MAINTENANCE OF RURAL ROADS IN THE REPUBLIC OF PARAGUAY

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ABSTRACTS

The present report has been elaborated for presentation at the "XXIV World Congress of the Road", (Mexico City – Mexico) about the experience in Paraguay on local roads' maintenance.

In Paraguay the local roads are a basic need to supply a regular flow of agricultural produce, livestock breeding and services, from and to a certain location. Likewise, they allow for communities' development, thus improving their inhabitants' life quality; that is to say that these roads are growth inducing agents, by providing significant social and economic benefits to regions.

Therefore, with the objective of contributing to the increasement of competitivity of national production and to raise the standard of living of rural population, the Republic of Paraguay has signed agreements with multilateral organizations (Inter American Development Bank, World Bank, Japan International Cooperation Agency (JICA), Open Fund for International Development (OFID) and others) in order to have availability of financial resources needed to strengthen the management and maintenance of a road network of local tracks, so to keep them usable the most time of the year and with an adequate road safety.

1. GEOGRAPHIC AND ENVIRONMENTAL REFERENCES OF PARAGUAY.

The Republic of Paraguay, placed in the center of the southern hemisphere of the american continent, is placed between the 19º 18' and 27º 03' south latitude parallels and between the 54º 15' and 62º 38' west longitude. The Tropic of Capricorn crosses over the middle part of its territory. The surface of Paraguay is 406.752 km2. It has borders on north with Brazil and Bolivia; east with Brazil and Argentine; south with Argentine and west with Bolivia and Argentine. Generally, the surface of the territory is relatively flat and its highest altitude is around 500 meters above sea level. The Paraguay River divides the territory in two natural regions, the **oriental** and the **occidental** or **Paraguayan Chaco**. The **oriental** region covers 39% of national teritory and 97% of the population inhabits it. It has over 800 rivers and streams and 95% of its lands are cultivable. In this region are the main state institutions and the most important historic and cultural heritage. Politicaly and administratively it's divided in 14 departments, in which is placed the most of the health, road, educational, comunicational and basic services infrastructure. The **occidental** or **Paraguayan Chaco** covers 61% of national territory and contains 3% of the population. Its territory is shaped by a sea bed emerged during the quaternary and constituted by slimy and clayey lands, covered by extense brushwoods and palm trees, estuaries, lagoons and streams. It's divided in 3 departments and its economic production consists of some crops, livestock breeding and milk industry.

Figure 1 – Map of the Republic of Paraguay

In the **occidental** region of Chaco the presence of vegetation is directly related to the climatic and soil variables present from East to West. From the Paraguay River toward the Bolivian frontier a progressive decrease of humidity which sets the presence of different species. The plains are covered by thick tropical reeds, brushwoods, pastures and little developed trees.

In the **oriental** region, subtropical forests from Brazil show different characteristics. These forests cover half tthe region bordering with marginal Chaco areas. As this region shows better agricultural suitability, this zone has been strongly populated and deforested. Forests raise up to some 30 m height or more, with abundant undergrowth, lianas and epifits, often ferns; there is a wide variety of economically valuable species of trees.

About weather, the **Chaco** region is characterized by presenting three variants: the subhumid, semihumid and the arid. This climatic variation develops in the East-West direction, from the Paraguay River towards the frontier with the Bolivian territory. Strong North-South winds are predominant, along with a relative humidity oscillating between 20% and 65%. The mean annual temperature is above 23º C with a strong variation in the extremes. Differences of 28º C between the maximum and the minimum and 47º C between the absolute maximum and minimum can be registered. The mean annual precipitation varies between 600 mm in the arid zone and 1.300 mm in the zone corresponding to subhumid climate.

Besides, the Ministry of Public Works and Communications (MPWC), as a governing entity, has the responsability of estabishing norms and procedures for the execution of road maintenance, which by means of the Manual for Design, Construction and Maintenance of Roads, will officially provide the criteria to level the descripti on, characterization and quantification of activities related to the maintenance of roads, usage of machinery, equipments and tools, specialized and non-specialized work force; building materials and supplies.

