

## CHAPTER 6      MASTER PLAN OF SOIL CONSERVATION FOR PILOT RIVER BASINS

The soil conservation is to control the erosion below a threshold level depending on a specific object. The theoretical threshold is a state of equilibrium between the amounts of erosion and soil formation. On the other hand, the practical threshold generally applied is a less severe level to maintain soil fertility in the medium term (20 and 25 years) allowing soil amendment with fertilizer, green manure, lime etc.

To determine criteria and threshold, the specific object is required. Since no criteria are available in Paraná to establish a threshold of erosion control for the water environment, the widely acceptable figures in terms of area of river basin was adopted at the Strategy. These figures were applied to Pilot river basins also as a goal of soil conservation. Therefore, the threshold of soil loss to propose a soil conservation plan (Master plan) by the year of 2015, is 11 ton/ha-year. After the suppression of soil loss below the threshold, 2 ton/ha-year which is widely acceptable values for a large river basin will be achieved successively.

The soil conservation plan have to integrate the agronomic measures, soil management and mechanical measures because they have different effect on soil erosion and are the most effective when integrated rather than individual implementation.

Specific countermeasures depend on crop, size of farmers, farming system and so on. Considering the agricultural characteristics in Pilot river basins, the soil conservation plan was formulated as a Master plan. For the application of the soil conservation plan at field, the suitable measures should be selected from the Master plan examining local variation of agriculture.

The main target of the Master plan in Pilot river basins is to suppress the soil loss from crop lands because as shown in Table-5.2 and Table-5.3 the current soil loss from crop land is much greater than other landuse in both pilot river basins. Since terracing and non tillage are the most effective measures, their implementation is essential. Terracing with contouring should cover 100 % of the crop area and non tillage is expected to be practiced in 50 % of beans, maize and soybean fields by the year of 2015. Application of other measures, such as agronomic measures and soil management depend on the local characteristics of agriculture.

The effectiveness of soil conservation plan was examined applying USLE. For the computation sake, the following assumptions were made.

- 1) 100 % implementation of terracing with contouring to crop land
- 2) 50 % implementation of non tillage to beans, maize and soybean field where the current application of non tillage is less than 50 %
- 3) no consideration of other measures , such as agronomic measures and soil management

After confirming the effectiveness of the Master plan, cost for implementation of the Master plan was estimated. Finally cost was compared with benefit so as to determine whether the Master plan is worth to be implemented.

## 6.1 Iguaçú River Basin

### 6.1.1 Master Plan and Its Effect

Considering the agricultural characteristics in Iguaçú river basin, the soil conservation plan was formulated as a Master plan shown in Table-6.1. Countermeasures to suppress soil erosion are classified as essential and ideal. Since countermeasures proposed are general, their application at field involves the detail examination of the local characteristics of agriculture in order to select the appropriate countermeasures.

Among dominant crops in Iguaçú river basin, the crop land for soybean and wheat culture is well conserved, while the land for potato culture is the worst in terms of soil conservation (refer to Appendix-3). Although the area of potato culture is limited, 1.7 % of the total crop area in the basin, soil conservation is essential to improve the water environment of local micro river basin. Maize and beans are currently cultivated 54.3 % and 17.0 % of the total crop area, respectively. The implementation of soil conservation for these crops vary from 100 % to 1 % of the crop area depending on the location. It requires to raise the rate of soil conservation implementation.

With assumptions mentioned before, the effectiveness of the Master plan was examined with the application of USLE in terms of implementation of terracing and non tillage. As shown in Table-6.2, terrace is currently implemented 979 thousand ha of crop land in Iguaçú river basin and 1,078 thousand ha of crop land remains without soil conservation. To achieve the goal, this remained area has to be terraced.

As shown in Appendix-3, the productivity of beans, maize, soybean and wheat tends to increase with non tillage. Therefore, non tillage is effective not only in suppression of soil erosion but also improvement of crop productivity. The recent researches show that disadvantages of non tillage, such as higher herbicide costs and more complex weed control, can be overcome soon. Considering these favorable conditions, 50 % implementation of non tillage to applicable crop land is realistic.

Appendix-3 shows that non tillage is currently applied to 0.4 % of beans area, 11.8 % of maize area, 37.9 % of soybean area and 22.1 % of wheat area. Since in Paraná wheat is usually a second crop after soybean or maize, wheat was excluded from the area computation of non tillage for the future soil estimation and considered to be included in the area of either soybean or maize. As shown in Table-6.3, the area of non tillage application for beans, maize and soybean will expand to 177 thousand ha, 581 thousand ha and 319 thousand ha, respectively, by the year of 2015.

The result of future soil loss estimation with assumptions is shown in Table-6.4 (refer to Appendix-4 for the details of computation). The average soil loss in Iguaçú river basin would be reduced to 4 ton/ha-year with the Master plan. Since no other measures than terracing and non tillage are counted in the estimation, the result is underestimation. If the Master plan was implemented fully, less soil loss than Table-6.4 would be expected.

Current soil loss from crop land ranges from 146 ton/ha-year to 1.9 ton/ha-year, while future soil loss from crop land would be at range between 4.7 ton/ha-year and 0.2 ton/ha-year. This great reduction of soil loss would contribute to the improvement of water environment. Much less soil loss results in the low water contamination by sediment and agrototoxic stuck to soil particles.

Table-6.1 Soil Conservation Plan (Master Plan) in Iguacu River Basin

Crop	ML	Essential			Ideal		
		TY	Measures	Effect	TY	Measures	Effect
all crop field and Pasture	-	M	improvement of farm road	2	M	diversion ditches	2
		M	drainage along road side	2	M	terrace channels	2
		A	proper spacing of crops	1 & 2	M	grass water ways	2
		A	proper crop calendar	1 & 2	M	energy dissipater at outlet of drainage	2
		S	maintenance of soil fertility	1 & 2			
		A	proper plant selection	1 & 2			
Soybean Wheat Maize Beans	I	M	terracing with contour cropping	2	M	contour stripcropping	2
		M	buffer stripcropping	2	A	non tillage	1 & 2
		S	avoid excess operation of machinery	2			
		S	subsoiling to stir hard pan of soil	2			
		S	proper plowing or harrowing	2			
		A	mulching by crop residue	1 & 2			
A	seeding of winter green manure crops	1 & 2					
Maize Beans	II	M	terracing with contour cropping	2	A	non tillage with animal	1 & 2
		M	buffer strips with stones	2			
		M	buffer stripcropping	2			
		A	mulching by crop residue	1 & 2			
		A	seeding of winter green manure crops	1 & 2			
		M	contour stripcropping	2			
A	intercropping with green manure crops	1 & 2					
M	stripcropping with spring & summer crop	1					
Potato	I	M	terracing with contour cropping	2			
		S	proper plowing or horrowing	1			
		S	avoid excess operation of machinery	2			
Cotton Sugarcane Cassava	I	M	terracing with contour cropping	2	M	contour stripcropping	2
		M	buffer stripcropping	2			
		S	avoid excess operation of machinery	2			
		S	subsoiling to stir hard pan of soil	2			
		S	proper plowing or harrowing	2			
		S	seeding of winter green manure crops	1 & 2			
Cotton Sugarcane Cassava	II	M	terracing with contour cropping	2	M	contour stripcropping	2
		M	buffer strips with stones	2			
		M	buffer stripcropping	2			
		A	seeding of winter green manure crops	1 & 2			
Olericulture	I	M	terracing with contour cropping	2			
Pasture	I & II	M	terracing	2	A	crop rotation	1
		M	water supply system for cattle	1 & 2	A	perennial forage	2

Abbreviation: ML: Management Level, I: Mechanized Farming System, II: Farming System with Man or Animal Power

TY: Type of Measures, M: Mechanical Measures, A: Agronomic Measures, S: Soil Management

1: Effect on Rainsplash, 2: Runoff

Table-6.2 Area of Terrace to be Implemented (Iguacu River Basin)

No	Municipality	Crop Area in 1984 (ha)	Terraceed cropland fraction	Current Area of Terrace in 1984 (1,000ha)	Area of Terrace to be implemented (1,000ha)	No	Municipality	Crop Area in 1984 (ha)	Terraceed cropland fraction	Current Area of Terrace in 1984 (1,000ha)	Area of Terrace to be implemented (1,000ha)
I-17	Aguaes do Sul	13,500	0.414	5,600	7,900	I-171	Palmeiras	33,000	0.683	35,100	17,900
I-17	Almirante Tamandare	3,700	0.016	0.10	3,600	I-23	Palmeiras	10,100	0.762	7,700	2,400
I-17A	Ampere	12,500	0.714	8,900	3,600	I-51	Pato Branco	25,100	0.000	0.00	25,100
I-25	Antonio Olinto	15,500	0.038	0.60	14,900	I-32	Paulo Frontes	16,200	0.470	7,600	8,600
I-10	Arucana	24,400	0.103	2,500	21,900	I-51	Paulo Frontin	20,600	0.551	11,300	9,300
I-14	Balsa Nova	7,200	0.051	0.40	6,800	I-83	Penha do Oeste	19,900	0.439	7,000	8,900
I-13	Barra do Rio	14,900	0.433	6,400	8,500	I-18	Planalto	12,900	0.325	4,200	8,700
I-36	Bituruna	26,600	0.043	1,100	25,500	I-48	Pinhal	3,800	0.184	3,800	3,200
I-67	Boa Esperanca do Iguacu	13,000	0.841	8,700	4,300	I-77	Pinhal de Sao Bento	1,600	0.581	0,900	0,700
I-91	Boa Vista de Aparecida	12,000	0.706	8,500	3,500	I-40	Pinhao	100,800	0.807	61,200	39,600
I-35	Bom Sucesso do Sul	6,900	0.628	4,300	2,600	I-31	Pracuara	5,900	0.214	1,200	4,700
I-1	Campina Grande do Sul	1,000	0.046	0.10	0,900	I-94	Pratense	18,200	0.779	14,200	4,000
I-20	Campo do Tenente	13,100	0.228	3,000	10,100	I-22	Ponto Amazonas	4,800	0.045	0,200	4,600
I-9	Campo Largo	16,200	0.016	0,300	14,900	I-34	Porto Victoria	5,600	0.995	3,300	2,300
I-45	Candeia	36,500	0.549	20,100	17,400	I-76	Pranchita	14,000	0.744	10,400	3,600
I-46	Caraguaipe	30,300	0.167	5,100	25,200	I-2	Quatro Barras	2,600	0.191	0,500	2,100
I-66	Carleirias	22,900	0.647	14,800	8,100	I-64	Quilates do Iguacu	24,400	0.631	15,500	8,900
I-92	Castro Leonidas Marques	15,700	0.730	11,500	4,200	I-16	Quilates do Iguacu	21,600	0.237	5,100	16,500
I-60	Caucatel	55,400	0.845	49,300	6,100	I-85	Reboucas	20,700	0.673	13,900	6,800
I-68	Canadivava	24,800	0.735	18,200	6,600	I-27	Reboucas	29,100	0.282	8,200	20,900
I-86	Carazul	4,100	0.947	3,900	0,200	I-54	Recreancia	18,500	0.636	11,800	6,700
I-49	Chopimilto	41,700	0.964	27,700	14,000	I-29	Rio Azul	31,600	0.105	3,300	28,300
I-42	Clevelândia	31,800	0.369	11,700	20,100	I-61	Rio Bonito do Iguacu	9,900	0.433	2,600	3,300
I-5	Colombo	1,600	0.000	0,000	1,600	I-19	Rio Negro	14,100	0.436	6,100	8,000
I-15	Contenda	12,400	0.059	0,700	11,700	I-74	Salgado Filho	8,300	0.047	0,400	7,900
I-50	Coronel Vinhas	28,900	0.478	13,800	15,100	I-50	Santo do Lontra	15,400	0.513	8,400	8,000
I-37	Cruz Machado	58,600	0.078	4,600	54,000	I-51	Santa Isabel do Oeste	19,600	0.584	9,100	6,500
I-66	Cruzera do Iguacu	4,800	0.668	2,900	1,900	I-93	Santa Lucia	8,600	0.476	4,200	4,400
I-8	Curitiba	4,500	0.178	0,800	3,700	I-95	Santa Teresinha do Oeste	13,400	0.246	11,300	2,100
I-88	Dona Vitoria	20,100	0.678	13,600	6,500	I-100	Santa Teresinha do Oeste	6,400	0.888	7,500	0,900
I-69	Ereosa Marques	9,700	0.654	6,300	3,400	I-75	Santo Antonio do Sudoeste	15,900	0.519	8,300	7,600
I-11	Fazenda Rio Grande	5,400	0.033	0,200	5,200	I-58	Sao João	22,900	0.758	17,400	5,500
I-72	Floz da Serra do Sul	3,200	0.190	0,600	2,600	I-24	Sao João do Trunfo	14,300	0.281	2,900	11,400
I-01	Foz do Iguacu	6,700	0.787	6,800	1,900	I-65	Sao Joao do Oeste	17,700	0.561	9,900	7,800
I-70	Francisco Beltrao	36,000	0.551	19,800	16,200	I-4	Sao Jose dos Pinhais	29,400	0.052	1,500	27,900
I-35	General Carneiro	24,300	0.151	3,700	20,600	I-26	Sao Mateus do Sul	43,000	0.201	8,800	35,000
I-63	Guaranica	11,600	0.364	4,300	7,300	I-99	Sao Miguel do Iguacu	16,700	0.710	13,300	3,400
I-39	Guarapuava	154,500	0.802	123,900	30,600	I-60	Saude do Iguacu	7,800	0.512	4,000	3,800
I-43	Horopong-Serra	35,400	0.102	6,500	28,900	I-9	Sulina	8,700	0.448	3,900	4,800
I-89	Ibema	4,300	0.947	4,000	0,300	I-13	Tiucas do Sul	8,000	0.003	0,000	8,000
I-38	Inacio Manna	21,700	0.026	0,600	21,100	I-87	Tres Barras do Parana	24,300	0.722	17,500	6,800
I-68	Itani	22,000	0.346	7,600	14,400	I-33	Uniao da Victoria	15,100	0.329	5,000	10,100
I-96	Itaipava D'Oeste	13,000	0.381	5,000	8,000	I-57	Vere	18,600	0.606	11,400	7,200
I-21	Itaipu	87,900	0.512	45,000	42,900	I-47	Virmond	9,100	0.182	1,700	7,400
I-48	Itaperuna do Sul	36,000	0.170	6,100	29,900	I-53	Vitorino	14,500	0.538	7,800	6,700
I-64	Linopolis	16,000	0.263	4,100	11,900		Total	2,056,700		978,800	1,078,100
I-30	Mallet	28,400	0.388	11,300	17,100						
I-12	Mandrituba	18,800	0.242	4,800	14,000						
I-44	Mangueirinha	33,900	0.709	24,000	9,900						
I-02	Maracajus	11,300	0.852	9,600	1,700						
I-21	Marumbeiro	20,600	0.445	9,100	11,500						
I-87	Matelandia	5,900	0.940	5,500	0,400						
I-86	Medianeira	16,600	0.863	14,200	2,400						
I-79	Nova Esperanca do Sudoeste	9,400	0.479	4,500	4,900						
I-42	Nova Laranjeiras	8,100	0.197	1,600	6,500						
I-82	Nova Prata do Iguacu	17,900	0.741	13,300	4,600						

Table-6.3 (1/2) Current and Future Area of Non Tillage Application (Iguaçu River Basin)

