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Environmental assessment for non-prescribed infrastructure development projects: a case study in Bangkok Metropolitan

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Rapid urbanization and urban growth have caused serious environmental problems in most cities of developing countries. Many infrastructure projects on varying scales have been implemented to meet the growing demands of such cities, but only a few are subjected to environmental impact assessment as part of the project approval process. In an attempt to justify environmental assessment (EA) for all infrastructure development projects (IDPs), irrespective of their scales, this paper investigates the environmental effects of large, medium and small IDPs implemented in urban fringe areas to understand and compare the nature of their impacts. The survey results show that respondents' perceptions of physical environment pertaining to air quality and noise were similar regardless of the scale of the project. However, in terms of vibration, surface water quality and ground water quality, the respondents' perceptions differed between large projects and small or medium projects. In order to avoid such negative impacts from IDPs in the future, this study proposes a mechanism for integrating EA into the planning and development control processes of local authorities.

Keywords: development agency, developing countries, environmental assessment, infrastructure development projects, local authorities, negative impacts, physical environment, rapid urban growth, urbanization, urban fringe areas

GUIDING THE URBANIZATION process in cities of developing countries is a very challenging task. These cities grow beyond administrative limits without adequate backbone support from infrastructure networks, land-use planning guidance or development control. As a consequence, it is commonly seen that environmental problems arise in the fringe areas of cities where urbanization is allowed to spill over the city limits. In this context, the local authorities of the cities of developing countries need to transcend their conventional role of urban management to embrace urban environmental management and promote sustainable urban development. This paper argues that, in the absence of legally enforceable environmental impact assessment (EIA) requirements, environmental assessment (EA) should be made an integral part of the project approval procedure of local authorities.

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Urban development in fringe areas

The urbanization process in southeast Asia is mainly due to large population increases, rather than to technological and industrial development. Critical issues relating to urbanization in developing countries include adequate urban infrastructure and services, decent housing and settlements, affordable land for housing, security of land tenure, land use planning, development control, urban economic development, environmental safety, and poverty alleviation.

The increase in the proportion of under-served or non-served communities in and around cities of developing countries is a consequence of lapses in providing basic infrastructure services. This phenomenon results not only in unsustainable human settlements but also in deteriorating environmental conditions; the many new communities in suburban areas, which have sprung up around cities and towns, provide evidence of this. Such communities face more environmental problems than inner-city areas owing to the absence of essential infrastructure facilities such as water supply, waste water disposal, solid waste disposal, air pollution control and adequate drainage systems. Therefore, development in urban fringe areas needs to be controlled on the one hand and supported by the provision of infrastructure on the other.

In many developing countries, environmental impacts associated with infrastructure, or the lack of it, are generally ignored or perceived to be of secondary importance to the pursuit of rapid economic growth (Olokesusi, 1992; Pisanty-Levy, 1993; Fowler and de Aguiar, 1993). Similar to other developing countries, Thailand does not have adequate economic resources to accomplish many of its planned projects. Therefore, the government often seeks external investment, particularly for large infrastructure development projects (IDPs). A primary source of these investments is the World Bank, which introduced environmental impact assessment (EIA) into its programmes in the early 1970s to help ensure sustainable development (El-Fadel, 2001).

Today, EIA is firmly established in the project planning process in many developing countries; however, many authors (see, for example, Briffett, 1999; Sadler, 1999) suggest that despite the existence of good EIA guidelines and legislation, environmental degradation continues to be a major concern in these countries. Although legally required and enforced for large-scale and prescribed projects, EIA as an environmental management tool is not commonly applied in the context of small- and medium-scale IDPs in developing countries. Unless it is legally mandated, the use of EIA as a part of the project approval procedure for small- and medium-scale projects is unlikely to happen. As a result, most small and medium IDPs in local administrative areas are implemented without any assessment of probable environmental impacts and identification of mitigatory measures.

EA for infrastructure development projects

Infrastructure development is one of the essential requirements for urban growth in fringe areas. The major impacts of IDPs in these areas should be examined not only from the viewpoint of urban planning and development, but also from an urban management perspective. Environmental impacts of IDPs in extended areas may arise from unclear policy, inefficient administration and management, poor logistics and facilitation, inadequate measures for mitigation of adverse environmental impacts, and lack of human resources development capabilities (Aziz, 1996).

With respect to large-scale development projects in Thailand, an EIA has to be conducted to assess possible impacts and thereafter propose mitigatory measures. The Ministry of Science, Technology and Environment (MOSTE) has produced EIA guidelines to ensure that proper procedure is followed by all projects with potentially significant impacts on the environment. The prescribed projects are divided into 19 types (Sriburi, 1998).

In August 1992, MOSTE specified 11 categories of development projects that require EIA approval. This list included projects such as: dams/reservoirs with capacity above 100 million cubic meters or area greater than 3,750 hectares; irrigation schemes covering more than 32,000 hectares; airports of any size; hotels with more than 80 rooms; expressways of any width and length; railroads of any size and use; mines of any size; industrial estates of any size; sea ports with more than 500 metric tons' handling capacity; power plants of above 10 megawatts; eight types of industries[1]; and any project located within a class 1B watershed.

