- Kendall and Sen's slope estimator for the minimum temperature in Subang Jaya stations over the years. The result revealed statistically significant increase in the minimum temperature for all the months as well as the annual minimum temperatures with the exception of the month of July which showed no trend at 95% confidence level. Statistically significant upward warming corresponded with the month of March, December and the annual value with (.063°C) each. The month of August recorded the lowest significant minimum temperature warming (.028°C). The result confirmed the regression result for the minimum temperature for this station.

**Table 8:** Result of Mann- Kendall & Sen's Slope Estimator of Annual and Monthly Tmin for Subang Jaya (1981- 2014)

Month	n	Z- Value	Theil Sen's Slope (Q)	Trends	Kendall's Tau	P- Value
Jan	34	3.49	0.052	Increasing	0.425	0.000
Feb	34	3.03	0.040	Increasing	0.375	0.002
Mar	34	4.75	0.063	Increasing	0.584	0.000
April	34	4.72	0.057	Increasing	0.577	0.000
May	34	4.32	0.047	Increasing	0.530	0.000
Jun	34	4.15	0.050	Increasing	0.510	0.000
Jul	34	2.75	0.041	Increasing	0.337	0.006
Aug	34	2.33	0.028	Increasing	0.288	0.020
Sep	34	3.54	0.033	Increasing	0.437	0.000
Oct	34	4.33	0.040	Increasing	0.532	0.000
Nov	34	4.90	0.062	Increasing	0.599	0.000
Dec	34	3.45	0.063	Increasing	0.422	0.001
Annual	34	6.13	0.063	Increasing	0.751	0.000

Table 9 shows the result of Mann- Kendall tests and Sen's slope estimator for monthly and the annual minimum temperature of Kota Bharu station. The result revealed increasing trend in the monthly as well the annual minimum temperature over the periods. But, the minimum temperature for the months of May and November were statistically not significant, while all the

rest of the months as well as the annual values showed statistical significant increasing trends at 95% confidence level. For all the monthly temperatures, January minimum temperature observed the highest upward trends (Z= 3.21; Q= .056), while the month of April recorded the lowest upward trend (Z = 2.15; Q= .018).

**Table 9:** Result of Mann- Kendall & Sen's Slope Estimator of Annual and Monthly T min for Kota Bharu (1981- 2014)

Month	n	Z- Value	Theil Sen's Slope (Q)	Trends	Kendall's Tau	P- Value
Jan	34	3.21	0.056	Increasing	0.390	0.001
Feb	34	2.87	0.050	Increasing	0.351	0.004
Mar	34	2.41	0.044	Increasing	0.295	0.016
April	34	2.15	0.018	Increasing	0.268	0.032
May	34	0.57	0.004	No Trend	0.072	0.571
Jun	34	2.20	0.023	Increasing	0.272	0.028
Jul	34	2.41	0.025	Increasing	0.299	0.016
Aug	34	2.52	0.024	Increasing	0.312	0.012
Sep	34	2.99	0.027	Increasing	0.371	0.003
Oct	34	3.28	0.019	Increasing	0.409	0.001
Nov	34	1.75	0.010	No Trend	0.221	0.079
Dec	34	3.24	0.041	Increasing	0.399	0.010
Annual	34	4.56	0.028	Increasing	0.569	0.000

The result of Mann- Kendall and Sen's slope estimator of seasonal minimum temperature for the three stations are presented in Table 10. The result revealed statistically significant increasing trend for the minimum temperature in all the seasons. The rising seasonal minimum temperature was higher for all the seasons in Subang Jaya station, while Kota Bharu station observed the lowest upward trend for the two seasons.

Table 10: Result of Mann- Kendall & Sen's Slope Estimator of seasonal T min for the study Areas (1981- 2014)

Max. Temperature	n	Z- value	Theil Sen's Slope(Q)	Trends	Kendall's Tau	P- value
Alor Setar_MS	34	3.76	0.033	Increasing	0.465	0.000
Alor Setar_OS	34	3.88	0.030	Increasing	0.483	0.000
Kota Bharu_MS	34	4.12	0.032	Increasing	0.515	0.000
Kota Bharu_OS	34	4.16	0.023	Increasing	0.519	0.000
Subang Jaya_MS	34	5.79	0.059	Increasing	0.710	0.000
Subang Jaya_OS	34	6.24	0.060	Increasing	0.764	0.000

#### IV. SUMMARY

In summary, the variability of temperature in the three study areas were investigated using descriptive statistics, parametric (least square regression) and non-parametric (Mann- Kendall and Sen's slope estimator). The study identified significant warming trend in the annual mean maximum temperature in two of the study areas, i.e. Subang Jaya and Kota Bharu typifying the climate over Peninsular Malaysia.