2. ROAD NETWORK IN PARAGUAY

Regarding road infrastructure, the length of the road network in Paraguay, of which the Ministry of Public Works and Communications – MPWC – is in charge, is estimated in 60.000 kilometers, of which a length o **32.059** kilometers are inventoried: **4.507** kilometers are paved, **1.407** kilometers are cobbled, **2.452** kilometers are graveled and **23.310** kilometers are earthfilled. It's worth mentioning **72.71%** of the network is suitable for dry weather, and **27,29%** is suitable for all conditions.

3. ROAD MAINTENANCE PRACTICES ON LOCAL ROADS IN PARAGUAY

For local tracks the road maintenance is performed in the following ways:
i) road maintenance by **administration:** this maintenance practice is carried out by the Ministry of Public Works and Communications, tthrough the roads conservation districts, who are in charge of maintenance and conservation of national roads, departamental roads and local tracks under its jurisdiction, priorizing the sections that will be subject to maintenance according to its relevance, the state of the section and the available resources. The foreseen activities in this mode of maintenance are: Domain Strip, Roadway, minor Works of Art (Ditches, natural or coated, Drains, draining ditches), mayor Works of Art (Bridges), Signals and Works for Emergency situations;
ii) road maintenance by **contract:** carried out by **levels of service** schemes, through a building enterprise or enterprises consortium or a micro enterprise adjudged through a bidding carried out by the Ministry of Public Works and Comunications, based on the national norms in effect for hiring road maintenance works. The geographic areas maintained under this mode are: Concepción, San Pedro, Amambay, Caaguazú and Guairá;
iii) road maintenance by **agreement:** signed with civil asociation where the resources and/or road equipments are transferred to execute the foreseen maintenance activities. The geographic areas maintained under this mode are: Alto Paraná, Itapúa, Caazapá, Canindeyú, Presidente Hayes, Boquerón and Alto Paraguay.
iv) road maintenance with **micro enterprises:** in the geographic areas where maintenance by agreement and/or contract is implemented, and the departments of Paraguarí, Misiones, Ñeembucú and Cordillera.

4. IMPLEMENTATION SCHEMES

For any of the maintenance modes to be implemented, the activities for its implementation comprise the following stages:

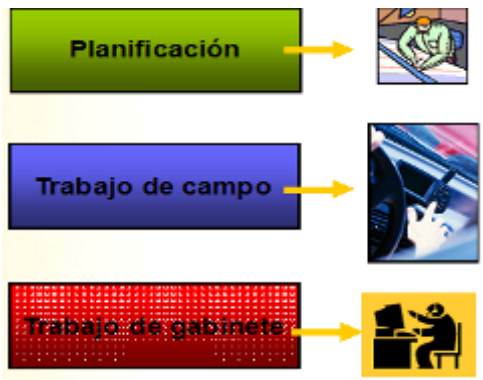

Figure 2 – Implementation stages

4.1 Field Work

Consisting on the elaboration of Base Lines of the sections to be affected to the Maintenance Management Plan. A characterization of the elements of the road to be maintained is carried out (roadway, domain strip, major works of art, minor works of art, signaling) in accordance with the Road Inventory Forms

4.2 Office Works

With the obtained data, the office works are carried out. Establishing (i) the scope of activities, (ii) the general obligations (iii) the control quality process, (iv) the methodology of measuring and payment to be used, and (v) the General Technical Specifications for the main maintenance activities.

For the maintenance by **contract** mode, a public bidding is carried out to adjudge an enterprise with the maintenance works within a determined geographic area; for the maintenance by **agreement** mode, an interinstitutional agreement is signed between the MPWC and a Civil Asociation, acting as an Executing Entity and form maintenance with **micro enterprises**, a contract is signed with them.