In September 1992, MOSTE proclaimed a second list with eight more categories. These include projects such as: land reclamation (of any size) near the coast; buildings measuring 23 meters in height or 10,000 square meters in area and located near river, sea or historical sites; roads of any size that pass through environmental conservation areas or within 50 meters of the coast line; condominiums containing 80 or more units; land sub-division projects with 500 or more lots or area at least 40 hectares; hospitals with 30 or more beds; and chemical fertilizer or pesticide manufacturers of any size (Sriburi, 1998).

These two lists show that the only road projects subject to EIA regulations in Thailand are expressways of any width and length and roads of any size running through environmental conservation areas or near the coast. It is noted that no revision of or addition to the above two lists has occurred since 1992.

Table 1 gives a summary of major events in the history of enforcing EIA regulations for road infrastructure projects in Thailand. The table shows that the progress of EIA regulation and criteria pertaining to road projects has not advanced much from the two MOSTE listings in 1992. For example, there has been no attempt to supplement the EIA regulation with a set of assessment guidelines similar to the Transport Appraisal Guidance in the United Kingdom.

Moreover, no action has been taken after the initial listings in 1992 to expand the categories and sizes of road projects covered (e.g. to encompass small- and medium-scale projects). In terms of enforcing EIA regulations for the prescribed road projects, it is noted that the EIAs so far have focused more on the planning and construction phases; little emphasis is placed on the operation and maintenance phases, since regulatory bodies are generally weaker

Table 1. Summary of major events in the history of EIA practice for road projects in Thailand

Year	Event
1978	Thailand initiated EIA for major development projects proposed by both public and private sectors even before making EIA a legal requirement for project approval.
1981	MOSTE announced that a list of categories and sizes of projects which require EIA and mitigation plans would be promulgated in due course.
1982	For widening and rehabilitation of roads that pass through environmental conservation areas or sensitive areas, approval of an initial impact assessment or a checklist is required according to the Cabinet resolution.
1992	The First Ministerial Decree of MOSTE is announced, setting an EIA requirement for all sizes and types of expressways and road/rail projects located within class 1B watersheds and environmental conservation areas.
1992	Under the National Environmental Quality Act, an EIA was required by MOSTE for many types of large transport development projects such as commercial airports, commercial sea ports, special highways and railways, and roads and highways that pass through conservation areas or sensitive areas.
1992	The Second Ministerial Decree of MOSTE set an EIA requirement for all sizes and types of new or upgraded highways or roads, as defined by the Highway Act, that traverse the following areas: (1) wildlife sanctuaries and no-hunting areas according to the Protection and Conservation of Wildlife Act, (2) national parks as defined by the National Park Act, (3) class 2 watersheds, (4) reserved mangrove forests, and (5) coastal zones within 50 metres of high tide level.
1996	The Office of Environmental Policy and Planning (OEPP) of MOSTE is responsible for implementing the EIA process under direction given by the National Environmental Board.
1996	In the transportation sector, there were at least five projects (three motorways and two new highways) of the Department of Highways (DoH) for which EIAs were approved and effective monitoring for EIA compliance will be required.
2001	OEPP received support from the DoH and the World Bank to include a project on “Strengthening Capacity of OEPP in Transportation” in the Fifth Highway Sector Project financed by the World Bank under Loan No. 3968: TH and implemented by DoH.

Source: OEPP (2001)

in post-construction monitoring and evaluation. EIA as an environmental management measure will be effective only when project proponents seriously carry out the environmental impact management plans as part of project implementation throughout the design, construction and operation stages. Therefore, enforcement of Thailand’s EIA regulations for road development projects has two major limitations: (1) EIA is mandatory only for large-scale projects such as expressways, and (2) too little attention is paid to the implementation and monitoring phases.

This deficiency has been partially addressed by the recent development of environmental assessment techniques that place more emphasis on policies, plans and programmes. Strategic environmental assessment (SEA), which goes beyond basic assessment of the environmental consequences of projects, is one of these developments (Sadler, 1999). However, although SEA attempts to cover environmental assessment at policy and planning levels (e.g. considering environmental impacts of urban development and, in particular, development plans), it is not yet a legal requirement like EIA. In the absence of legally enforceable environmental management tools, myriad environmental problems persist at lower levels of administration where numerous projects of small and medium scale are implemented.

The need for EA in small and medium projects

At the time of popularizing EIA as an environmental management tool, UNEP (1988) recommended that environmental assessment (EA) be incorporated in every stage of the project cycle; in other words, even without a legal mandate, EA should play a part in every decision-making stage of a project. While the professionals who engage in project planning, design, detailing, implementation, construction and post-construction monitoring are expected to include EA at each stage of a project, the local authorities involved in scrutinizing and approving the project proposals also need to incorporate EA in their decision-making; moreover, the latter expectation needs to go beyond conventionally employed scrutinizing tasks such as development control through planning regulations.

