An Experimental Approach to Highway Planning and Design

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Tadashi KUBO, Masami SUGIMOTO, Daishu ABE,
Yoshio KITAGAWA and Isao NAKASE

Laboratory of Urban Landscape Design, College of Agriculture

Currently, it is frequently discussed that everywhere, impact of highway development have a serious affect upon the environment. There are so many aspects which create this situation, but the lack of an approach from environmental perspective is considered as a dominant cause. The general process of highway planning and design is follows:

Step 1. A) to analize economic and transportation conditions i.e. traffic volume, origin and destination survey, traffic volume estimation and etc.
B) to investigate existing and proposed social programs i.e. social and cultural resorces, public undertaking, historical cultural resorces and etc.
C) to make an inventory of the natural components i.e. topography, geology, climate and etc.
D) from the synthesis A), B), C) to determine potential highway routes.

Step 2. Highway routes designated in Step 1 are first analized for road structure from their technical aspect i.e. sections-elevations of road, earthwork balance of cut and fill etc. and secondly, a comparison evaluation is made with the alternative routes.
Ultimately however, route determination is generally based upon financial considerations.

Step 3. In this step, the route design will be more precisely analized according to Step 1 and Step 2.

Highway planning and design concieved through this process has discussed social, technical and economical aspects throughly, but little emphasis has been given to the environmental preservation aspect. Therefore, the focus of highway planning and design should be correctly to assess potentialities within each zone and set up a methodology in which the highway becomes an organizational element of the total environment. Especially, in Japan where topographical characteristics show complicated or prime agricultural land, is an extremely necessary approach. In this point of view, this research intends to discuss highway planning and design focussed upon route selection.

1. Fundamentals of the Highway Development based upon Environmental Preservation

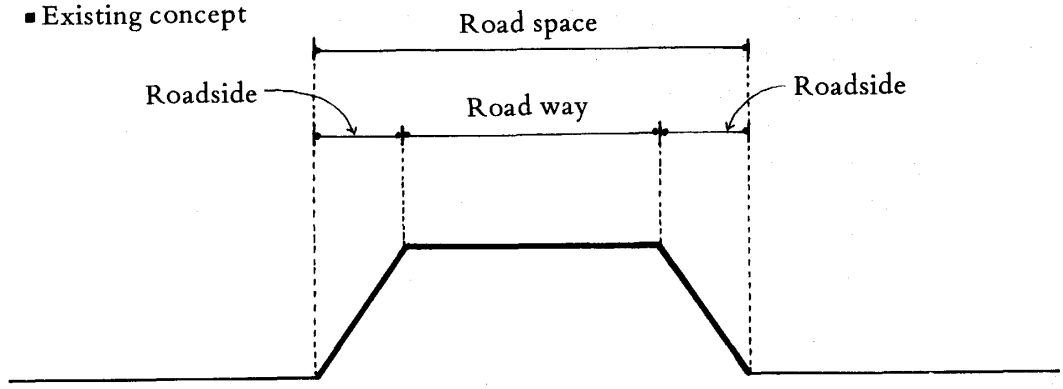
Generally, the environment categorized by both the natural habitat and human habitat will be considered as one total system of components for the highway impact

