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Environmental Impact Assessment of A Proposed Highway Project in Vijayawada Using Riam Software

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Abstract

Assessment of environmental impacts is necessary for any kind of major projects to safeguard the environmental sustainability. The state government and National highway authority of India has proposed 3 options for bypass road. This is a major project which involves acquisition of land for road construction which affects agriculture land, forests, water bodies, etc. The main focus in this project is identifying the impacts of the proposed Bypass Road in Andhra Pradesh and to present the results in such a way that decision making can be done easily. All the possible effects identified are fed to the Rapid Impact Assessment Matrix for assessment (RIAM). The RIAM calculates the impacts under four categories: Physicochemical, Biological Ecological, Social Cultural, and Economical Operational. The output of the RIAM shows that Bypass Road project has negative and positive impacts in all 3 options of all categories. These 3 options are compared and the results were presented in the form of bar charts. The results are very useful for better decision making. In RIAM software, titles are given initially as option-1, option -2 and option-3. The list of impacts is identified and values are given. In output, we are comparing of results of option-1, option-2 & option-3. Based on comparison option-3 found to be the best option with minimum impacts.

Keywords: Environmental Impact Assessment, RIAM Software, Arc GIS Software, East Bypass Road, Vijayawada.

Introduction

The roads are lifeline of any country. They are also important for the building the nation and are mirror of country's development. However, most of these roads on account of their location, route alignment and associated activities are invariably accompanied by significant environmental and social impacts during different phases (viz., Pre-construction, Construction and Operational phase) of the project. The nature of these impacts could be either positive or negative depending upon their potential to favorably or adversely affect the surrounding environment and the resident community. The aim of the present work is to explore the environmental impacts of the proposed Outer Ring Road around the new capital city of Andhra Pradesh state.

Environmental Impact Assessment

Environmental Impact Assessment (EIA) is an important management tool for ensuring optimal use of natural resources for sustainable development. To facilitate collection of environmental data and preparation of management plans, guidelines have been evolved and circulated to the concerned Central and State Government Departments. EIA has now been made mandatory under the Environmental (Protection Act, 1986 for 29 categories of developmental activities involving investments of Rs. 50 crores and above).

Environmental Impact Assessment (EIA) is the process by which the anticipated effects on the environment of a proposed development or project are measured. If the likely effects are unacceptable, design measures or other relevant mitigation measures can be taken to reduce or avoid those effects. The document from this process is called an Environmental Impact Statement (EIS). It aims to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts. By using EIA both environmental and economic benefits can be achieved, such as reduced cost and time of project implementation and design, avoided treatment/clean-up costs and impacts of laws and regulations.

Environmental Impact Assessment need for Bypass Road Project

The environmental impact of roads (both positive and negative) includes the local effects of highways (public roads) such as on noise, water pollution, habitat destruction /disturbance and local air quality, and the wider effects which may include climate change from vehicle emissions. The design, construction and management of roads, parking and other related facilities as well as the design and regulation of vehicles can change the impacts to varying degrees.

There is a growing awareness that road development has major environmental impacts Some of the major environmental impacts of road projects include damage to sensitive ecosystems, loss of productive agricultural lands, resettlement of large numbers of people, permanent disruption of local economic activities, demographic change, accelerated urbanization, and introduction of disease. Since environmental impacts from road development are quite common, such

projects usually call for comprehensive environmental assessment studies, carried out by EA professionals (both specialists and generalists) who support the main engineering team. Substantial time and effort is often required to identify potential impacts and options for minimizing them. In addition, contract clauses covering work procedures and staff training needs to be prepared, and work processes in relation to roadside communities, flora, and fauna given considerable attention. In order to conduct EAs successfully, road agency staff need to understand the assessment process and must coordinate it with road planning, design, and construction activities, allowing sufficient lead time and funds for the necessary additional steps. New skills may have to be developed to meet the demands of the EA process. This is especially true in the area of consultation with affected residents, interested members of the public, government departments, and other organizations (known collectively as the stakeholders).

Projects limited to road rehabilitation, maintenance, minor construction, as well as to traffic management and regulation, generally involve lesser environmental concerns. These situations do not call for full-scale EAs but do require impact identification, mitigation, and certain amount of compliance monitoring and documentation.