EA is a systematic process that examines the environmental consequences of development projects (Glasson *et al*, 1999). Basically, it studies probable changes in the various socio-economic and biophysical characteristics of the environment which may result from a proposed or impending intervention (Mitchell, 2002; Canter, 1996; Jain *et al*, 1993). The overall purpose for undertaking an EA is to seek ways to avoid or minimize adverse effects of a proposed project to the extent practicable, and to maintain, restore or enhance environmental quality as much as possible (EPA, 1992). Therefore, EA helps in achieving the ultimate goal of a project by formulating a suitable environmental management plan that minimizes adverse effects and enhances positive effects (Haque *et al*, 2000; World Bank, 1991b).

As identified by Sadler (1996), there are three main stages (steps) of the EA process: (1) preliminary assessment, (2) detailed assessment, and (3) follow-up actions. These three steps must consider biophysical, social and economic parameters in order to set the stage for an EA which weaves together actual cause-and-effect interactions between the natural and the social environment, thus leading to a more holistic outcome (World Bank, 1994). From the procedural perspective, EA for an infrastructure development project is a multi-step process and the major steps include: project planning, design and description; baseline description; scoping; identification and prediction of impacts; assessment and evaluation of significance of impacts; analysis of alternatives; environmental management planning (including a plan for mitigation, enhancement and monitoring); EA reporting; and monitoring of the impacts (Glasson *et al*, 1999; Lohani *et al*, 1997; World Bank, 1991b).

Generally, large-scale IDPs (e.g. highways, dams and power plants) require EIA as a condition for national and international funding; but some donor agencies do not explicitly introduce or consider EA when the main purpose of funding deals with small- and medium-scale projects. In contrast to the general notion that EIA is for large-scale projects, Spaling (2003) has stressed the importance of EA for community-based small-scale development projects. Spaling makes the case based on his experience of projects implemented by Canadian non-governmental organizations (NGOs) and their partners in sub-Saharan Africa. Small-scale projects funded by the United States Agency for International Development (USAID) and the Canadian International Development Agency (CIDA) require EA (CARE, 2001). Examples of such small-scale projects are community wastewater systems, community water supply systems, community-based sanitation projects, small-scale income generation projects, waste management, resettlement, or any kind of construction project (CARE, 2001; CIDA, 1997; Knausenberger *et al*, 1996).

Local authorities, however, have often overlooked the possibility of incorporating EA as a legal requirement in their by-laws. For example, in Thailand there is no EA requirement for small- and medium-scale IDPs in municipal by-laws, even though such projects, particularly roads, certainly could create adverse impacts on the environment if not planned, designed and constructed properly. Therefore, proposing EA for infrastructure projects of any size is to improve decision-making and to ensure that project options under consideration are environmentally sound and sustainable (World Bank, 1991a). This study identifies some environmental consequences of IDPs and limitations of local agencies in the project implementation and operation phases; these are major drawbacks when it comes to guiding infrastructure projects towards sustainable urban development in Thailand.

Profile of the study area

The study was conducted in one part of the Bangkok Metropolitan Area. Since Bangkok was established as the capital of Thailand 200 years ago, the city has grown steadily in size and function. Originally it covered only 4.14 square kilometers. Presently, Bangkok is the biggest growth center of the country with a total area of 1,568.73 square kilometers divided into 50 districts. The population of Bangkok increased from 1.6 million in 1958 to 5.4 million in 1986, and then to 5.6 million in 1999. Now, the registered population is around 7 million while the daytime population is around 10 million.

While the city plans of Bangkok Metropolitan Area restrict the scope of environmental management to within the city limits, urban growth takes place without regard for these boundaries and extends into the peripheral provinces

Bangkok as an urban area has expanded beyond the city limits and is linked with five surrounding provinces (Nakorn Pathom, Nonthaburi, Pathumtani, Samut Prakarn and Samut Sakhon) by well-developed transportation networks consisting of roads, railways and waterways to form a mega-city known as Bangkok Metropolitan Region (BMR). Investment in the road system in BMR has grown in recent years, from 4.1 billion Baht in 2001 to 5.5 billion Baht in 2005 (Bureau of the Budget, 2005). Although not officially recognized, the term 'Bangkok Metropolitan Region' makes more sense than 'Bangkok Metropolitan Area' in terms of planning and management. However, strict urban planning is constrained within the city limit of what is known as the Bangkok Metropolitan Area (BMA).

The areas beyond BMA city limits come under the jurisdiction of their respective provincial governments, where urban planning regulations are not as stringent as in the BMA. In the fringe areas of the city, the ability of the provincial and local governments to undertake urban development control and environmental management is often very weak. For example, most provincial governments have fewer than five professionals to attend to both urban/regional planning and environmental management tasks, while in local government offices within these provinces, urban planning and environmental management professionals are usually non-existent.

This is a detrimental situation in terms of planning, development and management of a metropolitan region. While the city plans prepared by the BMA restrict the scope of urban planning and environmental management to within the boundaries of the city, urban growth takes place without regard for these boundaries and extends into the peripheral provinces. Externalities of this growth manifest themselves in the form of land use conflicts, water use conflicts, air and water pollution, flooding, and land degradation. Hence, more careful planning and management of extended urban areas is warranted.