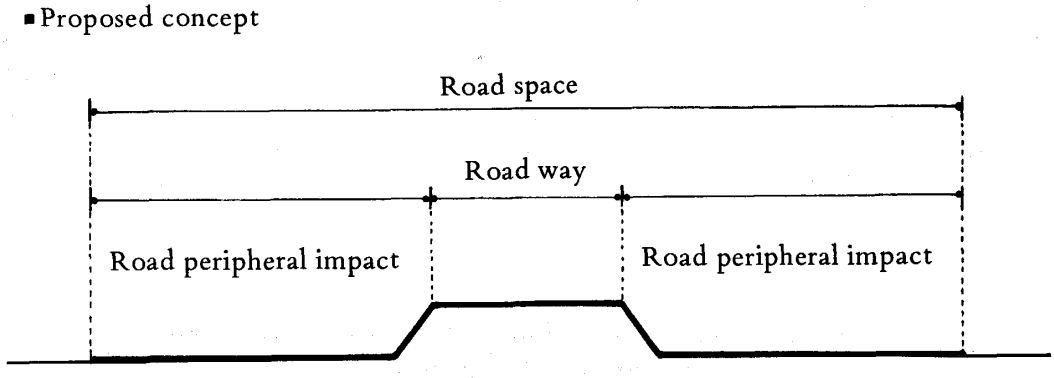
study. Therefore, the intention of highway development based upon environmental preservation, is to minimize impact which occur from highways to this environment. Fundamentals for preserving the natural habitat will be to avoid highway development within high priority natural environment area. In the areas of lesser priority, the development policy will be to minimized the alteration of the natural environment. Considering the principles from the site planning aspect in detail, methods will include 1) to avoid cut and fill as much as possible, 2) to utilize the underground route modifications, 3) to adopt overhead routing and 4) to divided the road way. Ultimately, it is optimal for the preservation of the natural environment to combine with construction techniques the minimization of alteration of topography regarding the potentialities of each site.

On the other hand, on the basis of the principle to preserve human habitat will be to designate the route selection which avoids those particular zone. Thus, the concept of the road space will have to regard different standpoints from existing ones in order to encorporate the new concept which considers a more wider peripheral range of impact zone by the highway development (Figure 1).

The meaning to lead new concept's purpose is to develop a program which reduces the need for sound screening wall construction, improves the road's aesthetic quality and creates adaptability of new space utilization.

Therefore, to achive these principles in highway planning and design is necessary to assess the environmental qualities objectively.





(Road space should include the highway impact zone.)

Figure 1 Road Space Concept

2. An Experimental Approach to Highway Route Selection and Design based upon Environmental Consideration

The planning flow will be the guide to approach the principles mentioned above (Figure 2). The flow shows five phases from the evaluation of potential zones to the route design as a single process. This means each component can not be assessed by one fixed measure and thus requires comprehensive analysis in order to ensure an optimum of environmental stability.