Methodology

The process of EIA report of Bypass Road done in 3 phases. In the first phase, the work is done in Geographic Information System Software (GIS). In this, an image is taken and it is Geo-referenced and then Digitization is done. Buffering is also created in GIS software. In the second phase, impacts are identified in Option-1, Option-2, Option-3 by using Google Earth Pro. In third phase, impacts are given as inputs of Option-1, Option-2 & Option-3 and results are compared in Rapid Impact Assessment Matrix Software (RIAM). Finally, EIA report is given as output. Study area map of East bypass road is shown in the flow chart figure 1 below.

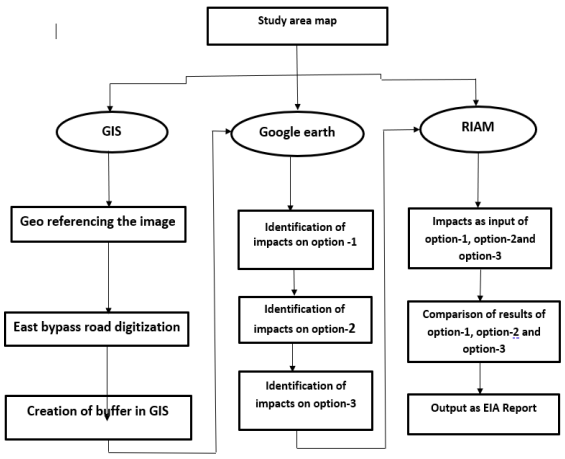

Figure .1 Methodology of East Bypass Road

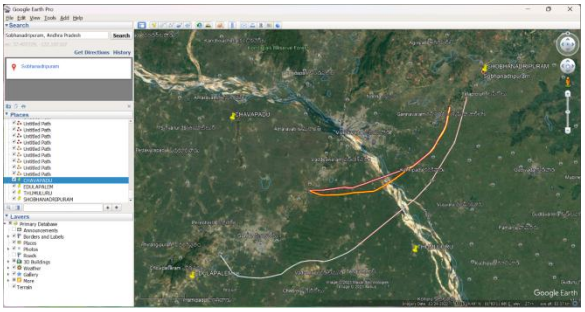

Figure.2 Proposed Three Options in Google Earth

Impacts of the Bypass Road

The environmental impact of roads (both positive and negative) includes the local effects of highways (public roads) such as on noise, water pollution, habitat destruction/disturbance and local air quality; and the wider effects which may include climate change from vehicle emissions. The design, construction and management of roads, parking, and other related facilities as well as the design and regulation of vehicles can change the impacts to varying degrees. Roads are increasingly common in today's world as human development expands and people increasingly rely on cars for transportation on daily basis. The United States contains over 4 million miles of roadways and an estimated 20% of land in the country is impacted by the presence of roads. This large network of roads has dramatically altered the landscape and can impact wildlife in number of deleterious ways.

In addition to causing mortality, roads can also shift population demographics and be a source of pollution into the environment. Studying the ecological impacts of roads is an important area of study in conservation biology and environmental science, as the impacts often extend far beyond the surface of the road itself.

The Rapid Impact Assessment Matrix

This paper describes a system of scoring within a matrix that has been designed to allow subjective judgments to be quantitatively recorded, thus providing impact evaluation and a record that can be re-assessed in the future. The system is ideally suited to E IA where a multi-disciplinary team approach is used (Morris & Biggs, 1995), as it allows for data from different components to be analyzed against common important criteria within a common matrix, thus providing a rapid, clear assessment of the major impacts.

The Rapid Impact Assessment Matrix (RIAM) method is based on a standard definition of the important assessment criteria as well as the means by which semi-quantitative values for each of these criteria can be collated to provide an accurate and independent score for each condition. The impacts of project activities are evaluated against the environmental components, and for each component a score (using the defined criteria) determined, which provides a measure of the impact expected from the component.

The important assessment criteria fall into two groups:

(A) Criteria that are of importance to the condition, and which can individually change the score obtained.