BACIA	Municipality	Soil Loss	Current			2015		
			Beans (1000 ha)	Maize (1000 ha)	Soybean (1000 ha)	Beans (1000 ha)	Maize (1000 ha)	Soybean (1000 ha)
1-93	Santa Lucia	99.6	0.0	0.0	0.0	0.6	2.0	1.5
1-79	Nova Esperanca do Sudoeste	86.2	0.0	0.0	0.0	1.1	3.5	0.1
1-67	Boa Esperanca do Iguaçu	77.1	0.0	0.0	0.0	1.4	4.1	1.1
1-9	Campo Largo	65.0	0.0	0.0	0.0	1.7	4.6	0.0
1-73	Barracão	62.5	0.0	0.0	0.0	0.8	6.1	0.1
1-46	Cantagalo	62.5	0.0	0.2	0.1	1.4	12.3	1.2
1-94	Uindoeste	59.5	0.0	0.0	0.0	0.3	5.7	0.3
1-56	Itapejara DOeste	57.2	0.0	0.2	0.2	0.5	3.1	3.0
1-85	Capanea	56.2	0.0	0.0	0.0	2.7	3.8	4.6
1-43	Honorio Serpa	53.3	0.0	1.7	4.7	1.4	9.4	6.9
1-59	Sulina	53.3	0.0	0.0	0.0	0.2	3.1	0.8
1-83	Perola do Oeste	50.5	0.0	0.0	0.0	1.1	3.8	2.4
1-69	Eneas Marques	42.4	0.0	0.0	0.0	2.1	2.6	0.0
1-81	Santa Izabel do Oeste	41.9	0.0	0.1	0.1	0.6	3.3	3.6
1-85	Realeza	40.2	0.0	0.1	0.0	0.9	4.5	4.7
1-47	Virmond	39.0	0.0	0.1	0.0	0.9	3.7	0.0
1-48	Laranjeiras do Sul	38.6	0.0	5.8	4.7	2.5	13.2	4.7
1-75	Santo Antonio do Sudoeste	37.9	0.0	0.0	0.0	2.4	4.2	1.2
1-57	Veré	36.9	0.0	0.0	0.0	1.5	5.6	2.2
1-84	Planalto	35.9	0.0	0.0	0.0	1.0	2.9	5.0
1-50	Coronel Vivida	35.7	0.0	0.0	3.2	0.6	9.5	4.1
1-17	Agudos do Sul	35.6	0.0	0.0	0.0	1.1	5.4	0.0
1-51	Pato Branco	34.9	0.0	0.0	0.0	1.3	4.5	6.7
1-30	Mallet	34.4	0.4	1.3	1.4	6.6	6.7	1.4
1-66	Cruzeiro do Iguaçu	34.1	0.0	0.0	0.0	0.3	1.4	0.7
1-63	Guaranicau	32.4	0.0	0.0	0.6	0.5	4.5	0.8
1-28	Irati	32.2	0.0	0.0	0.1	5.1	5.6	0.4
1-70	Francisco Beltrão	31.5	0.0	0.3	0.6	2.7	13.2	1.6
1-82	Nova Prata do Iguaçu	31.2	0.3	0.5	0.3	2.5	3.7	2.9
1-74	Salgado Filho	29.7	0.0	0.0	0.0	0.7	3.4	0.0
1-53	Vitorino	29.7	0.0	0.0	0.0	0.4	3.0	3.9
1-80	Salto do Lontra	28.6	0.1	0.2	0.0	2.2	4.8	0.8
1-65	Sao Jorge do Oeste	28.5	0.0	0.4	0.2	1.0	7.2	0.3
1-27	Rebouças	27.5	0.0	0.3	0.3	5.3	7.4	1.3
1-68	Dois Vizinhos	27.2	0.0	0.0	0.0	0.9	6.8	1.8
1-29	Rio Azul	26.6	0.0	0.0	0.2	7.0	8.1	0.5
1-92	Capitao Leonidas Marques	26.2	0.0	0.0	0.0	0.9	3.2	2.9
1-72	Flor da Serra do Sul	23.9	0.0	0.1	0.0	0.2	1.4	0.1
1-76	Pranchita	23.8	0.0	0.0	0.0	1.1	2.5	3.3
1-58	Sao Joo	23.6	0.0	0.5	2.0	0.5	6.0	4.7
1-60	Saudade do Iguaçu	21.8	0.0	0.9	0.0	0.5	3.0	0.2
1-78	Ampere	19.6	0.0	0.0	0.0	0.6	3.7	1.7
1-62	Nova Laranjeiras	19.6	0.0	0.1	0.1	0.6	3.4	0.1
1-18	Piçarra	19.4	0.0	0.0	0.0	1.2	5.1	0.0
1-91	Boa Vista da Aparecida	19.2	0.0	0.0	0.0	1.2	2.5	0.7
1-45	Candói	19.1	0.0	4.8	3.4	1.6	12.1	5.6
1-15	Contenda	18.7	0.0	0.0	0.0	1.6	3.0	0.0
1-55	Bom Sucesso do Sul	18.1	0.0	0.0	1.6	0.8	1.7	1.6
1-42	Clevelândia	18.1	0.0	0.0	0.0	1.5	6.1	8.3
1-99	Sao Miguel do Iguaçu	17.3	0.0	0.2	0.8	0.0	1.9	6.3
1-49	Chopininho	16.8	0.0	2.2	8.6	1.9	12.3	8.6
1-88	Catanduvas	14.7	0.0	1.6	1.2	0.3	8.9	2.3
1-16	Quitandinha	14.4	0.0	0.0	0.0	3.4	5.9	0.0
1-77	Pinhã de Sao Bento	14.0	0.0	0.0	0.0	0.2	0.6	0.1
1-10	Araucaria	13.8	0.0	0.3	0.1	2.1	7.8	0.1
1-101	Foz do Iguaçu	13.2	0.0	0.0	0.3	0.0	1.0	3.2
1-71	Marmeleiro	12.6	0.0	1.0	1.1	2.4	6.5	1.1
1-37	Cruz Machado	12.1	0.0	0.0	0.0	14.4	14.4	0.0
1-25	Antonio Clinto	12.0	0.0	0.0	0.0	3.7	3.7	0.0
1-4	Sao Jose dos Pinhais	11.8	0.0	0.0	0.0	3.3	10.9	0.0
1-12	Mandrituba	11.3	0.0	0.0	0.0	2.7	6.4	0.0
1-54	Renascença	11.2	0.6	0.3	0.0	0.6	3.5	5.0
1-19	Rio Negro	11.0	0.0	0.0	0.3	2.6	4.3	0.3
1-11	Fazenda Rio Grande	10.8	0.0	0.0	0.0	0.7	1.6	0.4
1-6	Pinhais	10.7	0.0	0.0	0.0	0.0	1.3	0.0
1-3	Piraquara	10.7	0.0	0.0	0.0	0.0	2.4	0.0
1-44	Mangueirinha	10.4	0.0	2.5	2.7	1.2	7.0	7.5
1-95	Santa Tereza do Oeste	10.4	0.0	0.8	4.5	0.0	2.6	4.5
1-87	Tres Barras do Parana	10.4	0.0	0.0	0.0	1.8	8.5	1.0
1-109	Santa Terezinha de Itaipu	10.2	0.0	0.0	0.0	0.0	0.9	3.2
1-20	Campo do Tenente	9.8	0.0	0.0	0.2	1.5	4.3	0.3
1-26	Sao Mateus do Sul	9.7	0.0	0.0	0.0	8.6	9.4	3.3
1-32	Paula Freitas	9.1	0.0	0.0	0.0	2.0	3.4	2.5
1-90	Cascavel	8.7	0.0	6.5	13.1	0.3	9.3	18.7
1-8	Curituba	8.6	0.0	0.0	0.0	0.0	2.0	0.0
1-14	Balsa Nova	8.3	0.0	0.0	0.0	1.2	1.7	0.0
1-22	Porto Amazonas	8.1	0.0	0.0	0.9	0.4	1.5	0.9

Table-6.3 (2/2) Current and Future Area of Non Tillage Application (Iguaçu River Basin)

BACIA	Municipality	Soil Loss	Current			2015		
			Beans (1000 ha)	Maize (1000 ha)	Soybean (1000 ha)	Beans (1000 ha)	Maize (1000 ha)	Soybean (1000 ha)
1-7	Almirante Tamandare	7.7	0.0	0.0		0.6	1.1	
1-36	Bisuruna	7.6	0.0	0.0		3.0	2.4	
1-38	Inacio Martins	7.5	0.0	0.0		3.7	7.2	
1-35	General Carneiro	7.4	0.0	0.0		1.4	10.8	
1-89	Ibema	7.2	0.0	0.7	0.6	0.1	1.6	0.6
1-31	Paulo Frontin	7.1	0.0	0.0	0.0	3.6	4.9	1.8
1-64	Quedas do Iguaçu	7.0	0.5	5.5	3.1	1.4	2.0	3.1
1-61	Rio Bonito do Iguaçu	6.8	0.0	0.9	0.4	0.4	2.2	0.4
1-21	Lapa	6.7	0.0	0.7	1.3	15.4	18.0	7.1
1-2	Quatro Barras	6.6	0.0	0.0		0.6	0.7	
1-40	Pinhao	6.5	0.0	29.6	45.4	3.0	29.6	45.4
1-34	Porto Vitória	6.2	0.0	0.0		0.6	1.9	
1-33	Uniao da Vitoria	6.2	0.0	0.0	0.0	2.1	4.8	0.3
1-13	Tijucas do Sul	5.8	0.0	0.0		0.4	3.6	
1-98	Medianeira	5.6		0.0	0.0		2.5	5.5
1-41	Palmas	5.1	0.0	1.5	12.9	1.4	12.5	12.9
1-34	Sao Joao do Triunfo	4.9	0.0	1.0	0.4	1.8	4.9	0.4
1-1	Campina Grande do Sul	4.6	0.0	0.0		0.2	0.4	
1-5	Cotombo	4.0	0.0	0.0		0.4	0.5	
1-39	Quarapuava	3.2	0.0	54.4	61.7	5.4	54.4	61.7
1-52	Mariópolis	2.9	0.0	2.1	5.6	0.6	2.1	5.6
1-23	Palmeira	2.8	0.0	2.1	3.6	0.3	2.1	3.0
1-97	Mateuslandia	2.2		0.0	0.6		1.3	1.5
1-96	Ceu Azul	0.8		0.1	0.1		0.9	1.1
	Total		1.3	131.6	192.3	177.3	580.8	319.1

Assumption: 50 % implementation of non tillage to beans, maize and soybean field by the year of 2015

where the current application is less than 50 %

Source: adopted and enlarged from EMATER (1994) for Current Non Tillage Area

Table-6.4 Soil Loss with Master Plan in 2015 (Iguazu River Basin)

No.	Municipality	2015				Area (km <sup>2</sup> )	Municipality	Area (km <sup>2</sup> )	2015				Pressure	Crop	Average
		Forest	2nd Veg.	Ref.	Pressure				Forest	2nd Veg.	Ref.	Pressure			
1-001	Campara Grande do Sul	79.2	3.2	1.3	1.6	2.1	1-052	292.1	0.3	2.9	3.4	0.3	1.6		
1-002	Quatro Barras	99.5	4.6	1.5	6.0	0.2	1-053	326.1	0.1	0.1	4.1	1.5	1.8		
1-003	Paraquero	171.9	0.2	4.7	11.4	0.6	2-81-054	434.7	0.3	7.1	4.0	0.7	3.4		
1-004	Sao Jose dos Pinhais	674.2	0.1	3.7	7.4	0.3	2-51-055	153.3	0.3	7.8	2.3	1.4	3.3		
1-005	Colombo	137.6	1.5	1.5	1.5	0.2	1-31-056	246.0	0.3	9.5	2.4	1.8	3.4		
1-006	Pinhais	96.2	0.3	0.3	1.6	0.3	0-81-057	345.6	0.3	10.1	24.2	1.7	9.6		
1-007	Almirante Tamandare	189.3	4.0	0.6	5.8	0.3	3-61-058	408.9	0.3	10.1	24.0	1.8	9.6		
1-008	Curitiba	431.7	0.6	3.8	1.9	0.3	0-81-059	158.5	0.3	10.1	26.3	1.8	10.4		
1-009	Campo Largo	297.2	3.8	1.6	13.1	1.9	3-71-060	147.8	0.3	7.8	20.6	0.9	7.4		
1-010	Atacama	503.7	1.7	1.5	1.5	0.4	0-91-061	459.3	0.2	0.8	7.0	1.4	0.8		
1-011	Fazenda Rio Grande	110.9	0.5	0.5	1.7	0.3	0-71-062	578.8	0.3	6.1	19.4	1.3	5.7		
1-012	Mandrituba	392.3	3.3	1.1	10.2	0.3	3-51-063	495.0	0.3	10.1	28.2	1.7	13.0		
1-013	Tijucas do Sul	422.6	0.2	3.1	4.0	0.2	2-31-064	1192.9	0.2	0.7	5.4	1.6	1.3		
1-014	Balsa Nova	319.7	2.2	1.1	2.0	0.3	1-71-065	385.1	0.3	10.1	14.1	1.2	6.8		
1-015	Conranda	232.2	3.3	3.3	4.2	0.3	1-91-066	96.6	0.3	9.1	11.4	2.0	5.7		
1-016	Quatanduiba	419.4	0.1	3.3	1.1	1.1	2-31-067	249.4	0.3	10.1	33.7	4.7	14.1		
1-017	Agudos do Sul	259.6	0.2	4.6	1.7	1.5	2-91-068	372.7	0.3	9.5	14.6	1.7	6.7		
1-018	Piren	261.7	0.1	3.3	1.1	1.1	1-81-069	234.7	0.3	9.5	31.8	3.1	13.5		
1-019	Rio Negro	603.2	4.3	1.7	12.4	0.3	2-91-070	696.7	0.3	9.5	7.3	1.6	4.6		
1-020	Campo do Tenente	314	4.7	1.9	5.5	0.4	2-71-071	449.9	0.3	9.5	4.0	0.5	3.9		
1-021	Lago	2203.9	0.2	3.8	1.9	0.5	2-11-072	94.7	0.3	1.0	3.5	0.7	1.1		
1-022	Porto Amazonas	153	1.5	0.2	5.1	0.4	2-21-073	386.3	0.3	9.5	31.8	2.6	12.7		
1-023	Paineira	273.4	2.5	0.9	2.0	0.3	1-61-074	506.4	0.3	9.5	12.0	1.5	8.9		
1-024	Sao Jose do Trunfo	708.1	0.1	2.6	0.3	0.3	1-41-075	313.8	0.3	9.2	22.9	1.5	9.2		
1-025	Antonio Olinto	482.5	0.3	2.7	0.3	0.4	1-51-076	297.1	0.3	8.6	10.5	2.1	5.9		
1-026	Sao Mateus do Sul	1352.8	0.1	1.5	0.9	0.4	0-91-077	107.6	0.3	7.8	9.1	1.5	7.2		
1-027	Robouca	498.9	0.1	4.0	0.9	0.3	2-01-078	307.9	0.3	9.2	5.6	1.8	5.0		
1-028	Itaipu	408.1	0.1	4.2	0.9	0.3	2-11-079	176.9	0.3	9.5	31.8	3.8	12.7		
1-029	Rio Azul	642.6	0.0	3.6	0.7	1.71-080	336.9	0.3	9.5	14.6	1.3	6.9			
1-030	Mallet	672.8	0.1	4.7	0.7	2.61-081	330.5	0.3	9.7	27.1	2.2	11.5			
1-031	Paulo Frontin	377.5	0.0	0.7	0.3	0.3	0-31-082	333.0	0.3	10.1	31.6	2.0	12.5		
1-032	Paula Freitas	417	0.0	0.8	0.3	0.3	0-61-083	337.1	0.3	9.7	24.4	1.9	10.3		
1-033	Uniao da Vitoria	775.9	0.1	5.7	0.3	2-51-084	337.1	0.0	9.7	32.2	3.0	13.6			
1-034	Porto Vitoria	229.2	0.3	6.9	2.9	0.3	3-81-085	351.9	0.3	9.7	29.4	2.2	11.3		
1-035	General Carneiro	1063.7	0.3	5.0	2.6	0.3	2-01-086	403.9	0.3	9.7	32.2	3.0	13.2		
1-036	Baturuxa	1209.7	0.2	5.1	0.3	2.11-087	521.7	0.3	10.1	3.4	3.3	0.8	3.6		
1-037	Cruz Machado	1500.5	0.2	5.9	2.3	0.3	2-11-088	593.9	0.3	2.2	10.4	1.8	3.7		
1-038	Inacio Martins	879.9	0.3	1.4	2.6	0.3	0-81-089	148.3	0.3	8.0	3.4	1.6	6.1		
1-039	Quapuruva	3402.7	0.3	7.4	4.7	0.3	2-41-090	1198.9	0.3	7.1	2.8	1.7	3.4		
1-040	Pinhao	2872.2	0.3	4.2	2.5	0.2	1-81-091	235.2	0.3	10.0	11.5	1.3	5.6		
1-041	Palmas	3125.5	0.3	7.7	4.3	0.7	3-61-092	279.8	0.3	9.7	32.2	3.0	13.1		
1-042	Clevelândia	708.4	0.3	3.9	2.8	0.7	2-01-093	137.1	0.3	10.1	10.8	1.7	4.8		
1-043	Honorio-Serpe	806.3	0.3	8.0	9.6	1.8	5-41-094	273.2	0.3	10.1	3.4	1.4	8.6		
1-044	Magnesianha	991.3	0.2	7.8	14.3	0.8	5-11-095	235.5	0.3	10.1	10.8	1.7	4.8		
1-045	Canobá	809.8	0.3	7.8	24.6	1.0	7-81-096	937.2	0.2	2.2	7.4	1.3	0.6		
1-046	Cantagalo	774.1	0.3	3.5	18.5	2.0	6-11-097	601.4	0.3	2.3	6.7	1.1	1.7		
1-047	Viramound	198.4	0.1	3.7	26.1	1.0	8-11-098	621.1	0.2	2.4	6.7	1.3	1.9		
1-048	Laranjeiras do Sul	1052.7	0.1	5.4	20.2	1.5	7-31-099	453.7	0.3	8.2	9.6	1.5	4.5		
1-049	Chopininho	992.5	0.1	7.4	0.7	1.2	7-51-100	162.1	0.0	0.7	3.9	2.1	2.3		
1-050	Coronel Vivida	681.5	0.3	9.9	15.2	2.0	7-71-101	312.2	0.1	3.1	8.6	2.4	4.0		
1-051	Pato Branco	570.2	0.3	3.7	4.1	0.8	Total	55776.0	0.1	3.1	8.6	2.4	4.0		

Area = 1 Local Area of Municipality - Area of Others in Landuse Classification and Veg. Secondary Vegetation, Ref.: Reforestation

### 6.1.2 Implementation Schedule

As current soil loss from the most of crop land in Iguacu river basin exceeds the threshold, 11 ton/ha-year, the implementation of soil conservation is urgently required. Thus, 100 % implementation of terracing should be achieved by the year of 2005. Since the total crop area which is not conserved currently is estimated 1,078 thousand ha, the implementation rate would be 110 thousand ha per year if implemented evenly in the next ten years.

The priority of location where terracing will be implemented depends on the magnitude of the current soil loss. The larger the soil loss is, the higher the priority is. In table-6.5, the priority of municipality is shown with the area to be terraced.

Although the farm roads is not counted in the estimation of current and future soil loss, the effect of farm roads on sediment yield is very large. Since farm roads in Paraná are left unpaved, bare soil surface, and water cannot infiltrate into soil profile due to compacted surface, farm roads generate the excess runoff during the rain. Therefore their improvement is essential to reduce sediment yield for the water environment at downstream.

Based on the information regarding micro river basins (Appendix-5), the average length of farm roads was roughly estimated as 0.02 km/ha. Assuming that farm roads in the currently conserved area have been already improved, the improvement of farm roads is assumed to be implemented with terracing.

50 % implementation of non tillage is expected to be achieved by the year of 2015. Non tillage is currently practiced in 325 thousand ha of beans, maize and soybean field. With the Master plan, it would increase evenly in the next twenty years to 1,077 thousand ha.

The selection of other soil conservation measures, such as agronomic measures and soil management, is involved in the detail study at field to identify the local characteristics of agriculture. Since this study does not consider their selection site by site, the implementation of these measures is assumed to be continuous in the next twenty years.

### 6.1.3 Cost

Main soil conservation measures which should be considered for the cost estimation are terracing, improvement of farm roads and non tillage. The costs of other measures are considered as small compared to ones of main measures. For the computation sake, the assumptions made are: 1) Cost of terracing is 40 US\$/ha., 2) Cost of improvement of farm roads is 1,500 US\$/km and average length of farm roads per ha is 0.02 km., 3) Maintenance costs of terraces and farm roads are 3 % of their construction costs., 4) The difference between machinery costs for non tillage and for traditional tillage is 4,000 US\$. Thus, 4,000 US\$ is the cost for application of non tillage and its maintenance cost is negligible., 5) Machinery for non-tillage lasts ten years., 6) One machinery for non tillage covers 200 ha., 7) The cost for herbicide for non tillage is not considered.

The result of cost estimation is shown in Table-6.6 with the implementation schedule. The total cost would be 144 million US\$.





Table-6.6 Cost and Implementation Schedule of Soil Conservation (Iguaçu River Basin)

Soil Conservation Measures	Amount to be covered	Cost (million US\$)	1990s		2000s																	
			96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Terrace for crop Land	10,781 km <sup>2</sup>	43.1																				
Improvement of Farm Road	21,560 km <sup>2</sup>	32.3																				
Maintenance of Terrace and Farm Road	—	33.0																				
Non Tillage	7,520 km <sup>2</sup>	35.5																				
Agronomic Measures	30,700 km <sup>2</sup>	not estimated																				
Soil Management	30,700 km <sup>2</sup>	not estimated																				
5 Year Progress Rate		143.9			31%			38%						13%							18%	

Since the determination of agronomic measures and soil management involves the detail study, it was not estimated

#### 6.1.4 Benefit

Paraná Rural Program (SEAB, 1989) has estimated nutrient loss compensated by fertilizers assuming the average soil loss of 20 ton/ha-year and enrichment ratio of 1.0. Consequently, the fertilizer applications of nitrogen and potassium are 20 kg/ha and 2.3 kg/ha, respectively. The cost of fertilizer is approximately 200 US\$/ton for calcium nitrate and 220 US\$/ton for potassium chloride.

The reduction of fertilizer application with the Master plan is considered as one of benefits. Assuming that terraces and farm roads last 30 years with the proper maintenance, above rate of nutrient loss and cost of fertilizer were applied to estimate the benefit by the year of 2025.