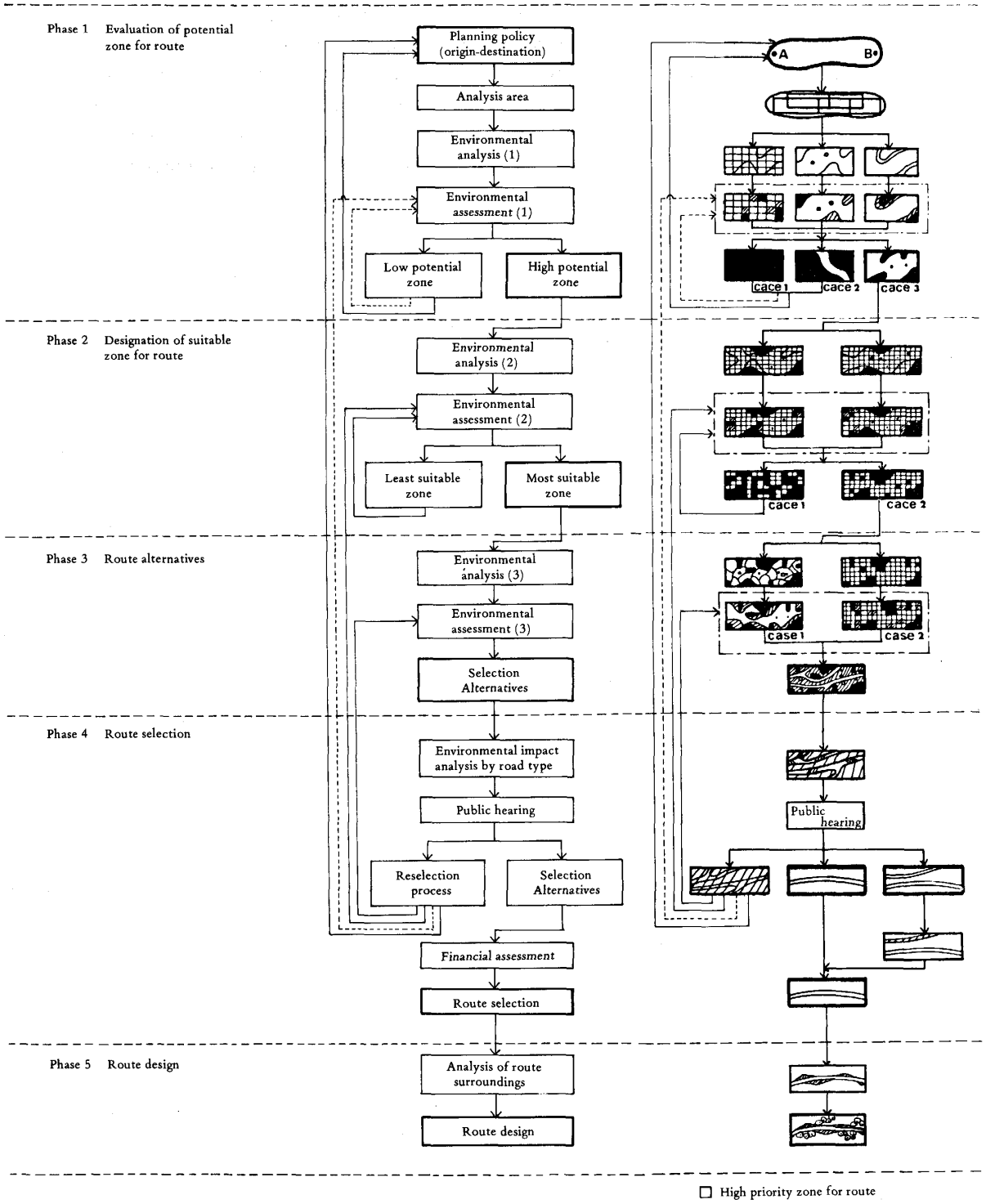


Figure 2 Planning Process for Route Selection

Phase 1. Evaluation of the potential zone for route selection.

After origin point A and destination point B have been determined, the objective of Phase 1 will be to designate the route alignment zone which maintains optimum environmental quality. The method in this phase will be to determine the analytical range correspoinding with the highway development. From an approximate 50 kilometer span the intention is to divide the range, by means of a 1 square kilometer grid system, in order to assess the potentiality of each grid according to the items of Table 1, Phase 1 pertain to the various environmental factors. The results should indicate which grids show high potential based upon items of Table 1 and thus which should be defined as misfit areas. If it is too difficult to set up the potential zone such as in case 1 and case 2 in Figure 1, then re-analysis is reguired in order to determine a potential zone within the analytical range, the highway development project must be re-assessed.