Also significant warming trend detect in the annual minimum temperature and significant increasing trend in some of the monthly maximum and minimum temperatures for all the three stations. Also, the result reveals spatial and temporal variation in both the maximum and minimum temperature at annual, monthly and seasonal scales.

For the annual scale maximum temperature, this study identified a warming trend for the two stations with about 0.014°C per year (1.4°C per 100 years) The monthly maximum temperatures trend ranges from 0.029 to 0.05°C per annum, whereas the seasonal maximum temperature warming trend ranges from 0.016 – 0.032°C per annum (1.6-3.2°C per 100years). The annual minimum temperature warming trend ranges from 0.018°C to 0.063°C per year (1.8 – 6.3°C per 100 years). The monthly minimum temperature warming trend ranges from 0.014 – 0.063°C. For the seasonal minimum temperature revealed statistically significant warming trend in all the seasons ranging from 0.023°C – 0.060°C per year (2.3 – 6.0°C per 100 years).

#### V. CONCLUSION

Firstly, it can be concluded that there were spatial as well as temporal variation of temperature across the three granary areas. Secondly, the study identified significant warming trend in the annual mean maximum temperature in two of the study areas, i.e. Subang Jaya and Kota Bharu. Also significant warming trend were detected in the annual and seasonal minimum temperature for all the stations as well as significant increasing trend in some of the monthly maximum and minimum temperatures for all the three stations.

The findings from this study have the following implications; firstly, the result from the trend analysis provides an insight to agricultural development agencies

in these areas and paddy farmers themselves, to make pre-emptive measure in relation to climate change variability. Timely measures and institutional actions will surely assist in ameliorating the damages that may be caused by the climate variability. This is in view of the fact that 34 years temperatures and rainfall data do not suffices the denial of the occurrence of climate change variability.

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**Conflict of Interests:** The authors wish to summarily declare that they have no conflict of interest concerning the publication of this paper.

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## The Devastating Effect of Gully Erosion Menace on Urban Infrastructures in Calabar Metropolis, Nigeria

By Dr. Eni, D. Imoke & Miss. Udoh, U. Isidore

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**Abstract-** Gully erosion is caused by several factors such as heavy rainfall, industrial construction, poor drainage system and deforestation were overtime resulted in loosening the soil structure and expose it to vagaries of agents of erosion. The study was aimed at assessing the effect of gully erosion menace on urban infrastructures in Calabar metropolis. Data for the research were collected using a structured questionnaire, handheld, measuring tape, leveling staff and rope. The coordinates of gully erosion sites and the affected infrastructure were obtained from the field using the Global positioning system (GPS). Findings revealed that the total length and average width of each of the gullies as at 2015 were 385m and 20m for Ikot Anwantim, 1925m and 43m for Ikot Udaok, 3995m and 68m for Ikot Nkebre, 721m and 40 for Etinyim Abasi, 1430m and 48m for EdimOtop and 1700m and 28m for Ekeya respectively. Also 18 houses were destroyed at Ekeya gully site. Seventy respondents attributed the impact of gully erosion menace in urban infrastructure to be the collapse of buildings with 35 percent. The researcher recommended that public awareness programme sensitization be undertaken to discourage the inhabitants from developing areas prone to gully erosion.

**Keywords:** gully, erosion, hazards, degradation and infrastructures.

**GJHSS-B Classification:** FOR Code: 050299



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## I. INTRODUCTION

The rate of environmental problems that have occurred in recent decades has assumed unprecedented height, especially in human populated areas such as Calabar metropolis and the multi-facet environmental issues that plague the global community includes global warming, pollution escalated desertification, drought, soil and land degradation, deforestation, food shortage, oil spillage, flora and fauna specie extinction, and flooding, which overtime defaced the earths structure, with a dire consequence on urban settlement in both developed and developing countries.