Table-6.7 shows the computation for saved money for fertilizer application. For example, the current soil loss from crop land in Santa Lucia is 137.3 ton/ha-year. Therefore, the current application rates of nitrogen and potassium are;

$$137.3 / 20 \times 20 \text{ kg/ha} = 137.3 \text{ kg/ha for nitrogen}$$

$$137.3 / 20 \times 2.3 \text{ kg/ha} = 15.8 \text{ kg/ha for potassium}$$

Since area to be terraced in Santa Lucia is 4.6 thousand ha, the cost of fertilizer application if the Master plan is not applied will be;

$$137.3 \text{ kg/ha} / 1000 \times 4600 \text{ ha} \times 200 \text{ US$/ton} = 126,000 \text{ US$ for nitrogen}$$

$$15.8 \text{ kg/ha} / 1000 \times 4600 \text{ ha} \times 220 \text{ US$/ton} = 16,000 \text{ US$ for potassium}$$

Future soil loss with the Master plan is 4 ton/ha-year. The fertilizer application at this rate was computed by the same way. The difference of fertilizer costs between current and future soil loss is considered as benefit. Annual benefit was computed in accordance with the priority of municipality for Master plan, Table-6.5.

The result shows in table-6.8. The total cost would be 188 million US\$, while the benefit would be 272.5 million US\$. Although other benefits, such as the increase in crop productivity, reduction of suspended sediment and so on, are not counted, there is a large benefit with the implementation of the soil conservation. The result shows that the soil conservation measures proposed (Master plan) are worth to be implemented in terms of cost and benefit evaluation.



Table-6.8 Cost and Benefit with Master Plan ( Iguacu River Basin)

The case that the terrace will last 30 years.

Soil Conservation Measures	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2025 Total
Terrace for Crop Land 40 US\$/ha	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	3.52			43.12
Improvement of Farm Road 1500 US\$/km	3.30	3.30	3.30	3.30	3.30	3.30	2.30	3.30	3.30	2.60			32.30
Maintenance Cost for terrace and farm road 3 %		0.23	0.46	0.69	0.92	1.16	1.39	1.62	1.85	2.08	2.26	2.26	55.60
Difference between the machinery cost of non-tillage and regular tillage 4000 US\$/machinery	14	(1996-2005), 21.5	(2006-2015), 21.5	(2016-2025)									57.00
Benefit born from Fertilizer Application		2.83	4.61	6.29	7.41	8.09	8.67	9.17	9.73	10.09	10.23	10.23	10.23
													84.47

Benefit by the year of 2025

## 6.2 Tibagi River Basin

### 6.2.1 Master Plan and Its Effect

Considering the agricultural characteristics in Tibagi river basin, the soil conservation plan was formulated as a Master plan shown in Table-6.9. Countermeasures to suppress soil erosion are classified as essential and ideal. Since countermeasures proposed are general, their application at field involves the detail examination of the local characteristics of agriculture in order to select the appropriate countermeasures.

Among dominant crops in Tibagi river basin, soybean and maize are currently cultivated 44.5 % and 39.3 % of the total crop area, respectively (refer to Appendix-3). The implementation of soil conservation for soybean is very high, more than 80 % of its area in the most of cases. One for maize vary from 100 % to 5 % of its area depending on the location; however, it is generally well conserved. Compared to Iguaçu river basin, soil conservation is well practiced in Tibagi river basin resulting in the lower current soil loss.

With assumptions mentioned before, the effectiveness of the Master plan was examined with the application of USLE in terms of implementation of terracing and non tillage. As shown in Table-6.10, terrace is currently implemented 666 thousand ha of crop land in Tibagi river basin and 334 thousand ha of crop land remains without soil conservation. To achieve the goal, this remained area has to be terraced.

As shown in Appendix-3, the productivity of beans, maize, soybean and wheat tends to increase with non tillage. Therefore, non tillage is effective not only in suppression of soil erosion but also improvement of crop productivity. The resent researches show that disadvantages of non tillage, such as higher herbicide costs and more complex weed control, can be overcame soon. Considering these favorable conditions, 50 % implementation of non tillage to applicable crop land is realistic.

Appendix-3 shows that non tillage is currently applied to 7.3 % of beans area, 23.1 % of maize area, 41.1 % of soybean area and 37.3 % of wheat area. Since in Paraná wheat is usually a second crop after soybean or maize, wheat was excluded from the area computation of non tillage for the future soil estimation and considered to be included in the area of either soybean or maize. As shown in Table-6.11, the area of non tillage application for beans, maize and soybean will expand to 42 , 205 and 286 thousand ha respectively by the year of 2015.

The result of future soil loss estimation with assumptions is shown in Table-6.12 (refer to Appendix-4 for the details of computation). The average soil loss in Iguaçu river basin would be reduced to 2.4 ton/ha-year with the Master plan. Since no other measures than terracing and non tillage are counted in the estimation, the result is underestimation. If the Master plan was implemented fully, less soil loss than Table-6.12 would be expected.

Current soil loss from crop land ranges from 128 ton/ha-year to 0.1 ton/ha-year, while future soil loss from crop land would be at range between 4.7 ton/ha-year and 0.1 ton/ha-year. This great reduction of soil loss would contribute to the improvement of water environment. Much less soil loss results in the low water contamination by sediment and agrototoxic stuck to soil particles.

Table-6.9 Soil Conservation Plan (Master Plan) in Tibagi River Basin

Crop	ML	Essential			Ideal		
		TY	Measures	Effect	TY	Measures	Effect
all crop field and Pasture	—	M	improvement of farm road	2	M	diversion ditches	2
		M	drainage along road side	2	M	terrace channels	2
		A	proper spacing of crops	1 & 2	M	grass water ways	2
		A	proper crop calendar	1 & 2	M	energy dissipater at outlet of drainage	2
		S	maintenance of soil fertility	1 & 2			
		A	proper plant selection	1 & 2			
Soybean Wheat Maize Beans	I	M	terracing with contour cropping	2	M	contour stripcropping	2
		M	buffer stripcropping	2	A	non tillage	1 & 2
		S	avoid excess operation of machinery	2			
		S	subsoiling to stir hard pan of soil	2			
		S	proper plowing or harrowing	2			
		A	mulching by crop residue	1 & 2			
A	seeding of winter green manure crops	1 & 2					
Maize Beans	II	M	terracing with contour cropping	2	A	non tillage with animal	1 & 2
		M	buffer strips with stones	2			
		M	buffer stripcropping	2			
		A	mulching by crop residue	1 & 2			
		A	seeding of winter green manure crops	1 & 2			
		M	contour stripcropping	2			
		A	intercropping with green manure crops	1 & 2			
M	stripcropping with spring & summer crop	1					
Potato	I	M	terracing with contour cropping	2			
		S	proper plowing or harrowing	1			
		S	avoid excess operation of machinery	2			
		S	seeding of winter green manure crops	1 & 2			
Cotton Sugarcane Cassava	I	M	terracing with contour cropping	2	M	contour stripcropping	2
		M	buffer stripcropping	2			
		S	avoid excess operation of machinery	2			
		S	subsoiling to stir hard pan of soil	2			
		S	proper plowing or harrowing	2			
		S	seeding of winter green manure crops	1 & 2			
Cotton Sugarcane Cassava	II	M	terracing with contour cropping	2	M	contour stripcropping	2
		M	buffer strips with stones	2			
		M	buffer stripcropping	2			
		A	seeding of winter green manure crops	1 & 2			
Coffee	I	M	terracing with contour cropping	2	A	intensive planting	1 & 2
		M	contour bunds	2			
		A	intercropping with green manure crops	1 & 2			
Pasture	I & II	M	terracing	2	A	crop rotation	1
		M	water supply system for cattle	1 & 2	A	perennial forage	2

Abbreviation: ML: Management Level, I: Mechanized Farming System, II: Farming System with Man or Animal Power  
 TY: Type of Measures, M: Mechanical Measures, A: Agronomic Measures, S: Soil Management  
 1: Effect on Rainsplash, 2: Runoff

Table-6.10 Area of Terrace to be Implemented (Tibagi River Basin)

No	Municipality	Crop Area in 1994 (ha)	Terraced cropland fraction	Current Area of Terrace in 1994 (1000ha)	Area of Terrace to be Implemented (1000ha)
T-22	Apucarana	7,500	0.471	3.5	4.0
T-23	Arapongas	9,400	0.817	7.7	1.7
T-31	Assai	36,300	0.570	20.7	15.6
T-21	California	2,500	0.228	0.6	1.9
T-38	Cambe	9,300	0.829	7.7	1.6
T-8	Castro	73,900	0.900	66.5	7.4
T-28	Congonhinhas	8,000	0.840	6.7	1.3
T-33	Cornelio Procopio	16,600	0.435	7.2	9.4
T-16	Curiuva	12,700	0.631	8.0	4.7
T-36	Ibipora	18,600	0.909	16.9	1.7
T-5	Imbituva	23,700	0.569	13.5	10.2
T-6	Ipiranga	31,100	0.523	16.3	14.8
T-4	Irati	7,600	0.343	2.6	5.0
T-9	Ivaí	7,700	0.272	2.1	5.6
T-35	Jataizinho	10,800	0.649	7.0	3.8
T-41	Leópolis	5,600	0.964	5.4	0.2
T-24	Londrina	77,300	0.659	66.4	10.9
T-20	Marilândia do Sul	6,600	0.655	4.3	2.3
T-19	Maua da Serra	1,100	1.000	1.1	0.0
T-32	Nova America da Colina	8,900	0.680	6.1	2.8
T-29	Nova Fatima	5,000	0.721	3.6	1.4
T-25	Nova Santa Barbara	10,100	0.762	7.7	2.4
T-15	Ortigueira	65,600	0.245	16.1	49.5
T-2	Palmeira	55,300	0.761	42.1	13.2
T-12	Piraí do Sul	22,000	0.685	15.1	6.9
T-7	Ponta Grossa	82,600	0.736	60.8	21.8
T-1	Porto Amazonas	2,000	0.043	0.1	1.9
T-43	Primeiro de Maio	9,600	0.990	9.5	0.1
T-40	Rancho Alegre	15,100	1.000	15.1	0.0
T-10	Reserva	24,600	0.271	6.7	17.9
T-37	Rolandia	3,700	0.866	3.2	0.5
T-26	Santa Cecilia do Pavao	6,900	0.769	5.3	1.6
T-27	Santo Antonio do Paraíso	10,900	0.901	9.8	1.1
T-18	Sao Jeronimo da Serra	60,100	0.312	18.7	41.4
T-30	Sao Sebastiao da Amoreira	16,100	0.927	14.9	1.2
T-17	Sapopema	22,000	0.214	4.7	17.3
T-42	Sertaneja	15,300	0.985	15.1	0.2
T-39	Sertanópolis	29,600	0.925	27.4	2.2
T-3	Teixeira Soares	40,800	0.661	27.0	13.8
T-14	Telemaco Borba	9,800	0.455	4.5	5.3
T-11	Tibagi	85,700	0.743	63.7	22.0
T-34	Uraí	18,100	0.831	15.0	3.1
T-13	Ventania	14,400	0.670	9.7	4.7
	Total=	1,000,500		666.1	334.4

Table-6.11 Current and Future Area of Non Tillage Application (Tibagi River Basin)

BACIA	Municipality	Soil Loss	Current			2015		
			Beans (1000 ha)	Maize (1000 ha)	Soybean (1000 ha)	Beans (1000 ha)	Maize (1000 ha)	Soybean (1000 ha)
F-18	Sao Jeronimo da Serra	928	0.0	0.0	0.0	1.2	11.8	3.9
F-17	Sopopema	51.7	0.0	0.0	0.0	2.4	8.3	0.0
F-35	Jataizinho	34.2	0.0	0.4	0.3	0.0	2.2	3.0
F-26	Santa Cecilia do Pavao	32.1	0.0	0.0	0.3	0.1	1.1	2.3
F-29	Nova Fatima	29.6	0.0	0.3	0.4	0.1	0.6	1.4
F-31	Assai	28.2	0.0	0.0	0.0	0.2	4.5	12.2
F-33	Cornelio Procopio	25.6	0.0	0.1	0.0	0.0	0.9	5.7
F-34	Urai	25.0	0.0	0.0	0.0	0.0	2.5	5.5
F-15	Ortigueira	24.1	0.0	0.9	0.4	7.2	23.3	1.3
F-1	Porto Amazonas	23.4	0.0	0.0	0.4	0.2	0.6	0.4
F-41	Leopolis	16.4	0.0	0.0	0.2	0.0	1.0	1.7
F-22	Apucarana	15.5	0.0	0.7	0.3	0.1	1.8	1.1
F-32	Nova America da Colina	15.4	0.0	0.0	0.0	0.2	0.6	1.5
F-25	Nova Santa Barbara	14.1	0.0	0.3	0.7	0.0	0.8	2.3
F-10	Reserva	11.8	0.0	0.0	0.0	4.6	7.5	0.3
F-4	Iraí	11.4	0.0	0.0	0.0	1.8	2.0	0.1
F-16	Curuva	10.1	0.0	0.0	0.0	1.8	3.6	0.0
F-9	Ivaí	8.6	0.0	0.5	0.3	1.6	2.1	0.3
F-21	California	8.3	0.0	0.0	0.0	0.2	1.0	0.0
F-28	Congoninhas	7.9	0.0	0.0	0.0	0.1	1.2	1.6
F-36	Ibipora	6.8	0.0	0.0	0.0	0.0	0.2	8.3
F-27	Santo Antonio do Paraíso	6.8	0.0	0.0	0.5	0.0	1.2	4.2
F-19	Maua da Serra	6.6	0.0	0.0	0.0	0.0	0.3	0.3
F-23	Arapongas	5.7	0.0	0.2	0.8	0.1	1.3	2.8
F-39	Sertanópolis	5.7	0.0	0.0	0.0	0.0	1.1	13.3
F-38	Cambe	5.3	0.0	0.6	1.3	0.0	1.0	3.2
F-24	Londrina	4.7	0.0	3.6	6.4	0.8	13.9	20.1
F-12	Piraí do Sul	4.7	0.0	3.6	5.6	1.3	6.0	5.6
F-6	Spiranga	4.6	0.0	7.1	4.9	1.1	11.1	4.9
F-20	Marilandia do Sul	4.2	0.0	2.3	2.4	0.2	2.3	2.4
F-37	Rolândia	4.1	0.0	0.2	0.8	0.0	0.4	1.0
F-2	Palmeira	3.7	0.0	11.6	16.1	1.4	11.5	16.1
F-3	Faxeira Soares	3.4	4.1	7.7	11.1	4.9	8.2	11.1
F-13	Ventania	3.4	0.0	0.4	7.5	0.3	2.6	7.5
F-30	Sao Sebastiao da Amoreira	3.3	0.0	0.2	0.6	0.0	0.8	3.5
F-5	Imbituva	2.9	0.1	2.4	4.3	2.9	5.7	4.3
F-7	Ponta Grossa	2.9	0.3	13.4	27.5	2.9	18.2	27.5
F-11	Fibagi	2.9	0.9	14.8	51.2	1.9	14.8	51.2
F-43	Primeiro de Maio	2.7	0.0	0.0	0.0	0.0	0.5	4.3
F-40	Rancho Alegre	2.4	0.0	0.0	0.0	0.0	1.3	6.2
F-8	Castro	2.2	0.6	19.7	36.8	2.2	19.7	36.8
F-42	Sertaneja	1.9	0.0	0.0	1.7	0.0	1.6	6.1
F-14	Telemaco Borba	1.8	0.0	0.0	0.0	0.6	3.9	0.2
	Total		6.0	91.0	182.8	41.8	205.1	265.9

Assumption: 50 % implementation of non tillage to beans, maize and soybean field by the year of 2015

where the current application is less than 50 %

Source: adopted and enlarged from EMATER (1994) for Current Non Tillage Area



Table-6.12 Soil Loss with Master Plan in 2015 (Tibagi River Basin)

Unit: ton/ha\*year

No.	Municipality	Area (km <sup>2</sup> )	2015					Average
			Forest	2nd Veg.	Ref.	Pasture	Crop	
T-001	Porto Amazonas	53.8		3.1		11.4	0.9	6.6
T-002	Palmeira	1227.4	0.2	3.1	1.0	2.7	0.6	1.8
T-003	Teixeira Soares	1303.5	0.0	0.7	0.2	2.3	0.7	0.6
T-004	Irati	139.6	0.2	4.8	1.7		0.3	2.1
T-005	Imbituva	811.3	0.2	1.5	0.5	2.4	0.3	0.9
T-006	Ipiranga	932	0.1	1.1	1.5	2.3	0.5	1.0
T-007	Ponta Grossa	1870.8	0.2	1.5	1.1	2.1	0.4	1.2
T-008	Castro	2278.4	0.2	3.9	1.7	1.9	0.3	2.0
T-009	Ivai	212.2	0.2	3.2		2.4	0.3	2.0
T-010	Reserva	555.9	0.1	6.1	1.4	4.1	0.4	2.5
T-011	Tibagi	2926.6	0.2	3.1	2.0	4.3	0.2	2.3
T-012	Pirai do Sul	965.2	0.2	4.3	2.1	2.4	0.7	2.5
T-013	Ventania	380.1	0.2	4.5	2.0	4.5	0.2	2.3
T-014	Telemaco Borba	1625.3		3.1	0.5	10.3	0.3	0.9
T-015	Ortigueira	1588.5	0.2	5.3	1.8	16.3	0.7	5.0
T-016	Curiuva	361.8	0.1	0.8	0.3	3.6	0.9	1.2
T-017	Sapopema	531.9	0.2	5.3		17.5	1.8	5.7
T-018	Sao Jeronimo da Serra	851.3	0.2	5.5		7.9	3.4	4.4
T-019	Maua da Serra	48	0.2	6.9		15.9	0.1	6.6
T-020	Marilandia do Sul	152.2	0.3	4.0		9.4	0.3	2.3
T-021	California	97.2	0.3	2.5		6.1	0.4	1.5
T-022	Apucarana	182.2	0.2	4.1		7.8	1.0	2.2
T-023	Arapongas	191.9	0.1	2.3		7.8	0.9	1.5
T-024	Londrina	2095.6	0.2	4.1		5.8	0.7	2.8
T-025	Nova Santa Barbara	112.2		2.5		8.0	1.2	1.6
T-026	Santa Cecilia do Pavao	68.5					2.0	2.0
T-027	Santo Antonio do Paraiso	151.9	0.2	6.0		7.6	0.9	2.7
T-028	Congonhinhas	104.6		5.6		7.4	0.8	2.3
T-029	Nova Fatima	83.5		6.6		22.0	2.4	8.9
T-030	Sao Sebastiao da Amoreira	217.4	0.2	2.0		5.1	0.7	1.5
T-031	Assai	450.5	0.3	7.8		9.4	0.9	2.2
T-032	Nova America da Colina	133.3		7.0		21.6	0.7	6.5
T-033	Cornelio Procopio	336.7	0.2	6.6		17.8	0.8	7.4
T-034	Urai	209.6	0.3	7.8		26.0	2.3	5.2
T-035	Jataizinho	199.1	0.3	7.8		26.0	1.6	11.2
T-036	Ibipora	295.4		6.2		5.7	1.1	2.8
T-037	Rolandia	57.4		1.5			0.9	1.1
T-038	Cambe	143.5	0.0	1.8			0.7	1.1
T-039	Sertanopolis	478.9	0.3	5.8		5.5	1.0	2.6
T-040	Rancho Alegre	187.4		7.5			1.3	1.3
T-041	Leopolis	68.9	0.3	7.8		26.0	4.7	7.3
T-042	Sertaneja	226.7	0.1	1.7			0.9	0.9
T-043	Primeiro de Maio	142.8		4.7			1.0	1.7
	Total	25051					Average	2.4

Area = Total Area of Municipality - Area of Others in Landuse Classification

2nd Veg.: Secondary Vegetation, Ref.: Reforestation

### 6.2.2 Implementation Schedule

Crop land where the current soil loss exceeds the threshold, 11 ton/ha-year, requires the urgent implementation of soil conservation. Thus, 100 % implementation of terracing should be achieved by the year of 2005. Since the total crop area which is not conserved currently is estimated 330 thousand ha, the implementation rate would be 40 thousand ha per year if implemented evenly in the next ten years.