Table 1 Items of Analysis

Items	Methods of analysis		
	Phase 1	Phase 2	Phase 3
Urbanized areas	Area distribution(percentage) of existing and proposal land use by urban areas, commercial areas and industrial areas etc.	Area distribution(percentage) of land use zoning by restricted residencial areas, restricted industrial areas, quasi industrial areas, and residencial areas etc.	Same as Phase 2
Historical and cultural assets	Distribution of buried cultural assets and historical areas etc.	Area distribution(percentage) of same items in Phase 1. The locating of important shrines, temples, gardens and historical buildings etc.	Same as Phase 2
Flora	Distribution of scientific flora communities, virgin forest, natural conservation zones etc.	Area distribution(percentage) by rehabilitation area's potential. Distribution of landmark trees, sacred trees and designated trees etc.	Same as Phase 2
Fauna	Distribution of fauna protection areas.	Area distribution(percentage) of same items in Phase 1	Same as Phase 2
Geology	Distribution of general characteristics and scientific geological areas etc.	Distribution of poor ground areas, subsidence areas and landslide areas etc.	Same as Phase 2
Calamities	Distribution of land calamities areas, flood potencial areas, tide and landslide areas etc.	Same as Phase 1	Same as Phase 2
Agricultural areas	Distribution of prime agricultural areas as designated by agricultural land law.	Area distribution(percentage) of prime agricultural areas, agricultural promotion areas and agricultural areas in urbanized promotion zones etc.	Same as Phase 2
Parks	Distribution of national parks, quasi-national parks and prefectural parks etc.	Area distribution(percentage) of same items in Phase 1. Distribution of urban parks, cemeteries and urban open space areas etc.	Same as Phase 2
View	Distribution of picturesque sites and national monuments etc.	Area distribution(percentage) of spectacle view areas. Distribution of scenic landmarks (e.g. mountains, lakes, ridges and buildings etc.)	Same as Phase 2
Topography		Evaluation of topography by slope analysis(percentage), slope aspect, elevation and undulations etc.	Same as Phase 2
Water		Area distribution(percentage) of rivers, irrigation ponds, lakes, ocean and underground water etc.	Same as Phase 2
Public facilities		Distribution of hospitals, educational facilities(e.g. schools, libraries, research institutes) and welfare facilities etc.	Same as Phase 2
Landmarks and vistas from route			Distribution of mountains, lakes, ridges, valleies, monuments and buildings etc.

Phase 2. Designation of suitable zone for route.

This phase involves more detailed analytical method and aims to designate the suitable zones from the Phase 1, potential zone evaluation.

Here, the highway's impact will be assessed as to its potential effect within single grid units of a mesh system at a scale of 200 meter or 250 meter. The items which are analized here indicated in Table 1, Phase 2 and assessment criteria are determined through percentages of area distributed or are determined by distribution patterns of each item and relative assessment between interacting items. The result of Phase 2 should be the dividing of a high potential area and the selecting of a suitable zone for the route. However, if it is too difficult to designate the suitable zone as in case 1, the criteria must be re-analized in the environmental assessment process of Phase 2 (Figure 2).

Phase 3. Route alternatives.

This phase intends the selecting route alternatives in the designated zone. The items discussed in Table 1, Phase 3 will be driver's comfort, road construction ease or difficulty, a more detailed evaluation of the highway's topographical impact and broader qualitative examination of the general surroundings omitted from Phase 1 and Phase 2, viewed in context with the highway's impact.

Phase 4. Route selection.

In this phase, a route selection will be determined, based upon road types which best accomodate the surroundings, public hearing at which route zone selection, highway development proposals and alternative routes which were designated in Phase 3. The intention of analysis of this stage, is to clarify the impact by road types to the surroundings. That is, add greater emphasis to environmental impact assessment. Generally, environmental impact studies for highway development consider the physical, social and economic sectors. But in addition to those noted factors, this analysis system will quantify factors such as: 1) Noise, 2) Gas exhaust, 3) Landscape, 4) Sunlight, 5) Wind direction, 6) Traffic hazards, 7) Functional separation of land use and circulation etc. all to be considerd as relevant assessment factors. The impact level varies according to the road type through analysis of impact by each road type, comparative result can be depicted such as in Table 2. The surroundings the highway will be classified into four categories 1) the human community, 2) the plant community, 3) the animal community and 4) the highway users. Table 3 shows the impact elements which affect these environments. Thus, it is possible to incorporate the road type which minimizes the impact to the environment in each specific locale by overlapping Table 2 and Table 3. In addition to these results, a public hearing will be held. Ultimately, through the public feed back, a route selection will be made. Should there be any problem in route selection at this stage, the planning process will reprogress to Phase 3, Phase 2 and Phase 1.

Phase 5. Route design.

At this stage, the intentions is to discuss the design problems to pertaining the impact zone which includes the peripheral space of the highway. In order to develop a more homogeneous blending of the conflicting highway and environmental elements, the peripheral space can serve as a transitional zone. Thereby, smoothing the edges of the nomally incompatible components.