Amidst the different environmental hazard that occur in Nigeria. The most prevalent and threatening in Calabar is erosion, which involves the transportation of soil particles from one geographical space to another by a high flow of water at the peak of heavy down pour or after. Although we have three types of erosion namely; splash, rill and gully erosion, they most prevalent type in Calabar is the gully erosion, and it contributes to the sculpturing of the earth surface.

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Infrastructures such as schools, hospitals, roads, houses and telecommunication mass have been greatly destroyed by gully erosion in Calabar. The dramatic increase in population has resulted to the high demand of land for building and over dependence on the available infrastructures. The scenario of rapid population expansion have been playing out in the metropolis over time in diverse measures, leading to urban growth and expanded land use development. There are two major factors responsible for the urban population expansion to out weight the capacities of urban management systems provided, there are the natural growth of the population at an overwhelming rate and the poor urban development control mechanism, which do not act proactively to pre-erupt urban disorder. Gully erosion menace in Calabar has caused socio-economic and environmental issues such as; loss of arable lands, lives and properties, creation of bad land and topography, collapse of buildings and culverts, pot holes on roads and destruction of electricity and telecommunication poles. The researcher observed that along areas such as Murtala-Mohammed highway by Bebosco bus stop the road was almost cut off due to gully erosion, also at Ikot Anwatin gully site, but at EdimOtop a large chunk of a nursery school land collapsed and at Etinyin Abasi and Dr. Ekong street, several residential houses wave collapsed.

The effect of gully erosion on urban infrastructure can be assessed, studied, examined and evaluated when the morphometry of gully erosion in the study area is holistically studied. The morphometry of gully erosion is best explained through its variables which include gully, altitude, slope steepness, maximal catchment area as well as maximal, minimal, mean, horizontal, and vertical curvatures of mouth, base, fingers and end points of gullies. Gully morphometry indicators represent methods of describing basin attributes, impact on the development and expansion of ravines in the areas of processes compared to basin characteristics (Musa, 2006).

## II. STUDY AREA

Calabar metropolis lies between 8° 18' 00" E to 8° 24' 00" and 4° 54' 00" N to 5° 04' 00"N. it is bounded by Calabar River to the west, Great Kwa River to the

East, Odukpani Local Government Area to the north and the Greeks of the Cross River as it empties into the Atlantic ocean in the south. It covers a land area of 406 square kilometers. Under Koppen's climate classification, Calabar metropolis has a tropical monsoon climate with a lengthy wet season spanning eight more months and a short dry season covering the remaining three four months with an average annual rainfall of 270mm. Temperatures are relatively constant throughout the year with average high temperatures ranging from 25 to 28 degrees Celsius. Calabar is an inter-fluvial city that is drained by two major rivers, which are the Cross River and the Great Kwa River. The hydrological pattern influences the conventional rainfall commonly experienced in the city. The drainage pattern which is dendriliz is believed to be the remote factor responsible for gully erosion in the area. Calabar has a low lying gentle and undulating topography that forms the coastal plains of south Eastern Nigeria. The locations in Calabar closer to the coast are low lying with an average altitude of 10m above mean sea level, while the areas further away towards the north of the metropolis have heights of between 40 to 80m above sea level. The undulating nature of the Calabar terrain undoubtedly encourages the speed of gully erosion and agents of devaidation.

### III. RESEARCH METHODOLOGY

#### a) Population and Sample

This study adopted descriptive survey research design. The types of data used were, measurements of

gully morphometric properties (length, width, perimeter, depth, bed, shoulder width and slope), attribute data of the affected urban infrastructures (type of infrastructure, nature of damage, extent of damage, number of persons displaced), response of residents and population of the area.

#### b) Data and Sources of Data

The primary data were obtained from questionnaire field observation and measurement. Equipments such as the measuring tape, leveling staff and rope were used to obtained direct measurements such as the depth, bed width and slope of the gully. The coordinates of gully erosion sites and affected infrastructures were obtained by using the geographic positioning system (GPS). The residents were also interviewed at each gully site to have first hand information on the impact of gully erosion on the population and infrastructures within the study area.

A purposive sampling technique was used to select locations ravaged by the scourge of gully erosion. During the reconnaissance the researchers identified seven gully erosion sites within the area and the served as sampling scope for the study. Furthermore, systematic sampling technique was used to select buildings to be sampled in the area. The buildings encompasses different land uses from residential to commercial and public land uses. This was done to ensure effective coverage of the aim of study.