This study focused on IDPs constructed in urban fringe areas in order to identify the status of IDPs and their environmental consequences. The specific objectives of the research are: (1) to assess the environmental impacts of large, medium and small IDPs in urban fringe areas on a comparative basis in a selected study area; and (2) to develop suitable environmental management guidelines for integration into such projects.

The study was conducted in two municipalities of the Samuth Sakorn province, which is one of the provinces of BMR. Being adjacent to the city of Bangkok, this province attracts many urban functions as well as people from other areas. The rapid urbanization in the province is most significantly visible in Muang Samuth Sakorn (MSS) and Muang Krathum Baan (MKB) municipalities.[2] Several road projects as well as other IDPs have been implemented in these municipalities as backbone support for the urbanization process. Since the two municipalities are good representations of a fast-developing urban fringe area in BMR, they were selected as study areas for our research.

Since IDPs encompass many different types of projects, the scope of this study was limited to road projects developed or upgraded in these two municipalities within a ten-year period prior to commencement of the research. Fourteen road redevelopment projects met this criterion and they were identified as large-, medium- or small-scale projects for comparison of their environmental impacts. Expressways and highways implemented by the Department of Highways (DoH), having four or more lanes and wider than 30 meters, are defined as large-scale projects; these are technically arterial roads. Medium-scale projects are local highways (collector roads) implemented by local authorities and having two lanes and a width of 12 meters or more. Small-scale projects consist of local roads and community roads (access roads) implemented by local authorities, having one or two lanes and a width of 6 meters or more. The categorization of the 14 roads using these definitions revealed that four roads are large-scale projects, four more are medium-scale projects, and six are small-scale projects. Table 2 lists the selected projects, indicating the year of commencement, the funding agency and whether or not EA was involved in the development process.

To achieve the objectives of the study, a null hypothesis was formulated to test empirically the physical impacts of road projects in the immediate impact areas.[3] It was hypothesized that, *irrespective of the scale of the projects*, environmental impacts caused within the immediate impact areas are perceived as *similar* by affected stakeholders when environmental conditions before and after the construction phases are compared.

Methods of data collection

Project documents at the DoH, the Department of Public Works and Town & Country Planning (DPWTCP) and the MSS and MKB local authorities did not indicate any EA having been conducted prior to the implementation of these projects. Apparently, environmental assessment had been overlooked even for large-scale projects, because the proponents and funding agencies of these projects were either government agencies or local government units. As a result, no information was available on the state of the environment in the study areas prior to project implementation.

In the absence of recorded data on the state of the environment before and after the construction of

Table 2. List of redevelopment projects selected for analysis

Type of project	Year of commencement and completion	Funding or donor agency	EA before construction
Large-scale projects			
Praramsong Road (8 lanes)	1999–2002	Department of Highways	Preliminary EA
Ekkachai Road (4 lanes)	1994	Department of Highways	No assessment
Jitmanee Road (4 lanes)	1994	Department of Highways	No assessment
Satethakit Road (4 lanes)	1996–1999	Department of Highways	No assessment
Medium-scale projects			
Duem Bang Road (2 lanes)	2004	Provincial Administration Organization (PAO)	No assessment
Thamkunakorn Road (2 lanes)	1999	Municipality	No assessment
Suthivatvithi Road (2 lanes)	1999	Municipality	No assessment
Sukhonthawin Road (2 lanes)	1996–1997	Municipality	No assessment
Small-scale projects			
Somanutmakkra Road (2 lanes)	2004	Municipality	No assessment
Tawai Road (2 lanes)	2004	Municipality	No assessment
Donkaidee Road (2 lanes)	1995	Municipality	No assessment
Tesaban-3 Road (2 lanes)	1995	Municipality	No assessment
Jareonsawas Road (2 lanes)	1994	Municipality	No assessment
Aungthong Thani Road (2 lanes)	2001	Private investor	No assessment

these roads, a social survey method was selected as the best alternative for investigating the environmental impacts of the projects. In other words, perceptions of people affected by the road development projects were considered as a proxy for the measurement of environmental impacts generated by these projects. Perceptions pertaining to both pre-construction and post-construction phases were considered in assessing the change in environmental conditions. However, perceptions of environmental impacts during the construction phase were not considered, since temporary inconveniences experienced during this phase may lead to biased negative perceptions.

The respondents were divided into three main groups as follows.

- Group 1: respondents affected by intercity highways and expressways — identified as large-scale projects (LSP) in this study.
- Group 2: respondents affected by local highways and arterial roads — identified as medium-scale projects (MSP).
- Group 3: respondents affected by collector roads and community roads — identified as small-scale projects (SSP).

A random sample of 402 respondents was drawn from areas affected by 14 road projects constructed in the two municipalities since 1994. All the respondents were interviewed in April and May 2004 using a standardized questionnaire. Respondents were asked about their perceptions of the implementation of the road development projects and the resultant environmental impacts. A five-point scale was used to record the perceptions, with scores ranging from 1 (insignificant impact) to 5 (most severe impact). In addition to using the questionnaire, in-depth interviews were conducted with officers from public-sector organizations such as DoH, Department of Local Highways (DLH), DPWTCP, Department of Local Administration, and the local authority to identify their approaches to project planning and implementation. Some experts in environmental assessment were also interviewed to explore and identify potential mechanisms for the integration of EA into infrastructure development projects.