The priority of location where terracing will be implemented depends on the magnitude of the current soil loss. The larger the soil loss is, the higher the priority is. In table-6.13, the priority of municipality is shown with the area to be terraced.

Although the farm roads is not counted in the estimation of current and future soil loss, the effect of farm roads on sediment yield is very large. Since farm roads in Paraná are left unpaved, bare soil surface, and water cannot infiltrate into soil profile due to compacted surface, farm roads generate the excess runoff during the rain. Therefore their improvement is essential to reduce sediment yield for the water environment at downstream.

Based on the information regarding micro river basins (Appendix-5), the average length of farm roads was roughly estimated as 0.02 km/ha. Assuming that farm roads in the currently conserved area have been already improved, the improvement of farm roads is assumed to be implemented with terracing.

50 % implementation of non tillage is expected to be achieved by the year of 2015. Non tillage is currently practiced in 280 thousand ha of beans, maize and soybean field. With the Master plan, it would increase evenly in the next twenty years to 532 thousand ha.

The selection of other soil conservation measures, such as agronomic measures and soil management, is involved in the detail study at field to identify the local characteristics of agriculture. Since this study does not consider their selection site by site, the implementation of these measures is assumed to be continuous in the next twenty years.

### 6.2.3 Cost

Main soil conservation measures which should be considered for the cost estimation are terracing, improvement of farm roads and non tillage. The costs of other measures are considered as small compared to ones of main measures. For the computation sake, the assumptions made are: 1) Cost of terracing is 40 US\$/ha., 2) Cost of improvement of farm roads is 1,500 US\$/km and average length of farm roads per ha is 0.02 km., 3) Maintenance costs of terraces and farm roads are 3 % of their construction costs., 4) The difference between machinery costs for non tillage and for traditional tillage is 4,000 US\$. Thus, 4,000 US\$ is the cost for application of non tillage and its maintenance cost is negligible., 5) Machinery for non-tillage lasts ten years., 6) One machinery for non tillage covers 200 ha., 7) The cost for herbicide for non tillage is not considered.

The result of cost estimation is shown in Table-6.14 with the implementation schedule. The total cost would be 53 million US\$.

Table-6.13 Priority of Municipality for Terracing (Tibagi River Basin)

No	Municipality	Soil Loss from Municipality (ton/ha year)	Area to be Terraced	Terrace (1,000 ha)												
				1996	1997	1998	1999	2000	2001	2002	2003	2004				
T-18	Sao Jerônimo da Serra	92.8	41.4	40.00	1.40											
T-17	Sapopema	51.7	17.3		17.30											
T-35	Jataizinho	34.2	3.8		3.80											
T-26	Santa Cecília do Pavao	32.1	1.6		1.60											
T-29	Nova Fatima	29.8	1.4		1.40											
T-31	Assai	28.2	15.6		14.50	1.10										
T-33	Corneio Procopio	25.8	9.4			9.40										
T-34	Ural	25.0	3.1			3.10										
T-15	Ortiguela	24.1	49.5			26.40	23.10									
T-1	Porto Amazonas	23.4	1.9				1.90									
T-41	Leopolis	16.4	0.2				0.20									
T-22	Apucarana	15.5	4.0				4.00									
T-32	Nova America da Colina	15.4	2.8				2.80									
T-25	Nova Santa Barbara	14.1	2.4				2.40									
T-10	Reserva	11.8	17.9				5.60	12.30								
T-4	Irati	11.4	5.0					5.00								
T-16	Curiuva	10.1	4.7					4.70								
T-9	Ivai	8.6	5.6					5.60								
T-21	California	8.3	1.9					1.90								
T-28	Congonhinhas	7.9	1.3					1.30								
T-36	Ibipora	6.8	1.7					1.70								
T-27	Santo Antonio do Paraiso	6.8	1.1					1.10								
T-19	Maua da Serra	6.6														
T-23	Arapongas	5.7	1.7					1.70								
T-39	Sertanópolis	5.7	2.2					2.2								
T-38	Cambe	5.3	1.8					1.8								
T-24	Londrina	4.7	10.9					0.9	10.00							
T-12	Piraí do Sul	4.7	6.9						6.90							
T-6	Ipiranga	4.6	14.8						14.80							
T-20	Marilândia do Sul	4.2	2.3						2.30							
T-37	Rolândia	4.1	0.5						0.50							
T-2	Palmeira	3.7	13.2						5.50	7.70						
T-3	Teixeira Soares	3.4	13.8							13.80						
T-13	Ventania	3.4	4.7							4.70						
T-30	Sao Sebastião da Amoreira	3.3	1.2							1.20						
T-5	Imbituva	2.9	10.2							10.20						
T-7	Ponta Grossa	2.9	21.8							2.40	19.40					
T-11	Tibagi	2.9	22.0								20.60	1.40				
T-43	Primeiro de Maio	2.7	0.1									0.10				
T-40	Rancho Alegre	2.4														
T-8	Castro	2.2	7.4												7.40	
T-42	Sertaneja	1.9	0.2												0.20	
T-14	Telemaco Borba	1.8	5.3												5.30	
	Total=		334.4	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	14.40	

Table-6.14 Cost and Implementation Schedule of Soil Conservation (Tibagi River Basin)

Soil Conservation Measures	Amount to be covered	Cost (million US\$)	1990s		2000s																						
			96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15					
Terrace for crop Land	3,344 km <sup>2</sup>	13.4																									
Improvement of Farm Road	6,690 km	10.0																									
Maintenance of Terrace and Farm Road	—	10.7																									
Non Tillage	2,530 km <sup>2</sup>	18.7																									
Agronomic Measures	14,300 km <sup>2</sup>	not estimated																									
Soil Management	14,300 km <sup>2</sup>	not estimated																									
5 Year Progress Rate		52.8	30%			36%			12%			22%															

Since the determination of agronomic measures and soil management involves the detail study, it was not estimated.

### 6.2.4 Benefit

The reduction of fertilizer application with the Master plan is considered as one of benefits. Assuming that terraces and farm roads last 30 years with the proper maintenance, the benefit by the year of 2025 was estimated in the same manner as Iguazu river basin.

Table-6.15 shows the computation for saved money for fertilizer application. The difference of fertilizer costs between current and future soil loss is considered as benefit. Annual benefit was computed in accordance with the priority of municipality for Master plan, Table-6.13.

The result shows in Table-6.16. The total cost would be 70.4 million US\$, while the benefit would be 76.6 million US\$. Although other benefits, such as the increase in crop productivity, reduction of suspended sediment and so on, are not counted, there is a benefit with the implementation of the soil conservation. The result shows that the soil conservation measures proposed (Master plan) are worth to be implemented.

### Literature Cited

1. SEAB. (1989). Program de Desenvolvimento Rural do Paraná. (Paraná rural development program). Curitiba.

Table-6.15 Saved Money for Fertilizer Application (Tibagi River Basin)

Unit of Soil Loss: ton/ha year

No.	Municipality	Area to be terraced (1000ha)	Soil Loss from Crop Land (1994)	N application cost (10000US\$)	K application cost (10000US\$)	Soil Loss after Terracing	N application cost (10000US\$)	K application cost (10000US\$)	N Benefit (10000US\$)	K Benefit (10000US\$)	Total (10000US\$)
T-18	Sao Jeronimo da Serra	41.4	128.0	106.0	13.4	3.4	2.8	0.4	103.2	13.0	116.2
T-17	Sapopema	17.3	113.1	39.1	5.0	1.8	0.6	0.1	38.5	4.9	43.4
T-35	Jataizinho	3.8	41.4	3.1	0.4	1.6	0.1	0.0	3.0	0.4	3.4
T-26	Santa Cecilia do Pavao	1.6	32.1	1.0	0.1	2.0	0.1	0.0	0.9	0.1	1.0
T-29	Nova Fatima	1.4	37.1	1.0	0.1	2.4	0.1	0.0	0.9	0.1	1.0
T-31	Assai	15.6	32.2	19.0	1.3	0.9	0.3	0.0	9.7	1.3	11.0
T-33	Comerio Procopio	9.4	37.3	7.0	0.9	0.8	0.2	0.0	6.8	0.9	7.7
T-34	Urai	3.1	25.2	1.6	0.2	2.3	0.1	0.0	1.5	0.2	1.7
T-15	Ortigueira	49.5	46.9	46.4	5.9	0.7	0.7	0.1	45.7	5.8	51.5
T-1	Povo Amazonas	1.9	45.9	1.7	0.2	0.9	0.0	0.0	1.7	0.2	1.9
T-41	Leopoldo	0.2	16.0	0.1	0.0	4.7	0.0	0.0	0.1	0.0	0.1
T-22	Apucarana	4.0	33.6	2.7	0.3	1.0	0.1	0.0	2.6	0.3	2.9
T-32	Nova America da Colina	2.8	14.1	0.8	0.1	0.7	0.0	0.0	0.8	0.1	0.9
T-25	Nova Santa Barbara	2.4	15.2	0.7	0.1	1.2	0.1	0.0	0.6	0.1	0.7
T-10	Reserva	17.9	21.5	7.7	1.0	0.4	0.1	0.0	7.6	1.0	8.6
T-4	Itai	5.0	16.6	1.7	0.2	0.3	0.0	0.0	1.7	0.2	1.9
T-16	Curuva	4.7	28.4	2.5	0.3	0.9	0.1	0.0	2.4	0.3	2.7
T-9	Ivai	5.6	18.7	2.1	0.3	0.3	0.0	0.0	2.1	0.3	2.4
T-21	California	1.9	27.3	1.0	0.1	0.4	0.0	0.0	1.0	0.1	1.1
T-28	Congonhinhas	1.3	8.2	0.2	0.0	0.8	0.0	0.0	0.2	0.0	0.2
T-36	Ibipora	1.7	7.1	0.2	0.0	1.1	0.0	0.0	0.2	0.0	0.2
T-27	Santo Antonio do Paraiso	1.1	6.7	0.1	0.0	0.9	0.0	0.0	0.1	0.0	0.1
T-19	Mou da Serra	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1
T-23	Arapongas	1.7	9.5	0.3	0.0	0.9	0.0	0.0	0.3	0.0	0.3
T-39	Sartanopolis	2.2	5.7	0.3	0.0	1.0	0.0	0.0	0.3	0.0	0.3
T-38	Cambe	1.6	7.1	0.2	0.0	0.7	0.0	0.0	0.2	0.0	0.2
T-24	Londrina	10.9	5.7	1.2	0.2	0.7	0.2	0.0	1.0	0.2	1.2
T-12	Piral do Sul	8.9	10.0	1.4	0.2	0.7	0.1	0.0	1.3	0.2	1.5
T-6	Ipiranga	14.8	11.3	3.3	0.4	0.5	0.1	0.0	3.2	0.4	3.6
T-20	Mariania do Sul	2.3	4.5	0.2	0.0	0.3	0.0	0.0	0.2	0.0	0.2
T-37	Rolandia	0.5	5.5	0.1	0.0	0.9	0.0	0.0	0.1	0.0	0.1
T-2	Palmeira	13.2	4.9	1.3	0.2	0.6	0.2	0.0	1.1	0.2	1.3
T-3	Felxeira Soares	13.8	9.4	2.6	0.3	0.7	0.2	0.0	2.4	0.3	2.7
T-13	Ventania	4.7	3.1	0.3	0.0	0.2	0.0	0.0	0.3	0.0	0.3
T-30	Sao Sebastiao da Amoreira	1.2	3.1	0.1	0.0	0.7	0.0	0.0	0.1	0.0	0.1
T-5	Imbituva	10.2	7.2	1.5	0.2	0.3	0.1	0.0	1.4	0.2	1.6
T-7	Ponta Grossa	21.8	4.2	1.8	0.2	0.4	0.2	0.0	1.6	0.2	1.8
T-11	Tibagi	22.0	2.1	0.9	0.1	0.2	0.1	0.0	0.8	0.1	0.9
T-43	Primeira da Maio	0.1	2.2	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
T-40	Rancho Alegre	0.0	2.4	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0
T-8	Castro	7.4	1.1	0.2	0.0	0.3	0.0	0.0	0.2	0.0	0.2
T-42	Sertaneja	0.2	1.9	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0
T-14	Telemaco Borba	5.3	13.9	1.5	0.2	0.3	0.0	0.0	1.5	0.2	1.7
Total =		334.4									

N: Nitrogen, K: Potassium

Table-6.16 Cost and Benefit with Master Plan (Tibagi River Basin)

The case that the terrace will last 30 years.

Item	Unit: million US\$											2025 Total	
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006		2007
Terrace for Crop Land 40 US\$/ha	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	0.58				13.38
Improvement of Farm Road 1500 US\$/km	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	0.40				10.00
Maintenance Cost for terrace and farm road 3 %		0.08	0.17	0.25	0.34	0.42	0.50	0.59	0.67	0.70	0.70	0.70	17.72
Difference between the machinery cost of non-tillage and regular tillage 4000 US\$/machinery													29.30
Benefit born from Fertilizer Application		1.12	1.75	2.13	2.46	2.61	2.68	2.74	2.76	2.78	2.78	2.78	76.63
													6.23
													Benefit by the year of 2025
													6.23

## **CHAPTER 7 STUDY OBJECTIVES AND METHODOLOGY FOR FOREST**

### **7.1 Study Objectives**

The study consists of two phases, one for the Strategy concerning the whole Paraná state and another for the Master plan concerning the selected pilot river basins. The following objective are common to both phases.

- 1) to examine the necessity of preservation of natural forest and afforestation
- 2) to propose a plan for preservation of natural forest and afforestation

### **7.2 Methodology**

With the following sequence, the study was conducted. For both Strategy and Master plan studies, the methodology is basically same.

- 1) identification of location and area of existing natural forest and afforestation
- 2) identification of factors inducing deforestation in the past
- 3) study of afforestation projects
- 4) examination of the necessity of afforestation
- 5) examination of the necessity of preservation of natural forest
- 6) proposal of plans for afforestation and preservation of natural forest
- 7) rough cost estimation (Master plan study only)

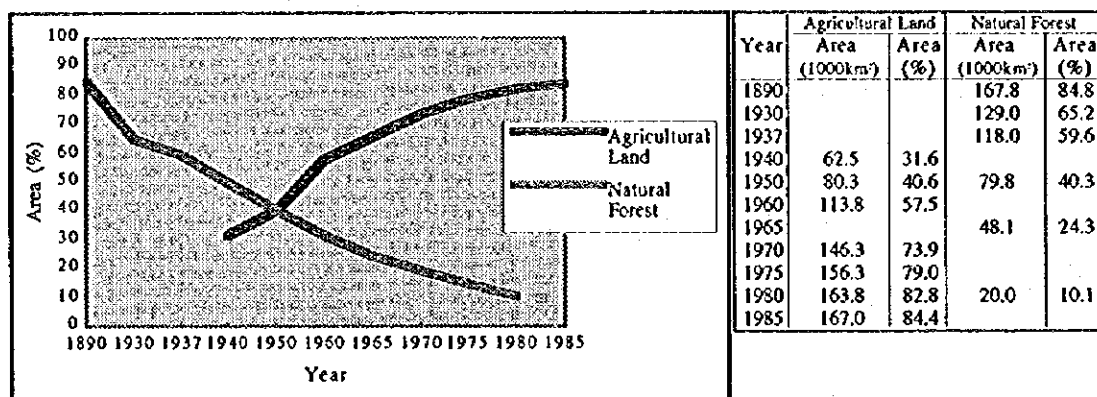
## CHAPTER 8 STRATEGY FOR FOREST

### 8.1 Deforestation

Native species in Paraná vary with location. The followings are considered as the main species in terms of the use, such as agroforestry, fuel wood and timber.

<u>Scientific name</u>	<u>Local name</u>
Araucaria angustifolia	Araucaria
Ilex paraguariensis	Erva mate
Mimosa scabrella	Bracatinga

According to Maack (1968) and IBDF (1980), natural forest covered 84.8 % of Paraná state in 1890 and declined to 10.1 % in 1980 as shown in Figure-8.1. At the beginning of the century, the degradation of natural forest was due to the timber industries. From 1920's, the agriculture had spread rapidly in the state inducing the sharp decline of the natural forest area. Deforestation had expanded from the first plateau to the third plateau as the progress of immigrants.