### IV. RESULTS AND DISCUSSION

#### a) Results of Descriptive Statistics of the study variables

*Table 4.1:* Gully erosion morphometry characteristics of each site in the study area

S/N	Gully erosion site	Coordinates	Total length @ 2006(m)	Total length @ 2018	Depth @ 2018	Average width @ 2005(m)	Average width 2018 (m)
1	Ikot Anwantim	8 20 02 <sup>1</sup> .86"E 5 00 08 <sup>1</sup> .87"N	260	385	42	41	20
2	Ikot Uduak	8 20 51 <sup>1</sup> .42"E 4 59 56 <sup>1</sup> .88"N	1350	1925	29	25	43
3	Ikot Nkebre	8 21 32 <sup>1</sup> .10"E 5 03 32 <sup>1</sup> .40"N	2690	3915	41	23	68
4	Etinyin Abasi	8 20 12 <sup>1</sup> .6"E 4 56 14 <sup>1</sup> .82"N	345	721	16	32	40
5	EdimOtop	8 21 18 <sup>1</sup> .58"E 4 57 46 <sup>1</sup> .55"N	1250	1430	29	52	48
6	Ekeya	8 19 37 <sup>1</sup> .24"E 4 55 35 <sup>1</sup> .29"N	652	1700	25	19	28

The research revealed that as at 2005 the total length for Ikot anwantim, Ikot Uduak, Ikot Nkebre, Etinyin Abasi, EdimOtop and Ekeya was 260m, 1350m, 2690m, 345m, 1250m, and 652m respectively. While the total

length for 2018 was 385m, 1925m, 3995m, 721m, 1430m, and 1700m. their depths as at 2018 was 42m, 29m, 41m, 16m, 29m and 25m. Their average width for 2018 was 52m, 43m, 68m, 20m, 68m and 28m.

The research reveals that the remediation work at each of this gully site was not comprehensive and even abandoned at some point due to paucity of funds from government. At Etinyim Abasi, Ikot Nkebre, Ikot Uduak and Ekeya gully points it was observed that

government intervention was not pronounced enough to reduce the threat posed by gully erosion to infrastructures such as buildings, electric poles and access roads, which were seen to be degraded.

Table 4.2: Number of urban infrastructures affected by active gully

Gully site	Urban infrastructures						
	Access roads	Houses	Electric pole	Schools	Communication installations	Water pipes	Health centres
Ikot Nkebre	10	15	4	3	1	4	1
Ekeya	13	18	5	4	3	19	3
Ikot Uduak	5	8	2	1	1	15	2
Etinyin Abasi	9	14	3	2	2	18	2

Table 4.2 depicts the number of urban infrastructures affected by active gullies within the study area. The table shows that we have four active gully sites in Calabar metropolis which are Ikot Nkebre, Ekeya, Ikot Uduak and Etinyin Abasi. These clearly indicated that at Ikot Nkebre gully sites 10 roads were destroyed, 15 houses, 4 electric poles, 3 schools, 1 communication installations, 4 water pipes and 1 health centre but at Ekeya gully site we had the highest level of environmental degradation with 13 access roads

destroyed, 18 houses, 5 electric poles, 4 schools, 3 communication installations, 19 water pipes and 3 health centres degraded. The lowest impact was at Ikot Uduak even though with pronounced degradation of infrastructures. From the research it is evident that gully erosion has affected urban infrastructures with the study area. Furthermore, the research finding was buttressed by the administration of 200 questionnaire and the result was presented in table 4.3 below:

Table 4.3: Effects of gully on urban infrastructures

Effects of gully on urban infrastructures	Frequency	Percentage
Loss of source of livelihood	5	2.5
Loss of lives	10	5
Collapse of buildings	70	35
Collapse of health centres	30	15
Destruction of access roads	40	20
Collapse of electric poles	35	17.5
Collapse of communication installation	5	2.5
Destruction of farm lands	5	2.5
Total	200	100