(B) Criteria that are of value to the situation, but individually should not be capable of changing the score obtained.

Scores for the value criteria group (B) are added together to provide a single sum. This ensures that the individual value scores cannot influence the overall score, but that the collective importance of all values in group (B) is fully taken into account.

The sum of the group (B) scores is then multiplied by the result of the group (A) scores to provide a final assessment score (ES) for the condition.

The process can be expressed:

(al) * (a2) - aT

(b1) + (b2) + (b3) - bT

(aT)* (bT) – ES

Where

(al) and (a2) are the individual criteria scores for group (A) (bl) to (b3) are the individual criteria scores for group (B) aT is the result of multiplication of all (A) scores bT is the result of summation of all (B) scores ES is the assessment score for the condition.

Positive and negative impacts can be demonstrated by using scales that pass from negative to positive values through zero for the group (A) criteria. Zero thus becomes the 'no-change' or 'no-importance' value. The use of zero in this way in group (A) criteria allows a single criterion to isolate conditions which show no change or are unimportant to the analysis.

Zero is a value avoided in the group (B) criteria. If all group (B) criteria score zero, the final result of the ES will also be zero. This condition may occur even where the group

(A) criteria show a condition of importance that should be recognized. To avoid this, scales for group (B) criteria use '1' as the 'no-change/no-importance' score.

Assessment criteria in the Rapid Impact Assessment Matrix

The criteria should be defined for both groups, and should be based on fundamental conditions that may be affected by change rather than be related to individual projects. It is theoretically possible to define a number of criteria, but two principles should always be satisfied:

1. The universality of the criterion, to allow it to be used in different EIAS.

2. The value of the criterion, which determines whether it should be treated as a Group (A) or Group (B) condition.

At this point only five criteria have been developed for use in the RIAM. Nevertheless, these five criteria represent the most important fundamental assessment conditions for all EIAS, and satisfy the principles set out above.

These criteria, together with their appropriate judgement scores as defined as:

Group (A) criteria

Importance of condition (A1)

A measure of the importance of the condition, which is assessed against the spatial boundaries or human-interest sit will affect. The scales are defined:

4-important to national/international interests

3-important to regional/national interests

2-important to areas immediately outside the local condition

1-important only to the local condition

0-no importance.

Magnitude of change/effect (A2)

Magnitude is defined as a measure of the scale of benefit / disbenefit of an impact or a condition:

+3-major positive benefit

+2-significant improvement in status quo

+1-improvement in status quo

0-no change/status quo

-1-negative change to status quoted

-2-significant negative disbenefit or change

-3-major disbenefit or change.

Group (B) criteria

Permanence (B1)

This defines whether a condition is temporary or permanent, and should be seen only as a measure of the temporal status of the condition. (e.g.: an embankment is a permanent condition even if it may one day be breached or abandoned; whilst a coffer dam is a temporary condition, as it will be removed).

1-no change/not applicable

2-temporary

3-permanent.

Reversibility (B2)

This defines whether the condition can be changed and is a measure of the control over the effect of the condition. It should not be confused or equated with permanence. (e.g.: an accidental toxic spillage into a river is a temporary condition (B1) but its effect (death of fish) is irreversible (B2); a town's

sewage treatment works is a permanent Condition (B1), the effect of its effluent can be changed (reversible condition) (B2)).

1-no change/not applicable

2-reversible

3-irreversible.

Cumulative (B3)

This is a measure of whether the effect will have a single direct impact or whether there will be a cumulative effect over time, or a synergistic effect with other conditions. The cumulative criterion is a means of judging the sustainability of a condition, and is not to be confused with a permanent/irreversible situation. For instance, the death of an old animal is both permanent and irreversible, but non-cumulative as the animal can be considered to have already passed its breeding capabilities. The loss of post-larval shrimp in the wild is also permanent and irreversible, but in this case cumulative, as all subsequent generations that the larvae (as adults) may have initiated will also have been lost.

1-no change/not applicable

2-non-cumulative/single

3-cumulative/synergistic

It is possible to change the cumulative component to one of synergism, if the condition warrens consideration of additive affects.