5. MAINTENANCE BY CONTRACT MODE

In this maintenance mode the adjudged contractor enterprise tries to optimize the frequency of its interventions and determines what, how, where, when and at what cost to carry out the maintenance activities. It consists of a road maintenance system by level of service, which essentially is a management contract, where the contractor is the one making the decisions about which activities to carry out on the roads to maintain the service level stipulated by the MPWC.

This kind of contract contemplates the execution of **(i)Starting maintenance works (readying)** which ought to be carried out in the initiall stages of the Contract so that roads are adjusted to predetermined standards; **(ii)Routine maintenance works**, comprising all the activities required to keep the road in good condition, with repetition frequencies varying according to the activity to be carried out. It also includes those road repairs destined to recovering minor damaged elements, deteriorated or destroyed, and related activities in order to provide the road with new characteristics attending the change of transit conditions, safety or other circumstances, and **(iii) Emergency works** comprising activities needed to repair the roads that suffered damage caused by unforeseen natural phenomenoms of imponderable consecuences.

Payment consists of a Fixed Raised Sum adjusted conforming to the reached Level of Service according to established standards.

Figure 3 – Maintenance by Contract Mode

This maintenance mode has been implemented in the departments of San Pedro (1), Guairá (2), Caaguazú (3) and will suitably be implemented in the departments of Concepción (4) and Amambay (5)

Monthly evaluations are carried out according to the corresponding evaluation charts.

The experience in Paraguay in the 3 geographic areas where this kind of maintenance have been implemented resulted in the following sums:

Table 1 – Average cost of Maintenance by Contract (Guairá)

MANTENIMIENTO VIAL (Dpto. Guair?	LONGITUD	DURACI?	COSTO UNITARIO DOLARES
MANTENIMIENTO INICIAL (/ Km)	242,35	8	890,53
MANTENIMIENTO RUTINARIO (/ Km x a?)	242,35	16	1.407,33

Table 2 – Average cost of Maintenance by Contract (Caaguazú)

MANTENIMIENTO VIAL (Dpto. Caaguaz?	LONGITUD	DURACI?	COSTO UNITARIO DOLARES
MANTENIMIENTO INICIAL (/ Km)	302,55	6	1.390,23
MANTENIMIENTO RUTINARIO (/ Km x a?)	302,55	18	890,47

Table 3 – Average cost of Maintenance by Contract (San Pedro)

MANTENIMIENTO VIAL (Dpto. San Pedro)	LONGITUD	DURACI?	COSTO UNITARIO DOLARES
MANTENIMIENTO INICIAL (/ Km)	251,50	6	2.612,77
MANTENIMIENTO RUTINARIO (/ Km x a?)	251,50	18	621,98