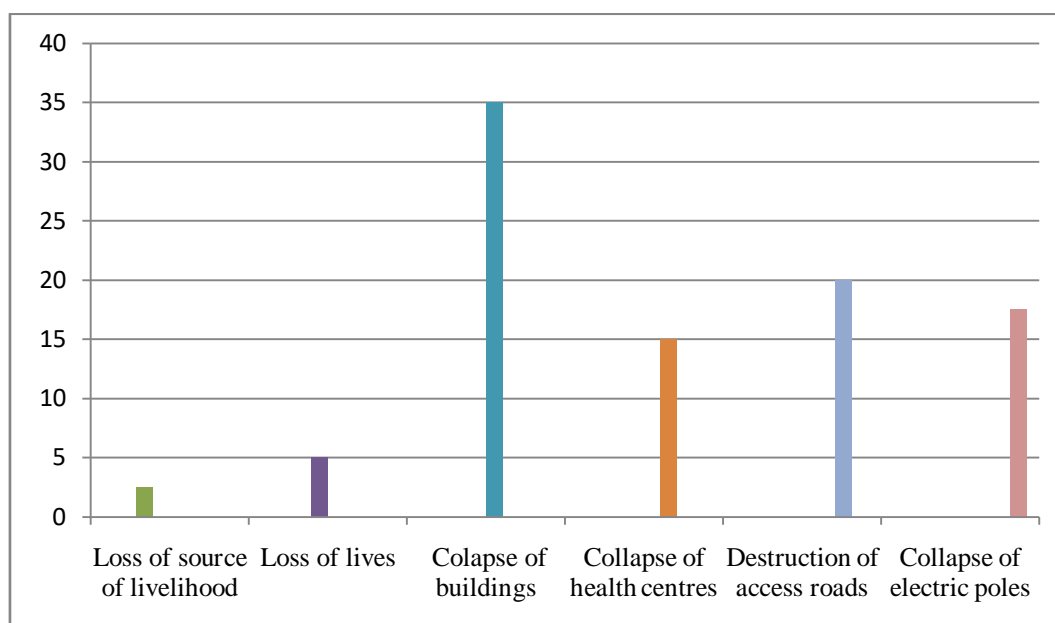


Fig. 1: Effects of gully on urban infrastructures

The table and figure revealed that 70 respondents agreed that the collapse of buildings was the major problem associated with gully erosion menace with 35 percent. But loss of livelihood, destruction of farmlands and collapse of communication installation were least affected with 2.5 percent.

From the study it was deduced that gully erosion distribution pattern cut across different wards within the study area, with each gully sites having unique features in terms of its morphometry properties. Also, it's was seen that the difference in magnitude of gully erosion sites is dependent on the morphometric characteristics. We can say that the morphometric parameters of any gully route do not only show the gully morphology, but also the rate of the gully development. Moreso, the study revealed that build up areas have encroached into the gully and green areas, thereby subjecting the gully route to pressure which results in expansion and ultimately effects the urban infrastructures. This finding is in line with Jimoh (2008), and Lonita(2006) findings on gully erosion research. Despite the intervention effort of government agencies towards ameliorating gully menace, some threatening gully sites in the study area are still expanding due to erosional processes, supported by agents of deviation. The researcher recommends that public awareness be created on the danger posed by gully and residents within these areas be encouraged to adhere strictly to turn planning regulations regarding the types of infrastructures to be created close to gully sites.

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The primary objective is to recognize the leaders in research and scientific fields of the current era with a global perspective and to create a channel between them and other researchers for better exposure and knowledge sharing. Members are most eminent scientists, engineers, and technologists from all across the world. Associate membership can later be promoted to Fellow Membership. Associates are elected for life through a peer review process on the basis of excellence in the respective domain. There is no limit on the number of new nominations made in any year. Each year, the Open Association of Research Society elect up to 12 new Associate Members.



## BENEFIT

### TO THE INSTITUTION

#### GET LETTER OF APPRECIATION

Global Journals sends a letter of appreciation of author to the Dean or CEO of the University or Company of which author is a part, signed by editor in chief or chief author.



### EXCLUSIVE NETWORK

#### GET ACCESS TO A CLOSED NETWORK

A ASSRC member gets access to a closed network of Tier 2 researchers and scientists with direct communication channel through our website. Associates can reach out to other members or researchers directly. They should also be open to reaching out by other.

Career

Credibility

Exclusive

Reputation



### CERTIFICATE

#### CERTIFICATE, LOR AND LASER-MOMENTO

Associates receive a printed copy of a certificate signed by our Chief Author that may be used for academic purposes and a personal recommendation letter to the dean of member's university.