RESULTS & DISCUSSION

Initially after giving spatial co-ordinates to the image geo-referencing is done to the image and finally buffering is done. Buffering is done by giving width of a road on both sides. A buffer image of an East Bypass Road is seen in Google Earth and then the length and the area is calculated know the area of agricultural lands, barren lands, forest areas, ponds, residential areas, roads, rivers, etc…., on the Google Earth in stretches. A proposed East Bypass Road is shown on the Google Earth in 3 options as Option-1, Option-2 & Option-3.

Each option is evaluated by feeding the RIAM with suitable values to the selected component parameters with the relevant semi-quantitative information regarding the components as per the procedure mentioned above. For example, a component from physical and chemical segment like ‘Land use’ has been assigned with the appropriate numerical values as described below. Since the ‘Land use’ is relevant to the areas immediately out of the local condition a value of 2 is given for condition A1. Because the bye pass road will have a significant negative impact on ‘Land use’ the magnitude A2 is given a value of -2.

The input value for B1 isgiven as 3 since the effect are permanent and the input value for B2 is given as 3 since it is irreversible. The negative effect on ‘Land use’ is cumulative with bye pass road activity hence the input value for B3 is given as 2. Like this all the components are assigned numerical values depending on the relevance conditions, magnitude, permanence reversibility and cumulative effect. The RIAM tool calculates the ES scores and fits all the components in appropriate range bands. Out of the three options for sample, data regarding one option were presented below:

KOTTURU TO POTTIPADU(74KM)

Physical and chemical components (PC)

	Components	ES	RB	A1	A2	B1	B2	B3
PC1	Land use	8	A	1	1	3	3	2
PC2	Landscape	-42	-D	3	-2	3	1	3
PC3	Topography	-21	-C	3	-1	2	2	3
PC4	Soil Erosion	-28	-C	2	-2	2	2	3
PC5	Ground Water Quality	-21	-C	1	-3	2	2	3
PC6	Surface Water Quality	-14	-B	1	-2	2	2	3
PC7	Ambient Noise	-21	-C	3	-1	2	2	3
PC8	Surface Temperature	-14	-B	1	-2	2	2	3
PC9	Geological Changes	-12	-B	1	-2	1	2	3
PC10	Local Climate	-7	-A	1	-1	2	2	3
PC11	Dust ? Debris	-36	-D	2	-3	1	2	3
PC12	Odour	-21	-C	3	-1	2	2	3
PC13	Landslides	-27	-C	1	-3	3	3	3
PC14	Borrow Earth Pits	-14	-B	1	-2	2	2	3
PC15	Ambient Air Quality	-48	-D	2	-3	3	2	3
PC16	Vibrations	-16	-B	1	-2	3	2	3
PC17	Mineral Resources	-12	-B	2	-1	1	2	3
PC18	Quarry Material	-54	-D	3	-3	1	2	3

Biological and ecological components (BE)

	Components	ES	RB	A1	A2	B1	B2	B3
BE1	Deforestation	-36	-D	3	-2	2	1	3
BE2	Vegetation	-7	-A	1	-1	3	1	3
BE3	Flora ?	-7	-A	1	-1	2	2	3
BE4	Natural Habitats	-14	-B	1	-2	2	2	3
BE5	Biodiversity	-24	-C	3	-1	3	2	3
BE6	Ecological Balance	-7	-A	1	-1	2	2	3
BE7	Endemic Species	-21	-C	1	-3	2	2	3
BE8	Aquatic Fauna	-48	-D	3	-2	3	2	3
BE9	Livelihood	-16	-B	1	-2	3	2	3
BE10	Residential Area	-16	-B	1	-2	3	2	3
BE11	Water Bodies	-72	-E	3	-3	3	2	3
BE12	Physiographic ? Soils	-7	-A	1	-1	2	2	3
BE13	Habitat Fragmentation	-6	-A	1	-1	1	2	3
BE14	Natural Resources	-7	-A	1	-1	2	2	3

Sociological and cultural components (SC)