The socio-economic characteristics of the respondents surveyed are shown in Table 3. The respondents were chosen by visiting houses, shops and other premises. Any adult available for interview was asked about his or her perceptions relating to the relevant project. Table 3 reveals that both genders are more or less equally represented in the survey, although the proportion of female respondents is slightly higher. This was due to the greater availability of self-employed women who were at home during the daytime. The occupational characteristics of the respondents reveal that nearly 50% of them are informal-sector workers; many of the informal-sector workers in Thailand are women. In terms of age, the majority of respondents were adults (over 20 years old). This was favorable in terms of recalling environmental conditions prevalent before the projects.

Table 3. Socio-economic characteristics of the respondents

Characteristic of respondent	LSP		MSP		SSP		Total	
	Number of respondents (n = 138)	%	Number of respondents (n = 156)	%	Number of respondents (n = 108)	%	Number of respondents (n = 402)	%
Sex:								
Male	73	52.9	65	41.7	42	38.9	180	44.8
Female	65	47.1	91	58.3	66	71.9	222	55.2
Age:								
< 20 years	5	3.6	7	4.5	6	5.5	18	4.5
20–39 years	63	45.7	58	37.2	35	32.4	156	38.8
40–59 years	59	42.8	65	41.7	55	50.9	179	44.5
> 60 years	11	8.0	26	16.7	12	11.1	49	12.2
Education:								
No formal education	6	4.3	8	5.1	4	3.7	18	4.5
Primary level	60	43.5	78	50.0	51	47.2	189	47.0
Secondary level	34	24.7	35	22.4	31	28.7	100	24.9
Tertiary level (university)	30	21.7	28	17.9	12	11.1	70	17.4
Tertiary level (vocational)	8	5.8	7	4.5	10	9.3	25	6.2
Occupation:								
Students	9	6.5	7	4.5	6	5.6	22	5.5
Public-sector employees	-	-	3	1.9	9	8.3	12	3.0
Private-sector employees	54	39.1	58	37.2	35	32.4	147	36.6
Farmers	-	-	2	1.3	-	-	2	0.5
Business owners	11	8.0	4	2.6	-	-	15	3.7
Informal/casual workers	64	46.4	82	52.6	58	53.7	204	50.7

Notes: LSP = large-scale projects, consisting of highways and expressways;
MSP = medium-scale projects, consisting of local highways and arterial roads;
SSP = small-scale projects, consisting of local and community roads

Respondents' perceptions of environmental impacts

The main purpose of the social survey was to identify changes in environmental conditions due to the construction of the roads by comparing conditions before and after project implementation, as perceived by the respondents. The significant physical environmental problems caused by road development projects in Samut Sakorn and Krathum Baan municipalities, according to the respondents, are presented below.

Change in environmental conditions from the stakeholders' perspective

Table 4 summarizes the general perceptions of the respondents regarding the physical environmental conditions that prevailed along the roads before and after their construction. It indicates that people generally perceived an aggravation in each physical environmental problem after the implementation of the projects.

The social survey revealed the following as the major physical environmental problems that the respondents encountered:

- change in air quality (due to dust and air pollution);
- change in noise and vibration level (due to changes in the speed and type of vehicles passing through);
- change in surface water condition (due to contamination/degradation, depletion and flooding);
- change in ground water condition (due to contamination/degradation and depletion).

Table 4 shows that the deterioration in air quality in the study areas after project implementation was perceived as the most serious problem. Specifically, 82.6% of all respondents opined that road (re)development affected air quality by generating enormous amounts of dust and pollutants (presumed to be sulphur dioxide SO_2, nitrogen dioxide NO_2 and carbon monoxide CO arising from traffic congestion).

The next most critical problems were noise and vibration caused by vehicles and machines. Table 5 indicates that 76.1% and 70.9% of respondents, respectively, perceived noise and vibration as major impacts resulting from road redevelopment projects. Similarly, 66.9% and 60.2% of respondents were affirmative about the impacts of road construction on surface and ground water conditions near the project areas. As expected, air- and sound-related pollution were perceived by respondents as being more serious issues compared with water-related pollution. Although not directly an environmental impact, exacerbated traffic congestion was reported by many respondents living near large-scale projects; the increased volume of traffic was a consequence of improved connections between local and regional urban centers. In contrast, respondents living near medium- and small-scale projects reported reduced congestion due to widening of the roads.

Test of differences

This study tested the (null) hypothesis that "irrespective of project scale, the physical environmental impacts of road development projects are perceived as similar by respondents". Initially, an ANOVA test was used to investigate whether the mean scores associated with respondents' perceptions were the same or not. Then, multiple comparisons with a post hoc test were used to compare the mean scores for individual variables among the three scales of projects.