As mentioned above, the primary aim of this highway route selection process, will be to involve the concept of environmental preservation: derive criteria which objectively contrast the environment with the various highway impacts. Thus, it is necessary to collect fundamental data and information concerning the environment and environmental preservation as a means of providing a more objective base for further discussion.

Table 2 Environmental Impact Assessment by Road Types

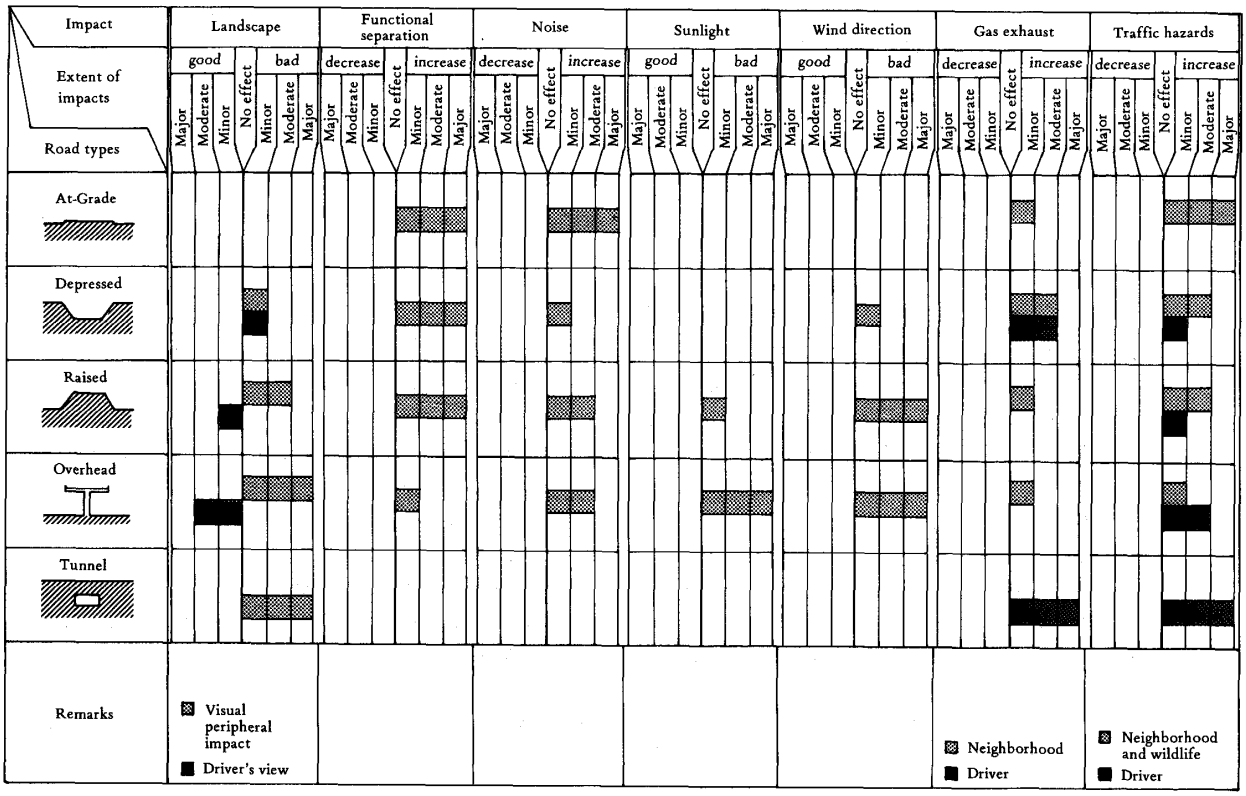


Table 3 The Relationship between Road's Impact and the Environment

Environment / Impacts	Human community	Plant community	Animal community	Users
Landscape	■			■
Functional separation	■		■	
Noise	■		■	
Sunlight	■	■	■	
Wind direction	■			■
Gas exhaust	■	■	■	■
Traffic hazards	■	■	■	■

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