	Components	ES	RB	A1	A2	B1	B2	B3
SC1	Rehabitation	-28	-C	2	-2	2	2	3
SC2	Resettlement	-21	-C	3	-1	2	2	3
SC3	Housing	24	C	1	3	3	2	3
SC4	Infrastructure	18	B	1	2	3	3	3
SC5	Health Aspects	9	A	1	1	3	3	3
SC6	Hygiene	14	B	2	1	2	2	3
SC7	Cultural Heritage	32	C	2	2	3	2	3
SC8	Education Centers	21	C	1	3	1	3	3
SC9	Religious Places	6	A	1	1	1	2	3
SC10	Recreation Facilities	7	A	1	1	2	2	3
SC11	Market Centers	12	B	1	2	1	2	3
SC12	Employment	16	B	1	2	2	3	3
SC13	Clinic Centers	21	C	3	1	1	3	3
SC14	Uplift of Standard Life	14	B	1	2	2	2	3
SC15	Basic Amenities	0	N	1	0	3	2	3
SC16	Labor Work	24	C	3	1	2	3	3
SC17	Traffic Problems	14	B	1	2	2	2	3
SC18	Urban Development	12	B	1	2	1	2	3

Economical and operational components (EO)

	Components	ES	RB	A1	A2	B1	B2	B3
EO1	Agricultural land	-18	-B	1	-2	3	3	3
EO2	Commercial Establishments	-8	-A	1	-1	2	3	3
EO3	Business Opportunities.	21	C	3	1	2	2	3
EO4	Finance	24	C	1	3	3	2	3
EO5	Land Cost	48	D	2	3	2	3	3
EO6	Land Value	42	D	3	2	2	2	3
EO7	Transportation Cost	21	C	1	3	1	3	3
EO8	Construction cost	24	C	1	3	2	3	3
EO9	Earth moving Equipment Cost	72	E	3	3	2	3	3
EO10	Large Scale Industries	21	C	1	3	2	2	3
EO11	Small Scale Industries	14	B	2	1	2	2	3
EO12	Local Area Development	16	B	1	2	2	3	3
EO13	Electricity Facilities	8	A	1	1	2	3	3

Scores Summary of option-1.

Summary of scores

Range	-108 -72	-71 -36	-35 -19	-18 -10	-9 -1	0 0	1 9	10 18	19 35	36 71	72 108
Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	4	6	6	1	0	1	0	0	0	0
BE	1	2	2	3	6	0	0	0	0	0	0
SC	0	0	2	0	0	1	3	7	5	0	0
EO	0	0	0	1	1	0	1	2	5	2	1
Total	1	6	10	10	8	1	5	9	10	2	1

Scores Summary of Option-2.

Summary of scores

Range	-108 -72	-71 -36	-35 -19	-18 -10	-9 -1	0 0	1 9	10 18	19 35	36 71	72 108
Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	0	0	0	1	0	8	6	2	1	0
BE	0	0	0	1	0	1	7	2	2	1	0
SC	0	0	1	1	4	1	8	2	0	1	0
EO	0	0	0	0	2	1	4	4	2	0	0
Total	0	0	1	2	7	3	27	14	6	3	0

Scores Summary of Option-3.

Summary of scores

Range	-108 -72	-71 -36	-35 -19	-18 -10	-9 -1	0 0	1 9	10 18	19 35	36 71	72 108
Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	0	0	1	0	4	5	6	1	1	0
BE	0	0	0	1	1	0	2	5	2	3	0
SC	0	0	1	0	0	1	4	5	3	3	1
EO	0	0	2	2	0	0	1	4	4	0	0
Total	0	0	3	4	1	5	12	20	10	7	1

The following points were observed.

1. In Option-1 the Road of length 74kms is not Economical and there are more negative impacts on the environment as per our study.
2. In Option-2 the Road of length 40kms is Economically preferable but negative impact on the environment are still exist.
3. In Option-3 the Road of 44kms is more ECO-FRIENDLY, even though it is having some negative impacts in economical segment compared to Option -2.

RIAM OUTPUT

The out put of the RIAM analysis was presented in the form of a bar chart given below.