Table 6 shows a summary of the mean scores of respondents on their perceptions regarding physical environmental impacts of the redevelopment projects, together with the corresponding p-values from the ANOVA test. The result of the ANOVA test is that, at 95% confidence level, no significant difference is found among the mean impact scores for air quality ($p = .064$ for increase in air-borne dust and $p = .193$ for increase in air pollution). Similarly, with

Table 4. Respondents' perception of the existence of physical environmental problems before and after road construction

Physical environmental problems	Before project implementation		After project implementation	
	Number of respondents (n = 402)	%	Number of respondents (n = 402)	%
Air quality	203	50.5	332	82.6
Noise level	191	47.5	306	76.1
Vibration	134	33.3	285	70.9
Surface water	208	51.7	269	66.9
Ground water	102	25.4	242	60.2
Land use	130	32.3	138	34.3
Natural resources	69	17.2	121	30.1
Land erosion	57	14.2	106	26.4

Table 5. Respondents' perception of the physical environmental problems created by road development projects of large, medium and small scale

Physical environmental problems	LSP		MSP		SSP		Total	
	Number of respondents (n = 138)	%	Number of respondents (n = 156)	%	Number of respondents (n = 108)	%	Number of respondents (n = 402)	%
Change in air quality	118	85.5	131	84.0	83	76.9	332	82.6
Increased Noise	112	81.2	115	73.7	79	73.1	306	76.1
Vibration	107	77.5	105	67.3	73	67.6	285	70.9
Surface water contamination	96	69.6	113	72.4	60	55.6	269	66.9
Ground water contamination	88	63.8	104	66.7	50	46.3	242	60.2
Land use changes	28	25.9	49	31.4	61	44.2	138	34.3
Deterioration of natural resources	49	35.5	51	32.7	21	19.4	121	30.1
Land erosion	40	29.0	46	29.5	20	18.5	106	26.4

noise level, no significant difference exists between the mean impact scores (p = .371 and α = .05). However, results pertaining to vibration show that there is a significant difference among the mean impact scores (p = .025 and α = .05), implying that different project scales have different levels of vibration impact as perceived by respondents. On water-related issues, the result of the ANOVA shows that there is a significant difference at 95% confidence level among the mean impact scores associated with change of surface water condition (p = .001 and α = .05 for local flooding) and ground water condition (p = .011 and α = .05 for ground water contamination).

The analysis of environmental impacts at all project scales indicate increase in air-borne dust as a severe impact while other environmental impact issues are moderate. Flooding caused by medium-scale projects is also perceived as having a severe impact on the respondents. This may be due to the specific locations and tracks of medium-scale road projects in the study area. The mean scores and ANOVA results (p-values) shown in Table 6 indicate that the null hypothesis should be rejected in relation to three environmental impact issues: increase in vibration, increase in flooding, and ground water contamination/degradation. All the other environmental issues were perceived by the respondents as similar across different scales of projects.

It is interesting to note that when it comes to local flooding and ground water contamination, respondents living near medium- and small-scale projects

Table 6. Summary of mean scores and results of ANOVA t-test according to the three project scales

Environmental impacts	Mean scores				ANOVA significance
	LSP	MSP	SSP	Total	p-value
Air quality					
• Increase in air-borne dust	3.30	3.66	3.54	3.50	.064
• Increase in air pollution (in general)	3.08	3.39	3.18	3.22	.193
Noise level					
• Increase in noise level	3.23	3.45	3.37	3.35	.371
Vibration level					
• Increase in vibration	3.01	3.47	3.29	3.25	**.025**
Surface water condition					
• Contamination/degradation	2.85	3.24	3.38	3.13	.090
• Depletion	2.18	2.15	2.31	2.19	.858
• Flooding	2.81	3.69	3.32	3.30	**.001**
Ground water condition					
• Contamination/degradation	3.02	3.36	3.78	3.32	**.011**
• Depletion	2.34	2.72	2.22	2.48	.166

Notes: Values in bold denote a significant difference in the mean scores between two groups of respondents at the 95% confidence level (if p < .05, the null hypothesis is rejected; if p > .05, the null hypothesis is accepted).
Interpretation of the mean scores: 1.00–1.49 = insignificant impact; 1.50–2.49 = small impact; 2.50–3.49 = moderate impact, 3.50–4.49 = severe impact; and 4.50–5.00 = most severe impact

perceive these issues to have moderate to severe impact, giving them scores that are considerably higher than the corresponding mean scores for large-scale projects. This may be due to the superior design and construction of large-scale road projects, which have an integral system for drainage. To summarize, the null hypothesis is rejected with respect to the problems of vibration, local flooding and ground water contamination.

Multiple comparisons

Multiple comparisons with a post hoc test were conducted to compare pair-wise differences among the three scales of projects. Table 7 shows the results of multiple pair-wise comparisons of mean scores for individual variables among the three respondent groups (i.e. people living near LSP, MSP or SSP), using the LSD post hoc test at 5% significance level.

The pair-wise comparisons show that vibration and flooding caused by large- and medium-scale projects are perceived as significantly different *(p* < .05 in bold type in Table 7). Similarly, ground water contamination/degradation caused by large- and small-scale projects are perceived as significantly different. There are no significant differences between the environmental impacts of MSP and SSP as perceived by the respondents.