Career

Credibility

Exclusive

Reputation



### DESIGNATION

#### GET HONORED TITLE OF MEMBERSHIP

Associates can use the honored title of membership. The "ASSRC" is an honored title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., ASSRC or William Walldroff, M.S., ASSRC.

Career

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Exclusive

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#### BETTER VISIBILITY AND CITATION

All the Associate members of ASSRC get a badge of "Leading Member of Global Journals" on the Research Community that distinguishes them from others. Additionally, the profile is also partially maintained by our team for better visibility and citation.

Career

Credibility

Reputation

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### GET DISCOUNTS ON THE FUTURE PUBLICATIONS

Associates receive discounts on future publications with Global Journals up to 30%. Through our recommendation programs, members also receive discounts on publications made with OARS affiliated organizations.

Career

Financial



## GJ ACCOUNT

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Associates get secure and fast GJ work emails with 5GB forward of emails that they may use them as their primary email. For example, john [AT] globaljournals [DOT] org.

Career

Credibility

Reputation



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To take future researches to the zenith, fellows receive access to almost all the premium tools that Global Journals have to offer along with the partnership with some of the best marketing leading tools out there.

Financial

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### ORGANIZE SEMINAR/CONFERENCE

Associates are authorized to organize symposium/seminar/conference on behalf of Global Journal Incorporation (USA). They can also participate in the same organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent. Additionally, they get free research conferences (and others) alerts.

Career

Credibility

Financial

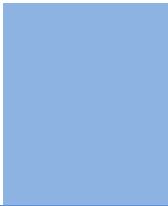
## EARLY INVITATIONS

### EARLY INVITATIONS TO ALL THE SYMPOSIUMS, SEMINARS, CONFERENCES

All associates receive the early invitations to all the symposiums, seminars, conferences and webinars hosted by Global Journals in their subject.

Exclusive





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Associates can publish articles (limited) without any fees. Also, they can earn up to 30-40% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.

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Associate members are eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get a remuneration of 15% of author fees, taken from the author of a respective paper.

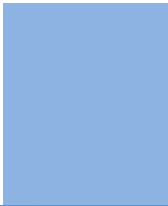
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## AND MUCH MORE

### GET ACCESS TO SCIENTIFIC MUSEUMS AND OBSERVATORIES ACROSS THE GLOBE

All members get access to 2 selected scientific museums and observatories across the globe. All researches published with Global Journals will be kept under deep archival facilities across regions for future protections and disaster recovery. They get 5 GB free secure cloud access for storing research files.





ASSOCIATE	FELLOW	RESEARCH GROUP	BASIC
<p>\$4800 lifetime designation</p> <hr/> <p>Certificate, LoR and Momento 2 discounted publishing/year Gradation of Research 10 research contacts/day 1 GB Cloud Storage GJ Community Access</p>	<p>\$6800 lifetime designation</p> <hr/> <p>Certificate, LoR and Momento Unlimited discounted publishing/year Gradation of Research Unlimited research contacts/day 5 GB Cloud Storage Online Presense Assistance GJ Community Access</p>	<p>\$12500.00 organizational</p> <hr/> <p>Certificates, LoRs and Momentos Unlimited free publishing/year Gradation of Research Unlimited research contacts/day Unlimited Cloud Storage Online Presense Assistance GJ Community Access</p>	<p>APC per article</p> <hr/> <p>GJ Community Access</p>





# PREFERRED AUTHOR GUIDELINES

**We accept the manuscript submissions in any standard (generic) format.**

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from <https://globaljournals.org/Template.zip>

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at [submit@globaljournals.org](mailto:submit@globaljournals.org) or get in touch with [chiefeditor@globaljournals.org](mailto:chiefeditor@globaljournals.org) if they wish to send the abstract before submission.

## BEFORE AND DURING SUBMISSION

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct*, along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s) names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

## Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

## POLICY ON PLAGIARISM

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures



- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

## AUTHORSHIP POLICIES

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

### Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

### Copyright

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### Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

### Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

### Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

## PREPARING YOUR MANUSCRIPT

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.