Source ; Agricultural Land 1940-1985 ; Agricultural and Livestock Census(1985) IBGE  
Natural Forest 1890-1965 ; Maack(1968), Natural Forest 1930 ; IBDF

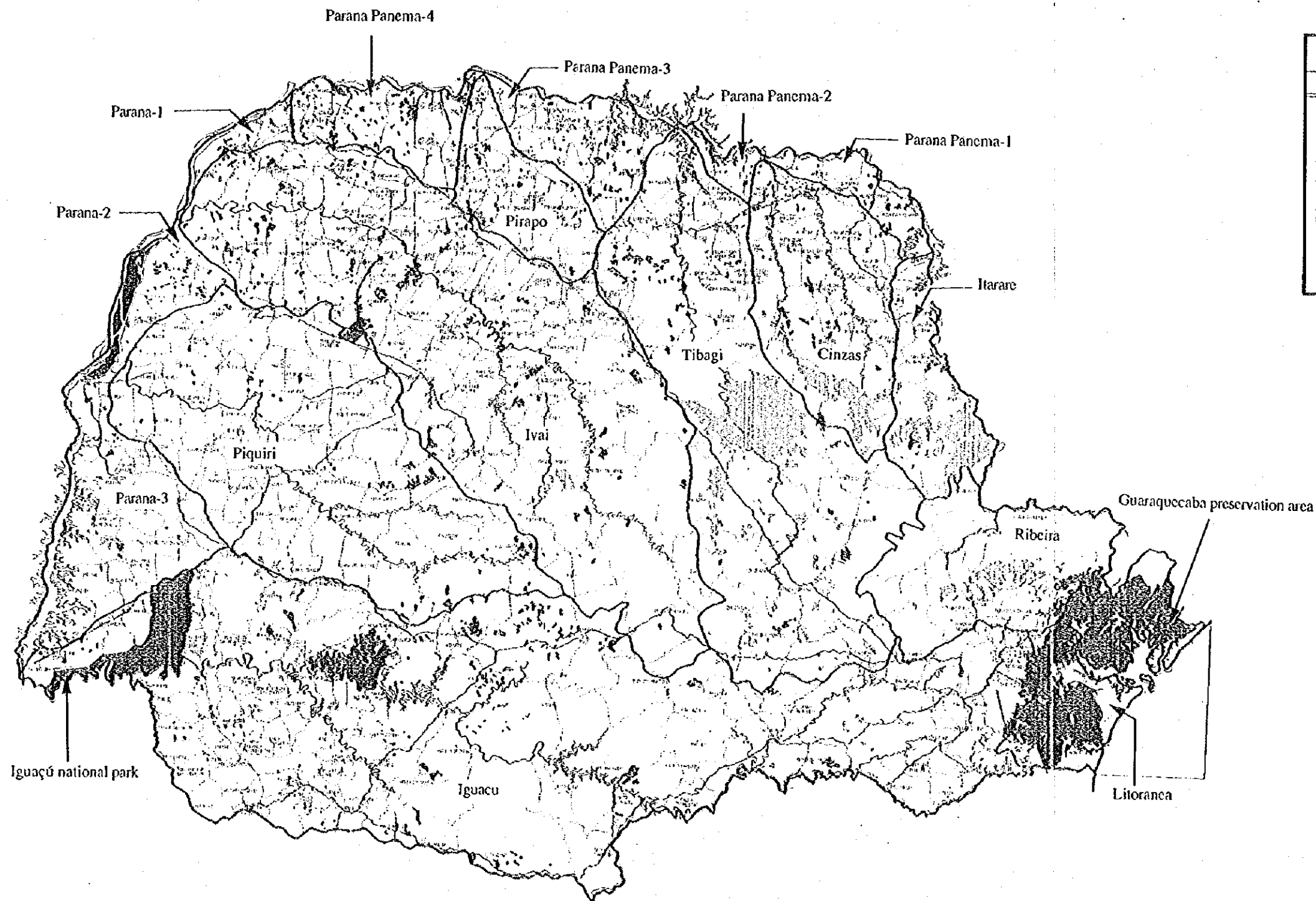
Figure-8.1 Expansion of Deforestation and Agricultural Land

The forest area in 1990 is available from SANEPAR as a result of GIS computation based on the satellite imagery analysis conducted by IAP (1990 and 1994). Natural forest occupied only 9.0 % of the state and reforestation covers 3.2 % in 1990, equivalent to approximately 17,800 km<sup>2</sup> and 6,300 km<sup>2</sup> respectively. The forest and reforestation coverage of each river basin, and the location of natural forest and reforestation as of 1990 are shown in Figure-8.2.

As shown in Figure-8.2, natural forest is mainly conserved in Litoranea and Iguaçú river basin; while afforestation is practiced in Cinzas, Itarare, Ribeira and Tibagi river basins. According to Milano (1990), the forest area conserved by the federal government in terms of parks and preservation area was approximately 5,000 km<sup>2</sup> and one by the state was 1,000 km<sup>2</sup>. The federal one consists of Iguaçú national park, Guaraquecaba preservation area and so on, indicated as natural forest in Figure-8.2.







	Total Area (km <sup>2</sup> )	Land Use (%)	
		Forest	Re
State	197882.0	9.0	3.2
River Basin			
Cinzas	9290.7	2.9	6.2
Iguacu	55318.0	14.3	1.7
Itararé	5197.7	1.3	21.7
Ivaí	35878.9	5.0	1.8
Litoranea	5766.0	68.9	3.9
Parana	13156.3	7.5	0.0
Parapanema	9797.0	4.9	0.0
Piquiri	24707.9	2.1	0.3
Pirapo	5005.9	2.5	0.0
Ribeira	9129.3	5.7	5.3
Tibagi	24634.7	3.8	9.4

Re: Reforestation

- Federal Road
- State Road
- Boundary of Municipality
- Boundary of River Basin
- Natural Forest
- Afforestation

Scale 1: 2,500,000

Source: GIS Computation by SANEPAR (1994)

Land Use Map by IAP (1990)

Figure-8.2 Existence of Natural Forest and Afforestation



## 8.2 Afforestation

Until 1987, the federal government assisted to promote afforestation in terms of loan; however, it has ceased for a long time. Afforestation during the federal government assistance, 1966 to 1987, has been registered at IBAMA. The total area of afforestation during this period is summarized in Table-8.1 with EMATER division (Figure-2.4). The total area of afforestation means the area replanted, and areas felled are not counted. Ponta Grossa, Curitiba and Paranagua regions were more benefited by the government assistance compared to other region and the result is obvious in Figure-8.2 as reforestation.

The total area and areas of main species afforested in the last 20 years is summarized annually in Table-8.2. The area of afforestation means the area replanted in a specific year, and the existence of afforested area in previous years and areas felled are not counted. Main species for afforestation are pinus, araucaria and eucalyptus for the commercial use, such as timber, paper mill and so on. The effect of the government assistance is apparent in Table-8.2. Since 1988, the total area afforested has declined rapidly.

DAGRI/SEAB has conducted currently an afforestation program, Program for Integrated Forest Development. The objectives are to motivate the implementation of afforestation aiming at preservation and production of forest in terms of loan, 50 % of the cost at maximum. The program has focused on supporting municipalities and regional associations. Since the program has started in January, 1994, its effect on the environment and rural economy is not assessed yet.

Since 1991, IAP has conducted the project of conservation and recuperation of riverian vegetation along rivers for the public water supply (Projeto Agua Limpa) in association with SANEPAR, city hall, and relative institutions. As of 1994, the implementation reached the planting of 2 million native forest seedlings to cover the riverian vegetation of 1,300 km of river length (Carmo, 1994).

Table-8.1 Total Afforestation Registered at IBAMA (1966 - 1987)

unit: km <sup>2</sup>		
EMATER No.	Municipality	Total Area
EM-17	Apucarana	28.07
EM-13	Campo Mourao	71.87
EM-10	Cascavel	163.26
EM-19	Cornelio Procopio	334.91
EM-2, 3	Curitiba	2,322.05
EM-9	Francisco Beltrao	75.95
EM-7	Guarapuava	877.64
EM-5	Irati	274.51
EM-14	Ivaipora	145.23
EM-20	Jacarezinho	134.31
EM-18	Londrina	11.83
EM-16	Maringa	0.65
EM-1	Paranagua	1,400.03
EM-15	Paranavai	5.86
EM-8	Pato Branco	230.15
EM-4	Ponta Grossa	3,068.01
EM-11	Toledo	15.63
EM-12	Umuarama	16.28
EM-6	Uniao da Vitoria	425.63

Source: IBDF, IBAMA  
Curitiba region includes Lapa region.

Table-8.2 Annual Afforestation Registered at IBAMA (1974 - 1993)

Unit: km<sup>2</sup>

Year	Total Area	Area of Araucaria	Area of Pine Tree	Area of Eucalyptus	Area of Palmaeace	Area of Fruit	Others	
1974	700.98	55.58	350.04	57.73	223.17	2.47	11.99	
1975	910.24	54.70	342.67	37.33	448.26	20.37	6.81	
1976	934.14	46.22	417.10	37.29	417.58	8.18	7.77	
1977	349.23	20.97	279.42	29.45	1.82	14.30	3.27	
1978	487.53	21.38	434.92	21.61	4.13	5.00	0.49	
1979	451.96	21.62	419.83	1.32	3.20	4.50	1.49	
1980	352.44	7.86	317.61	20.44	0.00	3.75	2.78	
1981	377.31	22.92	334.95	9.72	2.14	3.66	3.92	
1982	352.14	9.47	331.80	5.43	0.00	3.19	2.26	
1983	227.54	9.03	207.65	9.19	0.00	0.00	1.66	
1984	282.64	12.07	248.92	16.99	0.00	1.00	3.66	
1985	309.61	16.08	254.78	33.58	0.00	1.00	4.16	
1986	37.62	8.13	9.10	4.63	0.00	0.00	15.76	
1987	363.48	13.99	293.61	42.03	0.00	0.00	13.85	
Year	Total Area	Area of Araucaria	Area of Pine Tree	Area of Eucalyptus	Area of Palmaeace	Area of Leguminous Tree (Mimosa)	Area of Mata Tea	Others
1988	77.84	7.96	42.58	22.52	0.00	1.73	3.05	0.00
1989	54.96	10.25	35.71	4.61	0.00	4.06	0.00	0.53
1990	94.27	10.94	41.99	13.78	0.00	3.56	23.30	0.70
1991	95.87	7.15	45.98	29.22	10.73	1.71	0.02	1.06
1992	34.05	3.52	25.03	4.97	0.00	0.53	0.00	0.00
1993	2.97	0.00	2.05	0.32	0.00	0.60	0.00	0.00

Source: IBAMA, IBDF

### 8.3 Effect of Deforestation and Necessity of Afforestation

Deforestation decreases surface cover of land and increases rainfall impact to the surface simultaneously. Afterward, evapotranspiration decreases due to less biomass activities and soil erosion increases due to less surface cover. As a consequence, increase in surface runoff induces flood, while increase in sediment yield degrades water quality in downstream. These effects of deforestation on the water environment are summarized schematically in Figure-8.3.

If the whole land were covered by forest, there would be no problem associated with soil erosion as long as the normal erosion, one caused by nature, is considered as permissible level. The accelerated erosion, one caused by human activities, has been induced primarily by deforestation. Successively, it has been enlarged by improper land use. Therefore, soil erosion coincides with deforestation.

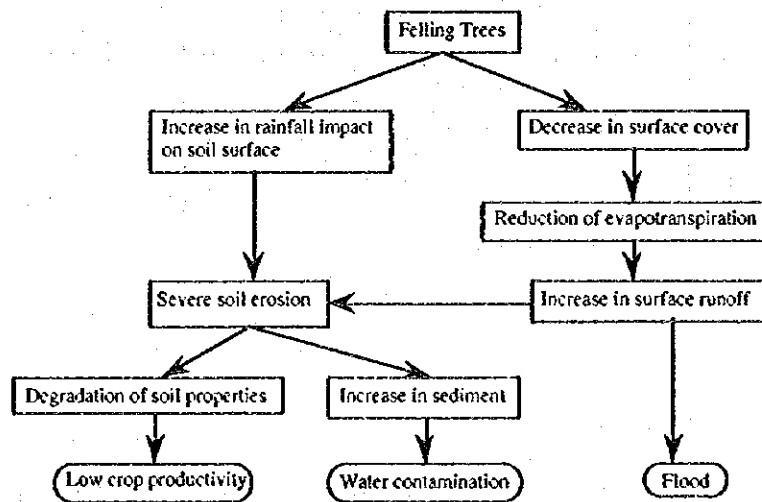


Figure-8.3 Effects of Deforestation

Proper management of forest contributes to sustainable level of production of timber, preservation of environment, erosion control, maintenance of soil fertility and so on. On the other hand, regional development plans, such as expansion of agriculture land, often have negative effect on forest. Since both sides are crucial for the society, the most difficult part regarding environmental issues is the determination of a boundary between preservation and development.

Considering the great reduction in forest area, it is not possible to go back 19 century when the forest area covered 84.8 % of Paraná state; however, afforestation is essential to improve the water environment and is a part of the river basin management. Benefits of afforestation consist of direct and indirect ones. The former is an income from timber production, wood as fuel and perennial crops. The latter is the conservation of the water environment, such as erosion control, flood control, improvement of water quality in a river basin and so on.

### 8.4 Strategy

#### 8.4.1 Strategy of Forest for Paraná State

Future afforestation in Paraná consists of preservation of natural forest, conservation of water

environment and commercial use to generate income. Strategy of forest aiming at the year of 2015 is described object by object in the following section and the recommended species and sites are summarized in Table-8.3. EMBRAPA (1985) divided the state in 7 bio-climatic regions (Figure-8.4) with the recommendations of native and exotic forest species (Table-8.4). The detail selection of species should refer to the result of EMBRAPA (1985).

Considering the current conditions, the area expansion of forest for conservation and preservation purposes is expected to be gradual. Therefore, afforestation should be promoted by means of commercial afforestation.

Table-8.3 Recommended Species and Sites

Purpose	Direct Benefit	Indirect Benefit	Site Recommended	Recommended Species
Preservation of natural forest	No	Yes	1) Current preservation area 2) Promotion of preservation area to protect ecosystem, landscape and so on	Native forest, Wild Fruits
Conservation of water environment	No	Yes	The area stipulated by law, such as along rivers or any water courses, steep land, etc.	Native Forest, Wild Fruits, Araucaria, Bracatinga
Agroforestry	Yes	Yes	Farm land	Bracatinga, Mate
Energy	Yes	Yes	The land whose slope steepness is less than 25 degree.	Bracatinga, Eucalyptus
Commercial use for timber & paper	Yes	Yes	1) Brush fields 2) The land not suitable for both crop and pasture cultivation	Eucalyptus, Araucaria, Pine

Direct Benefit: to generate income  
Indirect Benefit: to conserve the water environment

### (1) Preservation of Natural Forest

Currently preserved area must not be exploited as laws control. There are several plans to establish new preservation lands as federal and state parks; however, their areas are limited. Therefore, the area of preservation will not increase much by the year of 2015.

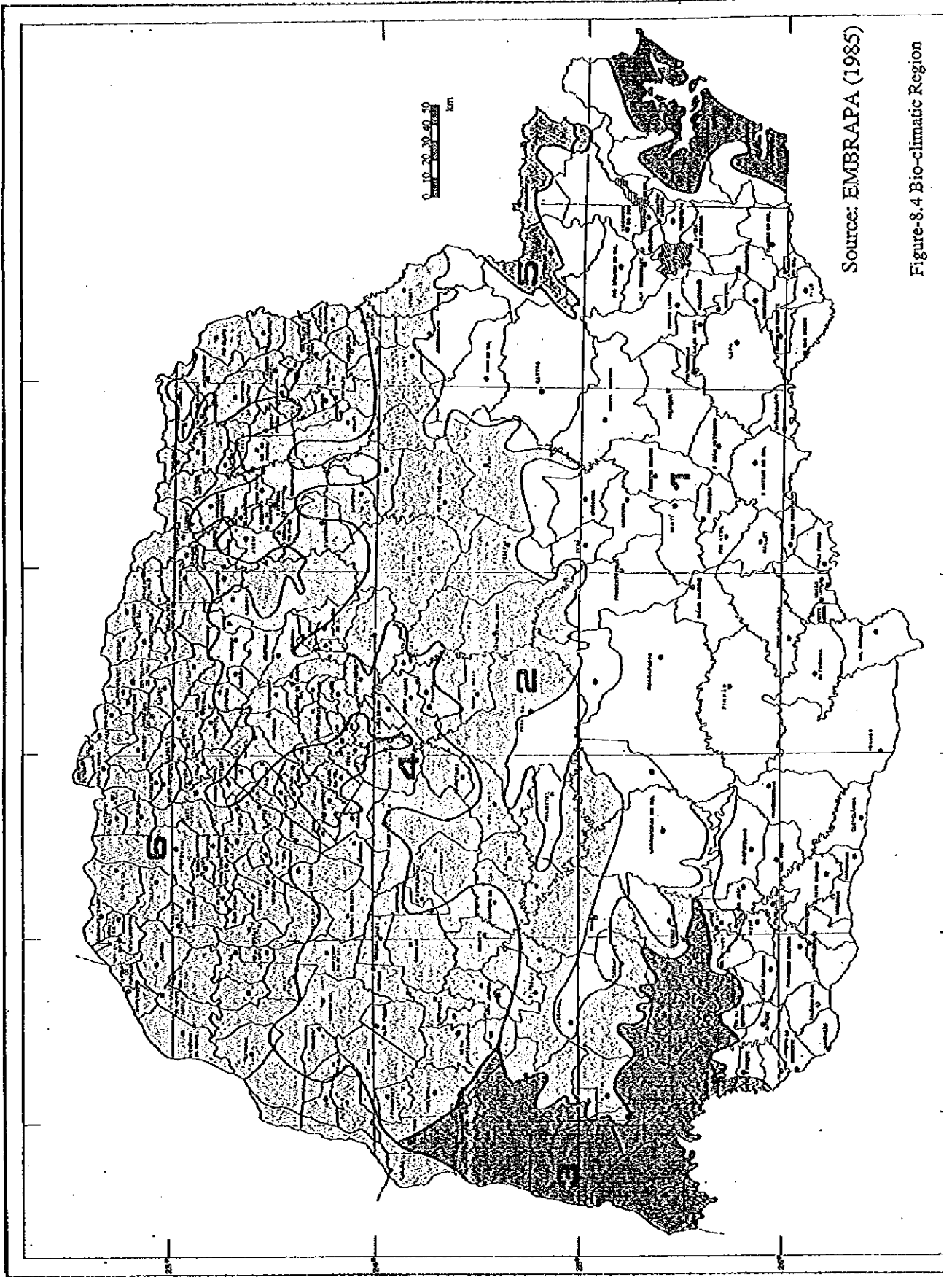
### (2) Afforestation for Conservation of Water Environment

Afforestation for conservation contributes preservation of native flora and fauna, erosion control, stabilization of hydrologic cycle and so on. Forest Code ( Law 4771/65) defines the areas where afforestation should be implemented for conservation and where the natural vegetation should be preserved permanently as shown in Table-8.5.

The recommended species for this purpose are the native ones because the exotic species often alter the ecosystem. Since this kind of afforestation is not directly profitable, the implementation requires persuasion of the public, legal enforcement and government subsidy.