Field monitoring

The above analysis is entirely based on the perceptions of affected people. To verify whether these perceptions are reliable, the state of the environment was assessed by using a selected set of environmental quality indicators which were compared against the corresponding Thai National Standards; see Table 8. A single reading for each quality indicator was taken at a selected point by the side of a large-, a medium- and a small-scale road. The three selected road projects were: Ekkachai Road (large-scale) upgraded in 2005 by the DoH, Thamkunakorn Road (medium-scale) upgraded in 2005 by the Samuth Sakorn Municipality, and Somanut Makkra Road (small-scale) upgraded in 2004 by the Muang Samuth Sakorn Municipality.

Although a single reading is not representative enough of the contexts of the 14 studied road projects in general or of the above three projects in particular, the readings did indicate that none of the measurements (except for noise level by the side of Ekkachai Road) exceeded the maximum limits set by Thai National Standards. Furthermore, the drainage and flooding situation along the three selected roads were evaluated by visual inspection and by checking records at the respective municipalities. This revealed that the situation pertaining to small- and medium-scale projects is unfavorable, which might be due to the construction of these roads without first putting in place integrated systems for drainage. In contrast, no detrimental consequences of large-scale projects were revealed, as these roads have better designs with integrated drainage systems.

Based on Tables 5–8, the following preliminary conclusions can be drawn, assuming that the comparisons hold true for all the studied roads and their traverses.

1. Negative environmental impacts have been generated by all three scales of projects as indicated by the increase in air-borne dust, increase in air pollution (smoke), increase in noise level, surface water contamination, surface water depletion and ground water depletion.
2. The vibration, flooding and ground water contamination caused by small- and medium-scale projects have significantly higher mean scores (i.e. are viewed as more severe) than those due to large-scale projects.
3. Environmental quality measurements indicate that the noise level associated with large-scale road projects is the only negative environmental impact exceeding the standard of what is acceptable.

The data collection also included interviews with some executive officers of road development agencies (i.e. DoH, DLH and DPWTCP); they confirmed that large-scale road projects in the two study areas were implemented without EA sanction. According to these interviews, only national highways of significant size and private-sector investments such as

Table 7. Multiple comparisons with LSD post hoc test

Physical environmental impacts	Significant difference in mean scores between pairs		
	***p*-value LSP–MSP**	***p*-value LSP–SSP**	***p*-value MSP–SSP**
Vibration level			
• Increase in vibration	**.007**	.142	.335
Surface water condition			
• Flooding	**.000**	.069	.174
Ground water condition			
• Contamination/degradation	.111	**.003**	.084

Note: Values in bold denote a significant difference in the mean scores between two groups of respondents at 95% confidence level

Table 8. Monitoring data for a large, a medium and a small road project (single reading only, 2005)

Characteristics of physical impacts	Measurement data from road projects of different scales			Thai National Standard	Inference
	LSP	MSP	SSP		
Air quality[a]					
• air-borne dust (mg/m^3)	0.207	0.156	0.063	0.33	Air-borne dust generated by all scales of projects has not reached the level of pollution.
Noise level[b]					
• Sound level (dbA)	75.2	65.6	61.1	70.0	Noise level generated by large-scale project exceeded the level of pollution.
Surface water condition[c]					
• Contamination					No national standard available to assess water quality on road sides. The existing standards are for drinking water.
- Turbidity (NTU)	42	10	8	-	
- Total suspended solids (mg/l)	61.5	56.0	28.0	-	
- Total dissolved solids (mg/l)	742	10544	5262	-	
Ground water condition[d]					
• Contamination					Ground water conditions associated with all scales of projects have not reached the level of pollution.
- PH	7.2	7.7	7.3	7.1–8.5	
- Color (Pt-Co)	1	2	2	5	
- Turbidity (NTU)	1	1	1	5	
- Hardness (mg/l as CaCo3)	220	147	229	300	

Notes: [a] Air quality measurement was taken for air-borne dust by using a TSP test with the gravimetric high volume method
[b] The measurement was taken using the method of Equivalent Continuous Sound Level (L_{eq}) for 24 hours
[c] There is no national standard available to assess surface water quality on road sides. The existing standard is only for surface water needed for drinking purposes
[d] Ground water quality data was obtained from the source of the municipal water supply (shallow bore hole)

toll-ways go through the EIA process. The main reasons cited for the omission of other roads were the central government's financial regulations pertaining to budget and time. Usually government agencies receive budgets for developmental work annually, and the funds must be spent within the financial year; any unspent budget has to be returned to the government. This system forces authorities to complete development projects within a tight schedule; therefore they tend to overlook development control and environmental management measures, and focus only on design and construction. Only special projects not under the direct supervision of local authorities, or projects that receive prior approval for a longer duration, are exempted from the budgetary system described above.