### ***Manuscript Style Instruction (Optional)***

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

### ***Structure and Format of Manuscript***

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

- a) A title which should be relevant to the theme of the paper.
- b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
- c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
- d) An introduction, giving fundamental background objectives.
- e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
- f) Results which should be presented concisely by well-designed tables and figures.
- g) Suitable statistical data should also be given.
- h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

- i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
- j) There should be brief acknowledgments.
- k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.



## FORMAT STRUCTURE

***It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.***

All manuscripts submitted to Global Journals should include:

### **Title**

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

### **Author details**

The full postal address of any related author(s) must be specified.

### **Abstract**

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

### **Keywords**

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

### **Numerical Methods**

Numerical methods used should be transparent and, where appropriate, supported by references.

### **Abbreviations**

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

### **Formulas and equations**

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

### **Tables, Figures, and Figure Legends**

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.



## Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

## PREPARATION OF ELETRONIC FIGURES FOR PUBLICATION

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

## TIPS FOR WRITING A GOOD QUALITY SOCIAL SCIENCE RESEARCH PAPER

Techniques for writing a good quality homan social science research paper:

**1. Choosing the topic:** In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

**2. Think like evaluators:** If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

**3. Ask your guides:** If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

**4. Use of computer is recommended:** As you are doing research in the field of homan social science then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

**5. Use the internet for help:** An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow [here](#).



**6. Bookmarks are useful:** When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

**7. Revise what you wrote:** When you write anything, always read it, summarize it, and then finalize it.

**8. Make every effort:** Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

**9. Produce good diagrams of your own:** Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

**10. Use proper verb tense:** Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

**11. Pick a good study spot:** Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

**12. Know what you know:** Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

**13. Use good grammar:** Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

**14. Arrangement of information:** Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

**15. Never start at the last minute:** Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

**16. Multitasking in research is not good:** Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

**17. Never copy others' work:** Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

**18. Go to seminars:** Attend seminars if the topic is relevant to your research area. Utilize all your resources.

Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

**19. Think technically:** Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.



**20. Adding unnecessary information:** Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

**21. Report concluded results:** Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

**22. Upon conclusion:** Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium through which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

## INFORMAL GUIDELINES OF RESEARCH PAPER WRITING

### **Key points to remember:**

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

### **Final points:**

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

*The introduction:* This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

### **The discussion section:**

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

### **General style:**

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

**To make a paper clear:** Adhere to recommended page limits.



### *Mistakes to avoid:*

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

### **Title page:**

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

**Abstract:** This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

*Reason for writing the article—theory, overall issue, purpose.*

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

### **Approach:**

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

### **Introduction:**

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.





*The following approach can create a valuable beginning:*

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

#### **Approach:**

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

#### **Procedures (methods and materials):**

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

#### **Materials:**

*Materials may be reported in part of a section or else they may be recognized along with your measures.*

#### **Methods:**

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

#### **Approach:**

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

#### **What to keep away from:**

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



**Results:**

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

**Content:**

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

**What to stay away from:**

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

**Approach:**

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

**Figures and tables:**

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

**Discussion:**

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."



Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

**Approach:**

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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<i>Result</i>	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
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<i>References</i>	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



# INDEX

---

---

## **A**

Accommodation · 34, 37  
Amalgamation · 28  
Amenities · 34, 38  
Ascribed · 42

---

## **C**

Contamination · 1  
Continental · 42  
Crucial · 34, 36, 38

---

## **D**

Degradation · 61, 63, 64  
Downward · 44, 51, 54, 55

---

## **E**

Emergence · 25, 35  
Endowed · 27  
Erosion · 61, 62, 63, 64, 65  
Ethnic · 23, 26, 28, 35  
Excessive · 38  
Exhibits · 41  
Extensive · 13, 35

---

## **G**

Gradation · 22

---

## **H**

Hereditary · 36  
Heritage · 24, 26, 28, 34

---

## **I**

Immense · 25, 35  
Inaccessible · 23  
Infrastructures · 61, 62, 63, 64  
Intensity · 21, 25, 41, 60

---

## **L**

Lacking · 34

---

## **M**

Mosaic · 23, 28, 35  
Multiplier · 36

---

## **N**

Negligible · 33

---

## **O**

Occurrence · 42, 58

---

## **P**

Plagued · 33  
Prevalent · 61  
Pristine · 37  
Probable · 42, 59

---

## **R**

Rationale · 35, 37  
Regression · 11, 41, 44, 50, 51, 52, 53, 54, 55, 56, 58, 59



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