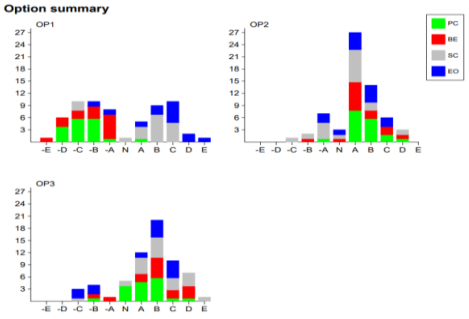

Figure.3. Option Summary of Each Option of Proposed East Bypass Road.

CONCLUSIONS

This research works major goal is to determine how the proposed East bypass road in Andhra Pradesh will affect the environment. The goal is to show the results in a way that makes it quick and simple to make a preliminary choice. The detected potential effects are fed into the Quick Impact Assessment Matrix (RIAM) for Evaluation. The RIAM calculates the impacts under four categories: Physicochemical, Biological Ecological, Social Cultural, and Economical Operational. The output of the RIAM shows that the project has severe negative impacts in all the categories. The three options of proposed project are compared and the results were presented in the form of bar charts. The results show that

- As option 1&2 are compared, option 1 has more negative impacts compared to 2nd option. The categorization is done by considering main impacts such as agricultural area, forest, ponds, grasslands, hill regions, barren lands, and built-up areas.
- In Option 1 which is 74 km long has impacts as, Physical and Chemical components recorded mostly negative impacts as compared to option 2 which is 44km. Biological and Ecological components have been recorded negative impacts. In the Economical and Operational components, the Option 1 is showing positive impacts. Sociological and Cultural components recorded both negative and positive impacts but option 2 has higher positive impacts in all the impact category.
- In option 3(40km) Physical and Chemical components recorded mostly positive impacts as compared to option 2. Option 2 of Biological and Ecological components have been recorded negative impacts when compared to option 3. In the Economical and Operational components, the Option 3 is showing more positive impacts than option 2. Sociological and Cultural components recorded both negative and positive impacts in both options.

So, the ultimate choice must be made after taking into account the advantages and disadvantages of Choices 1, 2, and 3. Option 3 is the best option based on the reports of RIAM software. There is a direct correlation between economic growth and environmental degradation. Thus, some financial gains must be forgone in order to achieve sustainability. It is necessary to create an appropriate environmental management plan, even for Option 3, to reduce the negative effects.

REFERENCES

[1] Dr. K. SundaraKumar, Koduru.Kavya, Venigalla.Akhil, Marupilla.SS. Deepthi, Velaga. Sai Krishna, Kambhampati. Datta Sairam, Environmental impact assessment of the proposed outer ring road project for new capital of Andhra Pradesh, India, International Journal for Technological Research in Engineering Volume 3, Issue 9, published in May-2016, ISSN.

[2] Dr.K. Sundara Kumar, L. Nagaraju, D. Leela

Krishnam Raju, L. Gopi, P. Harish, Environmental Impact Assessment of Proposed Airport in AP Capital Region, International Journal for Technological Research In Engineering Volume 7, Issue 12, Published in August-2020, ISSN.

[3] T. Subramani, M. Kavitha, P. Gandhimathi, Environmental Impact Assessment In Kannankurchi Town Panchayat, / International Journal of Engineering Research and Applications, Volume-2, Issue 3, published in May-Jun 2012, (IJERA),

[4] Aiswarya.M and Sruthi M, Environmental Impact Assessment of Water Using RIAM (Rapid Impact Assessment Matrix) International Journal of Scientific & Engineering Research, Volume 7, Issue 4, Published in April-2016, ISSN.

[5] Nitin Kamboj, Er. Sunita Kumari, Environment Impact Assessment for Highway: A Review, National institute Teachers training & research, Chandigarh, volume-17, Published in 26 march 2017, ISBN-978-93-86171-35-1.

[6] DANIDA (Danish International Development Agency), 1994. Environmental assessment for Sustainable Development.

[7] EBRD (European Bank for Reconstruction and Development), 1996. Environmental Procedures. London.

[8] Morris, P & J, Biggs, 1995. Water. In: P. Morris & R. Therivel, Methods of Environmental.

[9] World Bank, 1998. Environmental Guidelines. Environmental Department.

[10] Official Journal of the European Communities, Dir. 85/337/EEC.