### (3) Afforestation for Direct Benefits

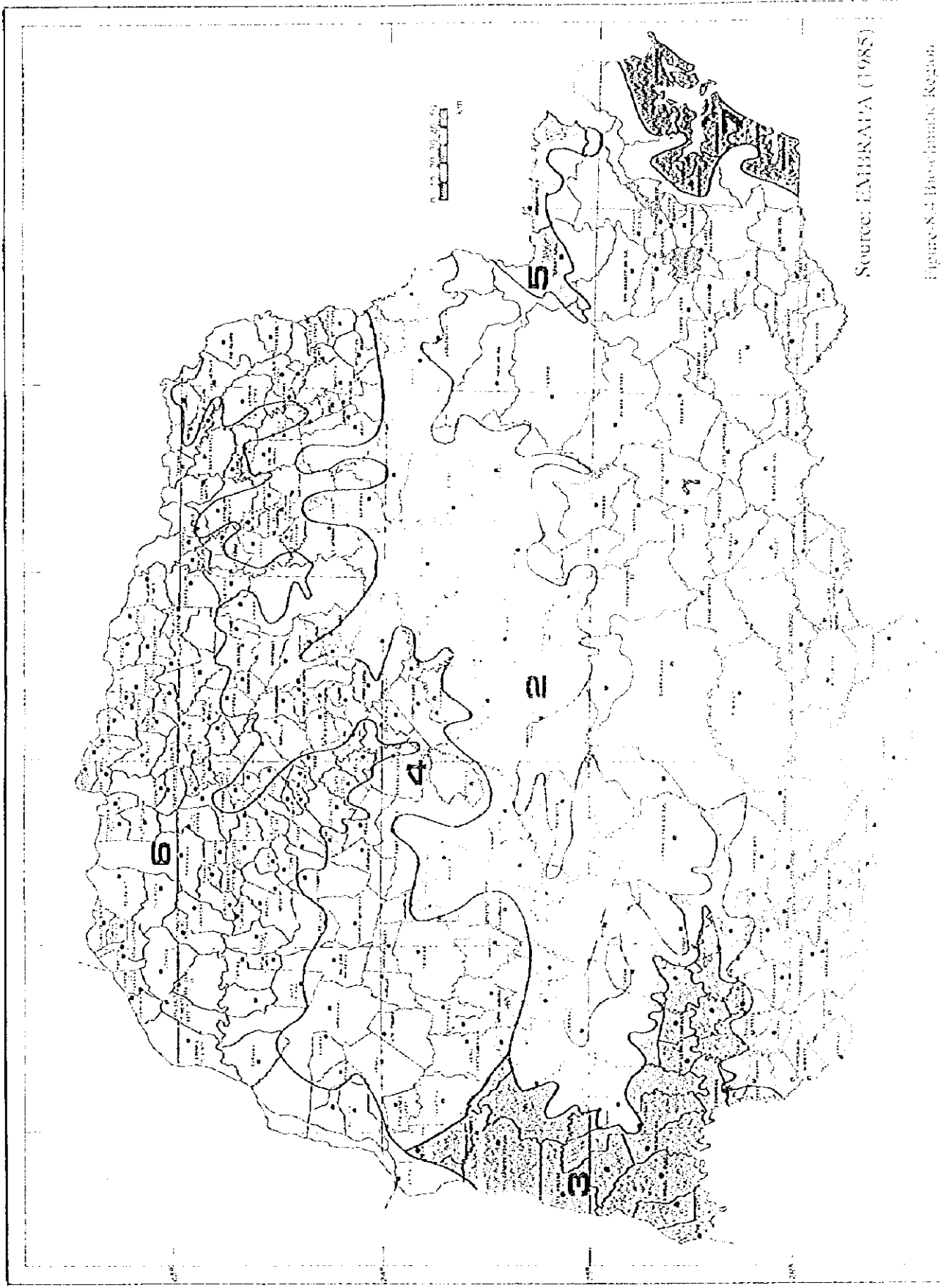
Since income is generated through this afforestation, land with no aptness for agriculture and pasture should be converted to forest. Agroforestry and afforestation for fuel will continue; however, their expansion will be limited even in future. Therefore, afforestation for paper and timber industry will be dominant.



Source: EMBRAPA (1985)

Figure-8.4 Bio-climatic Region





Source: EMBRAPA (1985)

Figure 8.4 Bauphonic Region

Table-8.4 Exotic and Native Forest Species Recommended

a; commercial planting

b; trial planting

Exotic Species		Bio-Climatic Region						
Scientific Name	Local Name	1	2	3	4	5	6	7
<i>Pinus caribaea</i>	var. bahamensis			b	a	a	a	a
<i>Pinus caribaea</i>	var. caribaea			b	a		a	
<i>Pinus caribaea</i>	var. hondurensis			b	a	a	a	a
<i>Pinus elliotii</i>	var. densa				a	a		a
<i>Pinus elliotii</i>	var. elliotii	a	a					
<i>Pinus oocarpa</i>				b	a	a	a	a
<i>Pinus patula</i>		b	b					
<i>Pinus taeda</i>		a	a	a				
<i>Eucalyptus camaldulensis</i>							a	a
<i>Eucalyptus "cambilo" (hibrido)</i>		a	a	b				
<i>Eucalyptus citriodora</i>				b	b	a	a	a
<i>Eucalyptus deanei</i>		a		b	b	b		
<i>Eucalyptus dunnii</i>		a	a	b	b	b		
<i>Eucalyptus grandis</i>				a	a	a	a	a
<i>Eucalyptus robusta</i>				b	b	a	a	a
<i>Eucalyptus saligna</i>			a	a	a	a		
<i>Eucalyptus tereticornis</i>							a	a
<i>Eucalyptus urophylla</i>				b	b		a	b
<i>Eucalyptus viminalis</i>		a	a					
<i>Acacia longifolia</i>		a	a	a	a	a	a	a
<i>Acacia mearnsii</i>		b	b	b	b	b		
<i>Agathis robusta</i>					b	b	b	b
<i>Alnus glutinosa</i>		b	b					
<i>Casuarina equisetifolia</i>		a	a	a	a	a	a	a
<i>Cryptomeria japonica</i>		b	b					
<i>Gunninghamia lanceolata</i>		b	b					
<i>Cupressus lusitanica</i>		a	a					
<i>Grevillea robusta</i>		b	b	a	a	b	a	b
<i>Hovenia dulcis</i> (Uva do Japao)		b	b	a	a	a	a	b
<i>Leucaena leucocephala</i>				b	b	b	b	b
<i>Melia azedarach</i>	var. sempervirens (Cinamomo)			b	b	b	b	b
<i>M. azedarach</i>	var. comum ou "sombriinha"	a	a	a	a	a	a	a
<i>Paulownia</i> sp. (Kirii-hibrido)					a	a	a	a
<i>Paulownia tomentosa</i>		b	b	b				
<i>Taxodium disticum</i>		b	b	b				

Native Species		Bio-climatic Region						
Scientific Name	Local Name	1	2	3	4	5	6	7
<i>Araucaria angustifolia</i>	Araucaria	a	a	a	a			
<i>Balfourodendron riedelianum</i>	Pau marfim			b	b		b	
<i>Cabralea glaberrima</i>	Canjarana			b	b	b	b	b
<i>Calopogonum brasiliense</i>	Guanandi					b	b	b
<i>Cariniana estrellensis</i>	Estopeira, Jeguitiba				b	b	b	b
<i>Centrodium tomentosum</i>	Aranha-vermelho			b	b	b	b	b
<i>Colubrina glandulosa</i>	Sobrasil						b	b
<i>Cordia tricholoma</i>	Louro pardo			b	b	b	b	b
<i>Enterobium conforisifigum</i>	Timbavá			b	b	b	b	b
<i>Euterpe edulis</i>	Palmito			b	b	b	b	b
<i>Ilex paraguariensis</i>	Erva-mate	a	a	a	b	b		
<i>Mimosa bimucronata</i>	Marica		b					b
<i>Mimosa fuculosa</i>	Bracatinga-de-campo-mourao	b	b	b	b			
<i>Mimosa scabrella</i>	Bracatinga	a	b					
<i>Ocotea pretiosa</i>	Canela sassaparilla	b	b			b		b
<i>Parapipladenia rigida</i>	Gurucuia	b	b	b	b		b	
<i>Peltophorum dubium</i>	Canafistula			b	b		b	
<i>Pipladenia gonoacantha</i>	Pau jacare				b	b	b	b
<i>Pipladenia macrocarpa</i>	Angico vermelho		b	b	b	b	b	
<i>Tabebuia cassinooides</i>	Caxeta							b
<i>Talauma ovata</i>	Baguacu					b	b	b

Source: EMBRAPA (1985)

Table-8.5 Afforestation and Preservation Controlled by Law

Countermeasures	Target Area	Law
Afforestation	no aptness for agriculture or livestock	Forest Code (Law 4771/65)
Permanent Preservation	around lagoons, lakes, natural or artificial reservoirs	Forest Code (Law 4771/65)
	in springs	Forest Code (Law 4771/65)
	on the top of hills, mountains and mountain ranges	Forest Code (Law 4771/65)
	on a slope with steepness greater than 100 %	Forest Code (Law 4771/65)
	on estuaries	Forest Code (Law 4771/65)
	on the edges of plateaus	Forest Code (Law 4771/65)
	natural or artificial prairie and natural forests with altitude higher than 1800 m	Forest Code (Law 4771/65)
	along river or any water courses with a certain margin strip depending on the width of a river or water course	Law 7511/86
Prohibition of Clear Felling	areas with steepness greater than 46 %	Forest Code (Law 4771/65)

#### 8.4.2 Future Forest Area with Strategy

Future forest area was estimated in accordance with the above Strategy. Afforestation for conservation and preservation was not considered because increase in their area will be limited. Therefore, only commercial afforestation for timber and paper industry was considered to estimate the future forest area.

Commercial afforestation should be implemented in where land is not suitable for agriculture and pasture. Brazil Ministry of Agriculture (1981) evaluated land in Paraná in terms of agriculture aptness and drew an agriculture aptness map. According to the map, there are approximately 886,000 ha of the land in Paraná suitable for afforestation but not for agriculture. The land use map in 1990 characterizes the current use of these areas as the combination of crop, pasture, forest and secondary vegetation. As a result of land evaluation by Ministry of Agriculture, productivity of crop or pasture in these areas is very low. Therefore, these areas should be shifted to forest for commercial use so as to generate more income.

Table-8.6 Future Projection of Forest Area

Kind of Forest	Year 1994		2015	
	Area (km <sup>2</sup> )	area ratio to whole state (%)	Area (km <sup>2</sup> )	area ratio to whole state (%)
Natural Forest	10200	5.1	10200	5.1
Afforestation	5000	2.5	13860	6.9
Total	15200	7.6	24060	12.0

Source: SANEPAR GIS Computation for 1994

If afforestation of 886,000 ha were implemented evenly in the next twenty years, the area of afforestation for each year would be 44,300 ha. During 1974 to 1985, when there was the government subsidy, the average annual area for afforestation is 48,000 ha. Further, the largest area afforested during that period is 93,000 ha. These figures verify that annual afforestation of 44,300 ha is feasible.

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## CHAPTER 9 MASTER PLAN OF FOREST IN PILOT RIVER BASINS

Since Iguaçú and Tibagi river basins were selected as pilot river basins, the following study was conducted only for Iguaçú and Tibagi river basins. After identification of forest area, Master plans of forest for both river basins were formulated. Finally, cost of the Master plan was estimated assuming that the implementation of afforestation will be evenly in the next twenty years. The Master plans for both river basins are basically same and difference is only area to be afforested.

### 9.1 Existing Forest in Iguaçú and Tibagi River Basins

As shown in Table-9.1, the natural forest and reforestation in Iguaçú river basin cover 14.3 % (7,900 km<sup>2</sup>) and 1.7 % (900 km<sup>2</sup>) of its area, respectively. The total area of natural forest in the state is approximately 17,800 km<sup>2</sup> and 44.4 % of them belongs to Iguaçú river basin. The natural forest is well preserved in Iguaçú river basin compared to other river basins and it is mainly achieved by means of parks and indigenous preserves of state and federal as shown in Figure-9.1. In contrast to the preservation of natural forest, the implementation of reforestation is low.

Table-9.1 Forest and Reforestation Cover in Paraná

		River Basin Area (km <sup>2</sup> )	Landuse (%)	
			Forest	Reforestation
State		197882.0	9.0	3.2
River Basin	Cinzas	9290.7	2.9	6.2
	Iguacu	55318.0	14.3	1.7
	Itarare	5197.7	1.3	21.7
	Ivai	35878.9	5.0	1.8
	Litoranea	5766.0	68.9	3.9
	Parana	13156.3	7.5	0.0
	Parapanema	9797.0	4.9	0.0
	Piquiri	24707.9	2.1	0.3
	Pirapo	5005.9	2.5	0.0
	Ribeira	9129.3	5.7	5.3
	Tibagi	24634.7	3.8	9.4

Source: SANEPAR GIS Computation  
IAP Satellite Imagery Analysis

The natural forest and reforestation in Tibagi river basin cover 3.8 % (900 km<sup>2</sup>) and 9.4 % (2,300 km<sup>2</sup>) of its area, respectively. The total area of reforestation in the state is approximately 6,300 km<sup>2</sup> and 36.5 % of them belongs to Tibagi river basin. Reforestation is well practiced in Tibagi river basin compared to other river basins and it is mainly achieved by means of commercial afforestation, especially paper industry, as shown in Figure-9.2. In contrast to reforestation, the area of natural forest is limited.

### 9.2 Master Plan

Proper management of forest contributes to sustainable level of production of timber, preservation of environment, erosion control, flood control, maintenance of soil fertility and so on. Considering the development of society, it is not possible and not necessary to go back 19 century, when forest covered most of the land; however, afforestation is essential to improve the water environment and is a part of the river basin management.

# IGUACU RIVER BASIN

## LEGEND

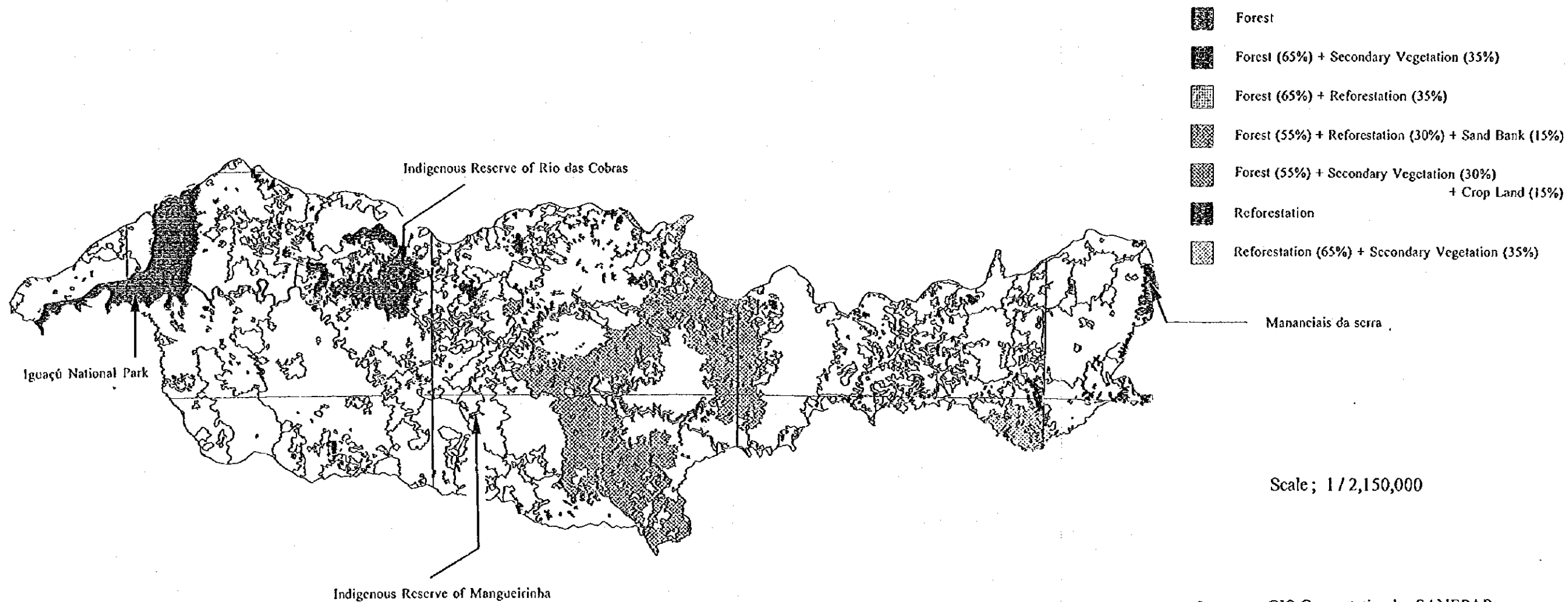
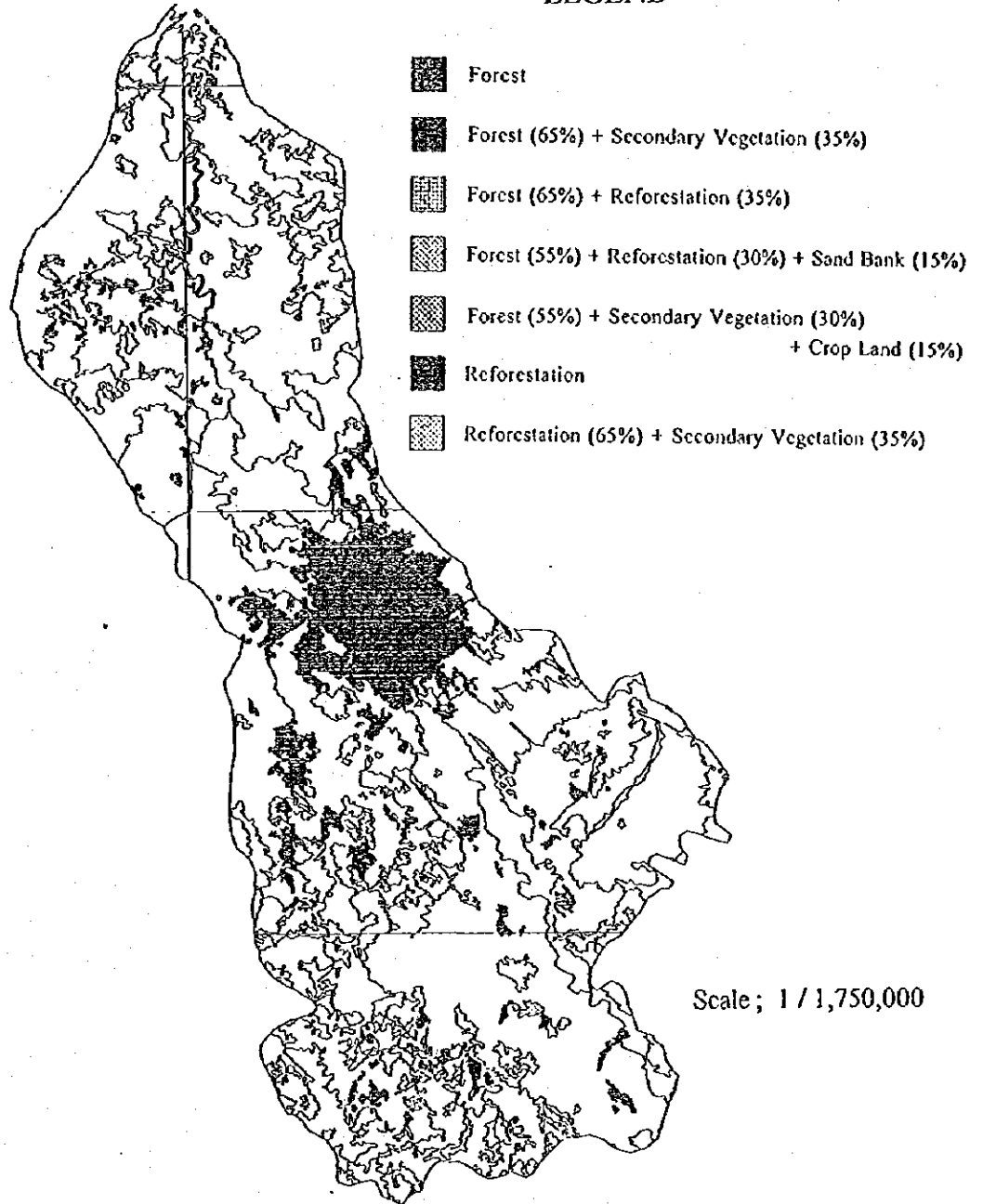


Figure-9.1 Location of Forest and Reforestation in Iguacu River Basin



# TIBAGI RIVER BASIN

## LEGEND



Source ; GIS Computation by SANEPAR  
Landuse Map by IAP (1990 & 1994)

Figure-9.2 Location of Forest and Reforestation in Tibagi River Basin



Benefits of afforestation consist of direct and indirect ones. The former is an income from timber production, wood as fuel and perennial crops, such as fruit trees. The latter is the conservation of the water environment, such as erosion control, flood control, improvement of water quality in a river basin and so on.