6. MAINTENANCE BY AGREEMENT MODE

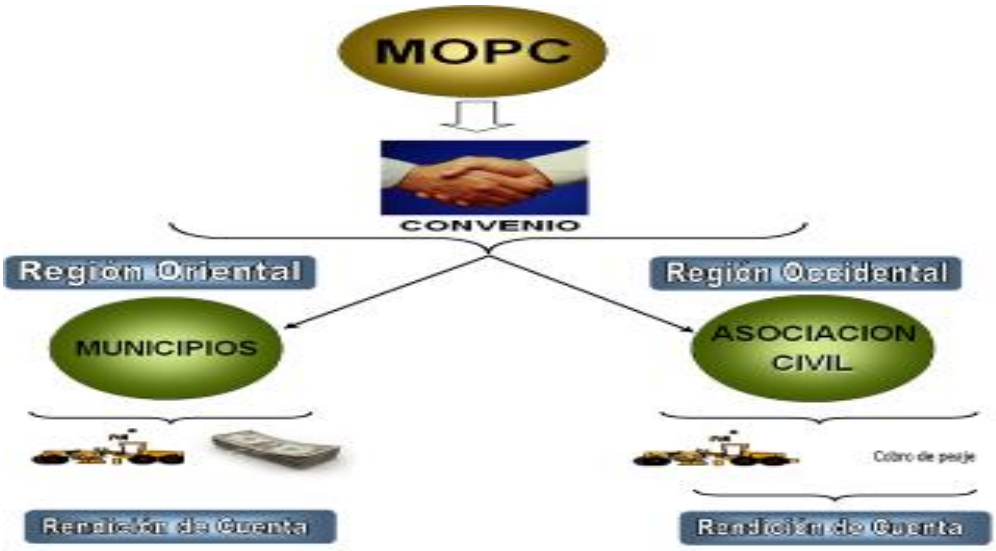

Figure 4 – Maintenance by Agreement Mode

In this maintenance mode, the MPWC signs an interinstitutional Agreement with a Civil Asociation, to which the competence of maintenance is transferred. For the **oriental region** the Civil Asociation is an Asociation of Municipalities, road equipments are delivered under commodatum, resources are transferred to carry out the maintenance activities and accounts are reported. For the **occidental region** the Civil Asociation is a Local Comission, road equipments are delivered under commodatum, tolls are charged and accounts are reported. In both cases, supervision is under the MPWC.

This maintenance mode has been implemented in the departments of Alto Paraná, Itapúa, Caazapá, Canindeyú, Presidente Hayes, Boquerón, and Alto Paraguay.

Monthly evaluations are carried out according to the following evaluation chart.

Table 4 - Model Evaluation Chart

Programa Nacional de Caminos Rurales 2?Etapa - 1?Fase - Pr? tamo BID N?1230/OC-PR
Plan de Gesti? de Mantenimiento
CONVENIO ITAPÚA

PLANILLA DE EVALUACION DE TRAMOS

C? igo:
Tramo:
Longitud:

Fecha:
Evaluaci? N?
Correspondiente al mes de:

	Calzada		Franja de Dominio	Cunetas Revestidas	Cunetas Naturales		Alcantarillas	Puentes	Se? lizaciones	Calificaciones
Sector A	Ondulaciones				Secci? y					
	Huellas				Veg. y Sedim.					
	Degradaciones				***Promedio:***					
	Promedio:									
Sector B	Ondulaciones				Secci? y		No posee	No posee		
	Huellas				Veg. y Sedim.					
	Degradaciones				***Promedio:***					
	Promedio:									
Sector C	Ondulaciones				Secci? y					
	Huellas				Veg. y Sedim.					
	Degradaciones				***Promedio:***					
	Promedio:									
Sector D	Ondulaciones				Secci? y					
	Huellas			No posee	Veg. y Sedim.			No posee		
	Degradaciones				***Promedio:***					
	Promedio:									
Sector E	Ondulaciones				Secci? y					
	Huellas			No posee	Veg. y Sedim.		No posee	No posee		
	Degradaciones				***Promedio:***					
	Promedio:									
Total de puntos del Item										
Factor de Ponderaci?	0,40		0,10	0,05	0,05		0,20	0,10	0,10	
Total de puntos ponderados										**A**
M? imo Puntaje Posible ponderado	6		1,5	0,45	0,75		1,8	0,6	1,50	**B**
									Calificaci? Final	**A/B**

Referencias: Buena (3)
Regular (2)
Mala (1)

Supervisor del MOPC
Convenio Itap?

Superintendente
Convenio Itap?

The control to make the source and application of resources clear is carried out in a monthly manner, through Accounts Settling, so much in the technical area as in the administrative area. Procedure manuals were elaborated and accounting plans where the eligibility of the expense is detailed according to its financial source.