Interviews with the executives of road development agencies revealed that neither the large-scale projects implemented by national/regional road development agencies nor the small- and medium-scale projects implemented by local authorities and the private sector are subjected to any serious scrutiny as regards development control and environmental management. Typically, the only environmental management measure used is post-construction monitoring of noise and air quality by the Pollution Control Department (PCD); however, such monitoring is also limited only to large-scale road projects. To overcome this deficiency, it is necessary to search for alternative strategies to integrate environmental management measures in the planning stage of infrastructure development projects.

The Department of Local Administration (DoLA) under the Ministry of the Interior has recommended that local authorities — municipalities and *Tambon* Administration Organizations (TAO)[4] — set up committees to oversee local development work (Mongkolchaiarunya, 2003). Each committee should be composed of representatives from the municipality/TAO, government offices, academic institutions, NGOs, local communities, civic groups and the private sector, with the mayor/administrator as chairperson. One of the tasks of such a committee is to develop an Environmental Management System (EMS) suitable for use at the local-government level. However, this task is quite challenging for most local authorities and they are thus unable to follow the DoLA's recommendation.

One of the main reasons underlying this difficulty is the absence of a separate unit in charge of environmental management at the local-authority level. In fact, in all Local Government Units (LGUs) throughout the local-government hierarchy, environmental management is a task dispersed among several divisions, including public works, public health, public safety, community development, and development planning. While the higher-order LGUs such as *Nakhorn* municipalities are capable of coordinating environmental management tasks among different divisions, lower-order LGUs such as TAOs struggle to integrate environmental management into their routine work, since expertise is lacking at this lowest level of local administration.

Negative environmental impacts prevail irrespective of the scales of the projects. This situation calls for a more serious enforcement of EIA regulations for large-scale projects and the introduction of EA for medium and small projects implemented by local authorities

So far, only two local authorities in Thailand (Chiang Mai Municipality in the north and Muang Klang Municipality in the east) have established EMSs and received ISO accreditation (ISO14000). However, these initiatives are limited to environmental management in office buildings and municipal solid waste management operations. Nine more municipalities are in the process of establishing EMSs, under a pilot project guided by the Thailand Environment Institute (TEI, 2007). This project aims to encourage the development of EMSs in more local authorities; it is also laying the ground-work for expanding EMSs at local authorities to cover a wider scope that encompasses development projects. The experience gained from this pilot project will be useful for setting up environmental management systems that can more effectively manage environmental impacts generated by development projects undertaken within the jurisdiction of local authorities.

Conclusions and recommendations

This paper assessed the environmental impacts of road infrastructure projects implemented by local authorities in comparison with those implemented by national agencies, with the aim of identifying any differences between different scales of projects. The assessment was based on the perception of local people who were affected by these projects. If the affected people's perceptions could be taken seriously, it can be concluded that negative environmental impacts prevail irrespective of the scales of the projects. Since only large-scale road projects are legally required to conduct an EIA before implementation, and even that is often overlooked for projects implemented by the public sector, there appears to be a serious gap in addressing negative environmental impacts generated by all types of road projects. This situation calls for a more determined enforcement of EIA regulations for large-scale projects regardless of who is implementing them, and the introduction of EA for medium- and small-scale projects implemented by local authorities.

Outlined below are two interrelated prospects for integration of EA into small and medium infrastructure projects implemented by local authorities.

Establishment of and compliance with environmental legislation Although environmental legislation is the most common environmental management tool, its enforcement may be extremely weak at the local-government level. Moreover, some local government bodies do not even have environmental by-laws. While the central government requires EIA for large-scale projects, small- or medium-scale projects at either the national or the local level are approved without even a simple environmental assessment; they may be evaluated according to existing planning regulations which often do not address environmental effects. Therefore, in order to mitigate the environmental impacts of such projects, the relevant authorities and municipalities at the local level should strengthen their environmental legislation with adequate by-laws to make EA compulsory for small- and medium-scale projects.

Capacity building Local authorities are generally familiar with environmental issues relating to public health, hygiene and sanitation. The environment division or public works division of the local authority usually attends to these issues. Conducting EA for small and medium projects will be a challenging task for such conventional divisions that have limited capacities. Moreover, it may require a dramatic change of the organizational culture. Therefore, capacity building for environmental management is essential at the local-government level. Subsequently, incorporating the EA process into the planning, approval and monitoring of projects can be institutionalized.

The introduction of EA to the planning and development control processes of local authorities is a vital change that is required for establishing an effective environmental management system in local authorities. It is, in fact, a first step towards bringing an environmental management culture to the organizational level of local government.

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Notes

1. Industries that require EIA approval are those involving production or processing of petrochemicals, petroleum refining, separation of natural gases, alkali and chlorides, steel, cement, iron-ore mining, and paper.
2. Muang Samuth Sakorn and Muang Krathum Baan are the

municipalities that have been identified as *urban* municipalities in Samuth Sakhon province.

3. 'Immediate impact area' is defined as the area along the traverse of each road with boundary at 100 meters measured from the center-line of the road to both sides.
4. A 'Tambon Administration Organization' (TAO) is the smallest body of local administration in Thailand. TAOs manage development work at the sub-district (*Tambon*) and village (*Muban*) levels and function under the direct supervision of the district (*Amphor*) head office.

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