The main concern to formulate the master plan is the proper land use. In other words, the land not suitable to agriculture and pasture should be converted to forest for direct and indirect benefits. For the conservation and preservation purposes only, direct benefit is not expected; however, indirect benefit is much greater than income born from forest if the effect on the environment, such as suppression of soil erosion and flood, is counted.

The master plan for forest consists of three purposes, preservation of natural forest, conservation of water environment and commercial afforestation. Recommended species and sites for each purpose are summarized in Table-8.3. The implementation of master plan will involve the detail study site by site, such as identification of soil and climate, selection of forest species, plan of thinning etc. For the selection of specific species, recommendations of native and exotic species dividing the site in 7 bio-climatic regions are available from EMBRAPA (1985), Table-8.4 and Figure-8.4.

Considering the current conditions, the area expansion of forest for preservation and conservation of the water environment purposes is expected to be gradual. Therefore, afforestation should be promoted by means of commercial afforestation. Each purpose of the master plan is described in the followings.

#### 1) Preservation of Natural Forest

Currently preserved areas must not be exploited as laws control (Forest Code, Law 4771/65). Besides, the promotion of preservation area should be continued not only to preserve the ecosystem and environment but also scenic and recreational purposes. In Iguaçú river basin, there are several plans of the establishment of new preservation areas, such as Irai reservoir area and Palmital river basin. For the implementation, the government assistance by means of finance, law enforcement and technical support is essential.

#### 2) Afforestation for Conservation of Water Environment

Currently degraded areas despite the fact that Forest Code defines the preservation areas have to be afforested for preservation of native flora and fauna, erosion control, stabilization of hydrologic cycle and so on. The recommended forest species for this purpose are native ones because exotic species often alter the endemic ecosystem.

#### 3) Afforestation for Direct Benefits

Land with no aptness for agriculture and pasture should be converted to forest to generate more income instead of bearing the low productivity. Besides, this afforestation contributes to conserve the water environment because the applicable land is steep and has a great potential of soil erosion and flood.

For the sustainable production of wood and conservation of the water environment, it requires the proper management system, such as space of seedlings, thinning plan and so on. The relative institutions, for example IAP and EMATER, should support the formulation of forest management system.

### (1) Use and Recommended Species in Iguazu River Basin

Since Iguazu river basin belongs to 1, 2 and 3 bio-climatic regions (EMBRAPA, 1985), main species recommended for commercial afforestation are Araucaria, Mate, Bracatinga, Eucalyptus and Pinus. The use of recommended species is shown in Table-9.2.

Table-9.2 Recommended Species and Their Use for Commercial Afforestation (Iguazu River Basin)

Species	Bio-climatic Region			Use					
	1	2	3	paper & cellulose	construction	timber	plywood	firewood & charcoal	nourishment
Araucaria angustifolia (Araucaria)	X	X	X	X	X	X			
Ilex paraguariensis (Mate)	X	X	X						X
Mimosa scabrella (Bracatinga)	X				X	X	X	X	
Eucalyptus	X	X	X	X	X			X	
Pinus (Pine)	X	X	X		X	X			

Source: EMBRAPA (1985)

### (2) Use and Recommended Species in Tibagi River Basin

Since Tibagi river basin belongs to 1, 2, 4 and 6 bio-climatic regions (EMBRAPA, 1985), main species recommended for commercial afforestation are Araucaria, Mate, Bracatinga, Eucalyptus and Pinus. The use of recommended species is shown in Table-9.3.

Table-9.3 Recommended Species and Their Use for Commercial Afforestation (Tibagi River Basin)

Species	Bio-climatic Region				Use					
	1	2	4	6	paper & cellulose	construction	timber	plywood	firewood & charcoal	nourishment
Araucaria angustifolia (Araucaria)	X	X	X		X	X	X			
Ilex paraguariensis (Mate)	X	X								X
Mimosa scabrella (Bracatinga)	X					X	X	X	X	
Eucalyptus	X	X	X	X	X	X			X	
Pinus (Pine)	X	X	X	X		X	X			

Source: EMBRAPA (1985)

## 9.3 Implementation Schedule and Cost

The average cost and gross income from afforestation of main species suitable for Iguazu and Tibagi river basins were estimated by Ferreira (1995) as shown in Table-9.4. Cost and income depend on the use of wood products. For example, the price of Eucalyptus for fuel is approximately 3.3 US\$/m<sup>3</sup>, while one for sawmill is 10 US\$/m<sup>3</sup>. Assuming the specific use of wood, cost and gross income were estimated.

Table-9.4 Cost and Gross Income of Afforestation

Species	Spacing (m. x m)	Cost (US\$/ha)		Pruning	Yield		Rotation Year	Gross Income (US\$/ha)	Net Income (US\$/ha-year)
		Planting	Maintenance		Product	Production			
General native species	4x4	270	100	-	-	-	-	non	non
<i>agustifolia</i> (Araucaria)	3x3	270	100	-	cellulose saw-mill lamination	400 m <sup>3</sup> /ha 30 m <sup>3</sup> /ha 180 m <sup>3</sup> /ha	45	4,000 900 9,000	301
<i>Ilex paraguariensis</i> (Mate)	3x3	430	360	-	Mate Tea	17 ton/ha/harvest	30	34,500	1124
<i>Mimosa scabrella</i> (Bracatinga)	1 kg seed/ha	260	370	-	fuel wood maize, beans	270 m <sup>3</sup> /ha	6	900 700	267
<i>Eucalyptus</i>	2x2	470	100	-	fuel wood	670 m <sup>3</sup> /ha	21	2,240	80
<i>Pinus</i> (Pine)	2x2	460	150	100	cellulose saw-mill lamination	160 m <sup>3</sup> /ha 150 m <sup>3</sup> /ha 150 m <sup>3</sup> /ha	25	800 1,500 4,500	244

Note 1) Harvest of Mate starts after 5 years of implantation and harvest rotation is every 20 months. Therefore, in 30 years, harvest is possible 15 times.

2) For Bracatinga, the intercropping with maize and beans is considered. Therefore, the income is a result of annual crop yields and Bracatinga felling which is once in 6 years.

3) For *Eucalyptus*, the natural regeneration method, which the stand regenerates by budding of the stumps, is considered. Three successive rotation is possible for one *Eucalyptus*.

4) Since the cost of felling and transportation depends on use of wood and location, their estimation requires the detail plan. Therefore, they are not included in the table.

5) Net Income = (Gross Income-Cost) / Rotation Year

Source: Ferreira (1995)

Net income of Mate is much greater than other species and the recent market seems to be favor to Mate. However, its internal and external market is still limited compared to one of Pinus or other species for timber. Since one of advantages of Mate is the harvest during the winter, when the source of farmers' income is limited. Therefore, Mate is recommended for agroforestry, intercropping with maize and beans. Its area expansion depends on the future market and to avoid the risk of market crush, agroforestry is practical for Mate.

In general, the lateral of each plot of agricultural land inclusive of pasture faces to the water course and is deforested for the maximum cultivation despite the fact that Forest Code defines the preserved area. Exact figures of these area is not countable at this study level; however, the approximate figures were estimated with the following assumptions.

- 1) The river margin protected by Forest Code occupies 3 % of each plot of agricultural land.
- 2) All river margins belonged to agricultural land are currently deforested.

#### (1) Iguaçu River Basin

Based on the agriculture aptness map (Ministry of Agriculture, 1981) and Landuse map (IAP, 1990 & 1994), the area of existing secondary vegetation spreading over the suitable land for forest was estimated at approximately 1,900 km<sup>2</sup>. This land should be afforested for commercial use to generate income. If Pinus was adopted, the total cost and net income would be US\$ 135 million and US\$ 1157 million, respectively. The implementation depends on ability of annual afforestation. Considering its annual average of the state, 9,500 ha/year of implantation is feasible. Therefore, 1,900 km<sup>2</sup> of the land should be afforested evenly in next twenty years.

Since the total area of agricultural land in Iguaçu river basin is approximately 30,000 km<sup>2</sup>, the river margins deforested is 900 km<sup>2</sup>. This land should be afforested with native forest species for conservation of the water environment. The total cost would be US\$ 33 million. The implementation would be evenly in the next twenty years. Therefore, annual area of afforestation would be 4,500 ha.

Table-9.5 Implementation Schedule for Iguaçu River Basin

	Area to be Afforested	Cost (million US\$)	Year			
			1996	2005		2015
Afforestation for conservation of the Water Environment	900 km <sup>2</sup>	33				
Commercial Afforestation	1,900 km <sup>2</sup>	135				
5 Year Progress Rate		168	25 %	25 %	25 %	25 %

#### (2) Tibagi River Basin

Based on the agriculture aptness map (Ministry of Agriculture, 1981) and Landuse map (IAP, 1990 & 1994), the area of existing secondary vegetation spreading over the suitable land for forest was estimated at approximately 2,000 km<sup>2</sup>. This land should be afforested for commercial use to generate income. If Pinus was adopted, the total cost and net income would be US\$ 142 million and US\$ 1,218 million, respectively. The implementation depends on ability of annual afforestation. Considering its annual average of the state,

10,000 ha/year of implantation is feasible. Therefore, 2,000 km<sup>2</sup> of the land should be afforested evenly in next twenty years.

Since the total area of agricultural land in Tibagi river basin is approximately 14,000 km<sup>2</sup>, the river margins deforested is 400 km<sup>2</sup>. This land should be afforested with native forest species for conservation of the water environment. The total cost would be US\$ 15 million. The implementation would be evenly in the next twenty years. Therefore, annual area of afforestation would be 2,000 ha.

Table-9.6 Implementation Schedule for Tibagi River Basin

	Area to be Afforested	Cost (million US\$)	Year			
			1996	2005	2015	
Afforestation for conservation of the Water Environment	400 km <sup>2</sup>	15				
Commercial Afforestation	2,000 km <sup>2</sup>	142				
5 Year Progress Rate		157	25 %	25 %	25 %	25 %

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## CHAPTER 10 RECOMMENDATION

The followings are recommended for the further study to improve the water environment in Paraná.

### (1) Monitoring of Effect of Soil Erosion on Water Environment

Effects of soil erosion on the water environment are mainly the contamination in the downstream by sediment and agro-toxic residue flowed with soil erosion. Monitoring of these effects at micro river basins is required to know the exact effect and formulate proper countermeasures.

Suspended sediment measurement is conducted by DNAEE, IAP and COPEL mostly along the main rivers for their specific purposes. The measurement at micro river basins together with soil loss computation by USLE makes easy to assess the effect of soil erosion in terms of sediment yield.

Although agro-toxic contamination is induced by not only soil erosion but also other factors, such as surface runoff, washing sprayers for herbicide and pesticide at water course, etc., the relationship between soil erosion and agro-toxic contamination is useful to control agricultural chemicals and formulate countermeasures of soil erosion. Since there are hundreds of agricultural chemicals, the monitoring should give priority to the most harmful and widely used chemicals.

### (2) Test of USLE (Universal Soil Loss Equation)

USLE (Universal Soil Loss Equation) and RUSLE (Revised Universal Soil Loss Equation) were applied for the soil loss simulations. During the factor determination of USLE or RUSLE, it was tried to take account of the reality as much as possible; however, the model itself have not been tested enough in Paraná. Since the factors involved in USLE and RUSLE depend on the local variables, the model should be examined through the comparison between the result computed and real data. USLE and RUSLE are expected to be more popular in Paraná state. Therefore, the reinforced model with adequate number of tests would contribute to estimate soil loss in a specific area and formulate proposals to suppress soil erosion.

### (3) Review of Data

During the study, it was often found the discrepancy of data among the government authorities or institutions. It is necessary to review the data by a government agency which has an authority over the data and to use each data from one reliable source.

### (4) Share of Data

For the improvement of the further studies or researches, it is necessary to make easy access to data of any government authorities. It is an ideal that there is a database accessible from any government authorities or individuals who have permission.

**Appendix-1**  
**Conserved Area of Primary Crops in Paraná with EMATER Division**

Table-A1.1 Conserved Area of Primary Crops in Parana with EMATER Division (1/6)

No.	Region	Items	No. of Producers	Area (ha)	Area Mechanized (ha)	Area Conserved (ha)	Coverage of conservation (%)	Average (%)
2	Curitiba	Beans	18,913	31,378	11,450	1,736	5.5	
3	Lapa	Beans	8,001	25,455	19,818	8,994	35.3	
4	Ponta Grossa	Beans	19,653	63,475	37,000	19,960	31.4	
5	Irati	Beans	13,529	58,550	47,050	14,610	25.0	
6	Uniao da Vitoria	Beans	11,620	37,514	23,769	4,580	12.2	
7	Guarapuava	Beans	23,694	65,020	36,460	14,330	22.0	
8	Pato Branco	Beans	10,886	20,760	11,405	7,010	33.8	
9	Francisco Beltrao	Beans	25,670	61,750	24,602	26,276	42.6	
10	Cascavel	Beans	11,182	16,540	9,015	8,243	49.8	
11	Toledo	Beans	2,613	5,315	3,685	3,253	61.2	
12	Umuarama	Beans	4,581	10,425	3,758	3,298	31.6	
13	Campo Mourao	Beans	5,303	15,954	8,480	8,150	51.1	
14	Ivaipora	Beans	16,696	71,490	39,393	24,251	33.9	
15	Paranavai	Beans	683	1,638	992	958	58.5	
16	Maringa	Beans	361	1,283	1,175	911	71.0	
17	Apucarana	Beans	1,722	4,330	3,085	2,095	48.4	
18	Londrina	Beans	450	1,280	1,034	1,197	93.5	
19	Cornelio Procopio	Beans	891	2,500	1,124	755	30.2	
20	Jacarezinho	Beans	9,317	27,339	17,443	10,925	40.0	30.9
2	Curitiba	Beans (winter)	1,368	4,256	1,017	293	6.9	
4	Ponta Grossa	Beans (winter)	1,882	11,520	10,830	7,905	68.6	
5	Irati	Beans (winter)	587	1,860	1,860	1,025	55.1	
6	Uniao da Vitoria	Beans (winter)	98	1,330	1,330	330	24.8	
7	Guarapuava	Beans (winter)	727	2,645	1,365	740	28.0	
8	Pato Branco	Beans (winter)	659	1,058	631	412	38.9	
9	Francisco Beltrao	Beans (winter)	4,605	6,215	1,910	1,570	25.3	
12	Umuarama	Beans (winter)	1,212	2,950	1,345	925	31.4	
14	Ivaipora	Beans (winter)	1,320	4,955	4,045	827	16.7	
15	Paranavai	Beans (winter)	803	7,115	6,666	5,286	74.3	
16	Maringa	Beans (winter)	380	2,280	2,252	2,045	89.7	
18	Londrina	Beans (winter)	644	3,880	3,730	3,505	90.3	
19	Cornelio Procopio	Beans (winter)	1,671	8,093	6,328	5,125	63.3	
20	Jacarezinho	Beans (winter)	4,229	16,555	12,868	10,151	61.3	53.7
1	Paranagua	Cassava	1,306	1,312	340	140	10.7	
2	Curitiba	Cassava	4,292	2,991	196	56	1.9	
3	Lapa	Cassava	2,440	370	330	0	0.0	
4	Ponta Grossa	Cassava	6,199	3,155	1,973	615	19.5	
5	Irati	Cassava	7,270	823	660	160	19.4	
6	Uniao da Vitoria	Cassava	4,500	2,233	589	90	4.0	
7	Guarapuava	Cassava	4,720	812	322	0	0.0	
8	Pato Branco	Cassava	7,485	3,075	1,050	709	23.1	
9	Francisco Beltrao	Cassava	25,470	13,955	7,123	6,380	45.7	
10	Cascavel	Cassava	20,233	18,095	15,229	12,678	70.1	
11	Toledo	Cassava	9,111	20,529	18,435	16,474	80.2	
12	Umuarama	Cassava	4,005	26,680	17,378	15,688	58.8	
13	Campo Mourao	Cassava	2,798	15,971	14,240	11,310	70.8	
14	Ivaipora	Cassava	2,761	2,681	861	355	13.2	
15	Paranavai	Cassava	1,815	29,972	29,842	24,716	82.5	
16	Maringa	Cassava	575	5,486	5,470	3,604	65.7	
18	Londrina	Cassava	615	2,407	1,962	1,902	79.0	
20	Jacarezinho	Cassava	1,644	2,051	1,342	537	26.2	62.5
9	Francisco Beltrao	Coffee	565	1,102	0	345	31.3	
11	Toledo	Coffee	1,308	7,290	395	360	4.9	
12	Umuarama	Coffee	7,868	48,931	1,501	12,938	26.4	
13	Campo Mourao	Coffee	2,387	21,353	3,083	6,393	29.9	



Table-A1.1 Conserved Area of Primary Crops in Parana with EMATER Division (2/6)