6.1 Foreseen activities

- Domain strip cleaning
- Cobble pavement maintenance
- Roadway shaping without materials reposition
- Roadway shaping with materials reposition
- Drains repairing
- Drains cleaning
- Coated ditches cleaning
- Reinforced concrete bridges repairing
- Wood bridges repairing
- Signals supply and maintenance

Experience in Paraguay for the geographic areas of Alto Paraná, Itapúa and implemented Canindeyú where this type of maintenance costs showed the following:

Table 5 - Average costs of Maintenance by Agreement:

CONVENIO ITAPÚA

TIPO DE MANTENIMIENTO VIAL	LONGITUD	DURACIÓN	COSTOS UNITARIOS	
			GUARANIES	DOLARES
MANTENIMIENTO INICIAL (/ Km)	303,95	12	4.860.162,84	960,51
MANTENIMIENTO RUTINARIO (/ Km x año)	309,05	11	3.869.930,94	764,81

CONVENIO ALTO PARANÁ SUR

TIPO DE MANTENIMIENTO VIAL	LONGITUD	DURACIÓN	COSTOS UNITARIOS	
			GUARANIES	DOLARES
MANTENIMIENTO INICIAL (/ Km)	354,9	12	4.599.480,98	908,99
MANTENIMIENTO RUTINARIO (/ Km x año)	299,20	11	3.522.167,98	696,08

CONVENIO CANINDEYÚ ESTE

TIPO DE MANTENIMIENTO VIAL	LONGITUD	DURACIÓN	COSTOS UNITARIOS	
			GUARANIES	DOLARES
MANTENIMIENTO INICIAL (/ Km)	293,40	12	5.690.426,39	1124,59
MANTENIMIENTO RUTINARIO (/ Km x año)	293,40	11	4.323.533,11	854,45

6.2 Evaluations - Indicators

The evaluation of the state of the road is carried out monthly to characterize the variables detemining its functional and structural conditions. The functional condition is influenced by the structural condition. In both cases, the surface defects are a symptom of faults influencing the state of the road.

The auscultation is carried out in a systematic process in two stages, which allows gathering of road state data and synthesizing them in indicators. So much for maintenance by agreement as by contract, visual inspection is a non invasive technique that is applied and allows for identification and characterization of road's defects.

For each element of the road subject to maintenance the evaluation indicators are defined with their respective admitted tolerances.

Table 6 - Example: Indicator for domain strip

ELEMENT	INDICATORS	INSPECTION	TOLERANCE	ASSESMENT
DOMAIN STRIP	Strip always clean, free of obstacles and without weeds	Visual inspection	There must not exist high vegetation all along the whole domain strip, from the border of the roadway until its limit. Vegetation must be no taller than **15 cm**.	If h <= 15 cm → CB (3) If 15 < h <= 40 → CR (2) If h > 40 → CM (1)

6.3 SANCTIONS

Once carried out the evaluation inspection, and according to the outlined indicator for each component of the road, issuing of MONTHLY APPROBATION ORDER is performed, as long as the summatory of components of sectors A, B, C,D, and E respectively result more or equal to **a determined amount (84 points)**. Lesser scores will be penalized according to description indicated in the agreement/contract. Evaluation indicators ensure roads work with optimal levels of service, that's why the sanctions are established, with their corresponding penalizations, if the maintenance activities aren't carried at the right moment.

6.4 Accounting reports

For the maintenance by agreement mode, the Executing Entities are under obligation to present accounting reports to make the origin and application of resources clear, according to the established eligibility of expenses. The transferred or collected resources must be used only and exclusively for the maintenance activities on the roads affected to the Maintenance Managing Plan. Not accomplishing this condition forces the Executing Entity to replace from their own resources, the amount declared as non eligible expense.

7. MAINTENANCE WITH MICRO ENTERPRISES

For local roads, this maintenance mode has been implemented in the departments of Itapúa, Caazapá, Misiones y Ñeembucú.

The activities of promotion, constitution, capacitation and monitoring are carried out through the Micro Enterprises Unit of the MPWC. For year 2011 it's expected to implement the maintenance of 6.302 kilometers of the road network from Paraguay under this mode, from which 3.429,5 kilometers belong to the local roads network from Paraguay, with a total of 257 micro enterprises in activity and 1.715 people affected to the maintenance scheme

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