No.	Region	Items	No. of Producers	Area (ha)	Area Mechanized (ha)	Area Conserved (ha)	Coverage of conservation (%)	Average (%)
14	Ivaipora	Coffee	2,672	15,817	1,140	2,430	15.4	
15	Paranavai	Coffee	2,159	25,533	11,300	9,043	35.4	
16	Maringa	Coffee	1,144	11,061	3,514	4,304	38.9	
17	Apucarana	Coffee	1,460	14,860	7,840	4,130	27.8	
18	Londrina	Coffee	1,289	25,080	13,506	12,691	50.6	
19	Cornelio Procopio	Coffee	1,177	19,715	14,948	8,739	44.3	
20	Jacarezinho	Coffee	4,440	31,537	16,775	15,880	50.4	34.8
10	Cascavel	Cotton	4,313	24,242	20,309	18,093	74.6	
11	Toledo	Cotton	5,297	38,910	36,440	31,409	80.7	
12	Umuarama	Cotton	6,041	44,022	39,631	31,660	71.9	
13	Campo Mourao	Cotton	8,168	79,250	70,043	52,727	66.5	
14	Ivaipora	Cotton	4,448	30,811	25,626	19,673	63.9	
15	Paranavai	Cotton	1,382	20,447	20,195	17,194	84.1	
16	Maringa	Cotton	1,229	18,238	17,418	14,085	77.2	
17	Apucarana	Cotton	1,156	11,270	10,620	7,505	66.6	
18	Londrina	Cotton	707	13,427	13,376	11,464	85.4	
19	Cornelio Procopio	Cotton	2,976	33,741	32,050	24,098	71.4	
20	Jacarezinho	Cotton	166	1,928	1,591	1,201	62.3	72.4
2	Curitiba	Maize	20,992	73,330	33,240	4,140	5.6	
3	Lapa	Maize	10,735	50,140	29,145	13,490	26.9	
4	Ponta Grossa	Maize	23,420	219,038	163,437	108,921	49.7	
5	Irati	Maize	15,549	81,620	58,170	21,740	26.6	
6	Uniao da Vitoria	Maize	11,450	51,210	31,456	10,610	20.7	
7	Guarapuava	Maize	27,748	308,554	203,775	121,200	39.3	
8	Pato Branco	Maize	14,872	164,570	100,150	63,596	38.6	
9	Francisco Beltrao	Maize	33,495	257,144	123,112	111,446	43.3	
10	Cascavel	Maize	23,574	221,605	162,190	145,320	65.6	
11	Toledo	Maize	13,155	132,230	125,380	114,820	86.8	
12	Umuarama	Maize	6,956	29,025	18,945	16,715	57.6	
13	Campo Mourao	Maize	12,406	124,550	106,740	91,820	73.7	
14	Ivaipora	Maize	22,933	200,335	114,600	71,910	35.9	
15	Paranavai	Maize	1,316	11,931	10,690	9,202	77.1	
16	Maringa	Maize	2,017	28,427	25,974	22,212	78.1	
17	Apucarana	Maize	4,777	56,290	45,350	32,260	57.3	
18	Londrina	Maize	3,836	49,819	46,719	43,606	87.5	
19	Cornelio Procopio	Maize	5,895	73,414	62,288	49,622	67.6	
20	Jacarezinho	Maize	15,046	103,217	65,497	45,245	43.8	49.1
4	Ponta Grossa	Maize (safrinha)	3,040	11,780	10,320	5,620	47.7	
7	Guarapuava	Maize (safrinha)	930	7,450	4,650	610	8.2	
8	Pato Branco	Maize (safrinha)	2,915	16,844	7,270	4,220	25.1	
9	Francisco Beltrao	Maize (safrinha)	18,372	78,592	37,660	35,806	45.6	
10	Cascavel	Maize (safrinha)	5,413	66,189	62,840	58,180	87.9	
11	Toledo	Maize (safrinha)	9,495	115,020	113,670	102,787	89.4	
12	Umuarama	Maize (safrinha)	1,102	5,895	5,132	4,377	74.2	
13	Campo Mourao	Maize (safrinha)	1,716	27,600	25,100	21,660	78.5	
14	Ivaipora	Maize (safrinha)	4,232	26,001	18,652	11,884	45.7	
15	Paranavai	Maize (safrinha)	258	2,436	2,274	1,626	66.7	
16	Maringa	Maize (safrinha)	1,498	41,877	33,221	30,652	73.2	
17	Apucarana	Maize (safrinha)	268	2,000	1,668	1,165	58.3	
18	Londrina	Maize (safrinha)	1,502	48,735	28,699	26,479	54.3	
19	Cornelio Procopio	Maize (safrinha)	1,879	45,867	44,497	38,479	83.9	
20	Jacarezinho	Maize (safrinha)	2,759	16,965	13,010	7,317	43.1	68.4
2	Curitiba	Pasture (natural)	10,525	99,478	NA	130	0.1	
3	Lapa	Pasture (natural)	8,107	85,220	NA	43,648	51.2	
4	Ponta Grossa	Pasture (natural)	9,119	248,873	NA	10,000	4.0	
5	Irati	Pasture (natural)	10,390	54,200	NA	0	0.0	
6	Uniao da Vitoria	Pasture (natural)	11,062	110,617	NA	0	0.0	

Table-A1.1 Conserved Area of Primary Crops in Parana with EMATER Division (3/6)

No.	Region	Items	No. of Producers	Area (ha)	Area Mechanized (ha)	Area Conserved (ha)	Coverage of conservation (%)	Average (%)
7	Guarapuava	Pasture (natural)	10,646	143,066	NA	0	0.0	
8	Pato Branco	Pasture (natural)	3,105	139,245	NA	0	0.0	
9	Francisco Beltrao	Pasture (natural)	8,892	38,630	NA	1,670	4.3	
11	Toledo	Pasture (natural)	1,220	18,658	NA	2,200	11.8	
13	Campo Mourao	Pasture (natural)	592	21,250	NA	7,250	34.1	
14	Ivaipora	Pasture (natural)	10,552	58,431	NA	2,000	3.4	
15	Paranavai	Pasture (natural)	99	10,384	NA	3,560	34.3	
16	Maringa	Pasture (natural)	189	4,310	NA	200	4.6	
17	Apucarana	Pasture (natural)	835	11,460	NA	50	0.4	
18	Londrina	Pasture (natural)	128	6,724	NA	0	0.0	
19	Cornelio Procopio	Pasture (natural)	1,025	43,425	NA	2,759	6.4	
20	Jacarezinho	Pasture (natural)	3,392	88,219	NA	2,950	3.3	6.5
2	Curitiba	Pasture (planted)	4,040	22,161	NA	660	3.0	
3	Lapa	Pasture (planted)	1,376	29,363	NA	26,180	89.2	
4	Ponta Grossa	Pasture (planted)	6,141	255,187	NA	59,158	23.2	
5	Irati	Pasture (planted)	2,756	15,525	NA	1,017	6.6	
6	Uniao da Vitoria	Pasture (planted)	3,970	51,302	NA	500	1.0	
7	Guarapuava	Pasture (planted)	9,386	228,000	NA	4,100	1.8	
8	Pato Branco	Pasture (planted)	10,543	120,932	NA	10,600	8.8	
9	Francisco Beltrao	Pasture (planted)	23,118	134,078	NA	12,002	9.0	
10	Cascavel	Pasture (planted)	27,346	356,928	NA	25,715	7.2	
11	Toledo	Pasture (planted)	17,422	123,267	NA	39,588	32.1	
12	Umuarama	Pasture (planted)	21,692	1,227,377	NA	232,364	18.9	
13	Campo Mourao	Pasture (planted)	13,001	380,255	NA	67,440	17.7	
14	Ivaipora	Pasture (planted)	17,269	338,367	NA	9,880	2.9	
15	Paranavai	Pasture (planted)	7,059	891,395	NA	256,997	28.8	
16	Maringa	Pasture (planted)	5,087	277,855	NA	66,371	23.9	
17	Apucarana	Pasture (planted)	2,121	100,593	NA	5,400	5.4	
18	Londrina	Pasture (planted)	4,696	254,038	NA	39,534	15.6	
19	Cornelio Procopio	Pasture (planted)	3,587	180,367	NA	12,519	6.9	
20	Jacarezinho	Pasture (planted)	8,160	358,122	NA	41,530	11.6	17.1
2	Curitiba	Potato	4,005	13,370	13,251	1,045	7.8	
3	Lapa	Potato	1,291	5,592	5,542	396	7.1	
4	Ponta Grossa	Potato	577	1,207	1,167	250	20.7	
5	Irati	Potato	544	1,521	1,441	366	24.1	
6	Uniao da Vitoria	Potato	657	1,229	1,177	14	1.1	
7	Guarapuava	Potato	485	1,063	1,053	49	4.6	
8	Pato Branco	Potato	4,045	313	270	66	21.1	
9	Francisco Beltrao	Potato	4,126	229	99	110	48.0	
10	Cascavel	Potato	5	1,800	NA	NA	NA	9.4
2	Curitiba	Potato(Winter)	3,410	8,008	7,904	591	7.4	
7	Guarapuava	Potato (winter)	110	2,980	2,830	30	1.0	5.7
2	Curitiba	Rice (upland)	3,562	1,193	632	171	14.3	
3	Lapa	Rice (upland)	1,502	908	782	124	13.7	
4	Ponta Grossa	Rice (upland)	9,440	8,149	5,616	3,094	38.0	
5	Irati	Rice (upland)	9,720	6,214	5,279	535	8.6	
6	Uniao da Vitoria	Rice (upland)	7,298	5,800	2,640	660	11.4	
7	Guarapuava	Rice (upland)	17,220	10,625	6,975	2,778	26.1	
8	Pato Branco	Rice (upland)	8,536	3,338	1,595	1,075	32.2	
9	Francisco Beltrao	Rice (upland)	21,150	7,805	3,485	3,261	41.8	
10	Cascavel	Rice (upland)	11,599	7,098	4,985	4,406	62.1	
11	Toledo	Rice (upland)	2,043	1,149	917	713	62.1	
12	Umuarama	Rice (upland)	1,267	1,510	713	546	36.2	
13	Campo Mourao	Rice (upland)	3,607	5,016	3,510	2,595	51.7	

Table-A1.1 Conserved Area of Primary Crops in Parana with EMATER Division (4/6)

No.	Region	Items	No. of Producers	Area (ha)	Area Mechanized (ha)	Area Conserved (ha)	Coverage of conservation (%)	Average (%)
14	Ivaipora	Rice (upland)	5,514	10,440	4,508	2,282	21.9	
15	Paranavai	Rice (upland)	586	1,184	946	538	45.4	
16	Maringa	Rice (upland)	550	1,339	736	713	53.2	
17	Apucarana	Rice (upland)	1,646	2,825	1,736	951	33.7	
18	Londrina	Rice (upland)	1,219	2,920	2,739	2,167	74.2	
19	Cornelio Procopio	Rice (upland)	988	1,148	970	689	60.0	
20	Jacarezinho	Rice (upland)	5,373	9,753	4,567	2,297	23.6	33.5
11	Toledo	Rice (paddy)	294	1,725	1,709	1,182	68.5	
12	Umuarama	Rice (paddy)	305	2,263	2,049	2,090	92.4	
15	Paranavai	Rice (paddy)	112	3,371	3,370	3,314	98.3	
18	Londrina	Rice (paddy)	251	1,263	1,243	1,211	95.9	
19	Cornelio Procopio	Rice (paddy)	1,476	2,965	1,993	704	23.7	
20	Jacarezinho	Rice (paddy)	575	1,882	1,766	1,729	91.9	76.0
3	Lapa	Soybean	122	4,800	4,800	2,525	52.6	
4	Ponta Grossa	Soybean	2,294	129,435	129,235	112,183	86.7	
5	Iraí	Soybean	602	16,750	16,750	13,160	78.6	
6	União da Vitória	Soybean	180	8,603	8,603	4,544	52.8	
7	Guarapuava	Soybean	1,026	86,050	85,550	81,775	95.0	
8	Pato Branco	Soybean	6,820	109,380	105,340	80,856	73.9	
9	Francisco Beltrão	Soybean	7,832	102,780	87,476	75,630	73.6	
10	Cascavel	Soybean	11,797	273,130	266,530	249,100	91.2	
11	Toledo	Soybean	18,455	310,050	308,950	272,180	87.8	
12	Umuarama	Soybean	875	24,445	16,445	22,445	91.8	
13	Campo Mourão	Soybean	8,192	320,635	318,335	275,185	85.8	
14	Ivaipora	Soybean	2,157	56,251	49,521	43,036	76.5	
15	Paranavai	Soybean	135	5,657	5,657	4,927	87.1	
16	Maringá	Soybean	4,982	160,886	160,886	145,447	90.4	
17	Apucarana	Soybean	1,192	37,126	33,726	26,066	70.2	
18	Londrina	Soybean	3,378	151,978	147,978	129,778	85.4	
19	Cornelio Procopio	Soybean	3,210	128,907	128,117	102,112	79.2	
20	Jacarezinho	Soybean	732	16,900	16,900	16,182	95.8	85.3
4	Ponta Grossa	Soybean (safrinha)	26	1,230	1,230	1,210	98.4	
10	Cascavel	Soybean (safrinha)	358	6,500	5,550	5,350	82.3	
11	Toledo	Soybean (safrinha)	3,938	58,750	58,750	54,200	92.3	
13	Campo Mourão	Soybean (safrinha)	136	3,435	3,435	3,190	92.9	
16	Maringá	Soybean (safrinha)	47	1,064	1,064	1,064	100.0	
18	Londrina	Soybean (safrinha)	73	1,666	1,666	1,586	95.2	
19	Cornelio Procopio	Soybean (safrinha)	245	3,694	3,660	3,211	86.9	91.4
7	Guarapuava	Sugarcane	2,103	385	120	50	13.0	
8	Pato Branco	Sugarcane	3,740	865	310	430	49.7	
9	Francisco Beltrão	Sugarcane	16,190	4,569	662	1,181	25.8	
10	Cascavel	Sugarcane	6,845	2,045	1,108	1,108	54.2	
12	Umuarama	Sugarcane	616	37,049	36,527	36,501	98.5	
13	Campo Mourão	Sugarcane	493	19,612	18,562	18,317	93.4	
14	Ivaipora	Sugarcane	2,564	6,790	6,325	6,235	91.8	
15	Paranavai	Sugarcane	294	22,816	22,816	22,604	99.1	
16	Maringá	Sugarcane	675	37,628	37,023	32,423	86.2	
17	Apucarana	Sugarcane	198	7,217	7,217	6,729	93.2	

Table-A1.1 Conserved Area of Primary Crops in Parana with EMATER Division (5/6)

No.	Region	Items	No. of Producers	Area (ha)	Area Mechanized (ha)	Area Conserved (ha)	Coverage of conservation (%)	Average (%)
18	Londrina	Sugarcane	412	40,519	30,293	30,161	74.4	
19	Cornelio Procopio	Sugarcane	164	28,814	27,204	24,581	85.3	
20	Jacarezinho	Sugarcane	912	40,949	28,534	26,405	64.5	82.9
3	Lapa	Wheat	686	2,145	1,870	840	39.2	
4	Ponta Grossa	Wheat	702	54,018	53,617	48,006	88.9	
5	Irati	Wheat	910	3,650	3,350	2,530	69.3	
6	Uniao da Vitoria	Wheat	382	1,113	854	196	17.6	
7	Guarapuava	Wheat	532	16,420	15,870	15,525	94.5	
8	Pato Branco	Wheat	2,167	27,360	25,490	17,168	62.7	
9	Francisco Beltrao	Wheat	9,337	50,390	42,594	31,924	63.4	
10	Cascavel	Wheat	5,451	114,040	113,520	103,430	90.7	
11	Toledo	Wheat	9,757	158,050	154,102	132,315	83.7	
12	Umuarama	Wheat	574	12,840	12,835	10,035	78.2	
13	Campo Mourao	Wheat	4,481	201,750	198,500	172,400	85.5	
14	Ivaipora	Wheat	1,888	33,399	33,211	25,738	77.1	
15	Paranavai	Wheat	79	2,432	2,432	2,432	100.0	
16	Maringa	Wheat	2,661	80,865	80,865	72,530	89.7	
17	Apucarana	Wheat	796	20,430	20,430	16,930	82.9	
18	Londrina	Wheat	1,402	55,960	55,910	50,210	89.7	
19	Cornelio Procopio	Wheat	2,676	85,770	84,190	60,553	70.6	
20	Jacarezinho	Wheat	633	13,465	13,465	13,115	97.4	83.1

Source: EMATER (1993)

NA: not available

safrinha: second cultivation in summer

**Appendix-2**  
**Soil Loss Computation for Paraná State and Relation**  
**between Discharge and Suspended Sediment**

## Appendix-2

### 1. Determination of Specific Land Use

Land use in 9 river basins, Cinzas, Iguacu, Itarare, Ivai, Litoranea, Piquiri, Pirapo, Ribeira and Tibagi, was determined based on the satellite imagery analysis conducted by IAP and GIS computation by SANEPAR. The reason why Parana and Paranapanema river basins are excluded from the erosion study is that both basins scatter in several locations and are not complete river basins. Anyway, their characteristics of soil erosion are considered to be similar to nearby river basins.

Although the satellite imagery analysis is based on the data in 1989 and 1990, it was assumed that the current land use does not vary from one in 1989 and 1990. The fraction of each land use was adopted from SANEPAR GIS computation and their area was calculated as shown in Table-A2.1. Since agriculture is not dominant in Litoranea river basin (coastal region) and forest inclusive of reforestation covers more than 70 % of its area, soil erosion is not significant in this region. Therefore, Litoranea river basin was excluded from the study.

Satellite imagery analysis was reviewed in 1994. The data in Table-A2.1 is before the review, while the data in Table-3.6 is based on the review. Since the difference between them is negligibly small to the soil loss simulation for the Strategy, the soil loss was not re-computed.

To specify crop area with dominant crops, EMATER data (Appendix-1) was applied. Since the data is EMATER division wise, the area fraction of each river basin in EMATER division has to be obtained. And further, since rainfall factor division determined by Rufino et. al. (1993) was adopted to assess the rainfall erosivity, the area fraction has to be divided by each rainfall region. As shown in Table-A2.2, the area fractions of the rainfall factor division per river basin and EMATER division were obtained with GIS computation overlapping EMATER division, river basin and rainfall factor division maps.

Since the result of IAP satellite imagery analysis was adopted to assess the area of land use, ratios of dominant crops to the total crop area, and application rate of conservation measures for dominant crops and pasture were extracted from EMATER data applying the area fraction in Table-A2.2. As a result, each land use in Table-A2.1 was classified into river basin and rainfall factor division, and crop land in the table was specified with dominant crops as shown in Table-A2.3.

### 2. USLE Computation

After knowing specific land use in the state, the amount of gross erosion in 8 river basins was computed. Each factor of USLE equation was determined following the assumptions in the main text (see Chapter 3). The figures of each factor and result of USLE computation are shown in Table-A2.4.

Table-A2.1 Ratio and Area of Land Use in 9 River Basins

River Basin	Crop Land	Forest	Pasture	Reforestation	Sand Bank	Second Vegetation	Swamp	Total
Cunzas	Ratio (%) 55.13	2.94	22.24	6.21	0.12	13.36	0.00	100.00
	Area (1,000 ha) 512.2	27.3	206.6	57.7	1.1	124.1	0.0	929.07
Iguacu	Ratio (%) 38.44	14.56	17.86	1.72	0.00	27.42	0.00	100.00
	Area (1,000 ha) 2,126.4	805.4	988.0	95.2	0.0	1,516.8	0.0	5,531.80
Iaurare	Ratio (%) 39.52	1.26	17.50	21.69	0.00	20.03	0.00	100.00
	Area (1,000 ha) 205.4	6.5	91.0	112.7	0.0	104.1	0.0	519.79
Ivai	Ratio (%) 33.16	5.05	28.92	1.80	0.00	31.07	0.00	100.00
	Area (1,000 ha) 1,189.7	181.2	1,037.6	64.6	0.0	1,114.8	0.0	3,587.89
Litoranea	Ratio (%) 4.84	70.08	5.33	3.97	7.08	4.68	3.82	100.00
	Area (1,000 ha) 27.9	404.1	31.9	22.9	40.8	27.0	22.0	576.60
Piquiri	Ratio (%) 42.88	2.10	34.27	0.33	0.00	20.42	0.00	100.00
	Area (1,000 ha) 1,059.5	51.9	846.7	8.2	0.0	504.5	0.0	2,470.79
Pirapo	Ratio (%) 34.10	2.49	38.12	0.00	0.00	25.29	0.00	100.00
	Area (1,000 ha) 170.7	12.5	190.8	0.0	0.0	126.6	0.0	500.59
Ribeira	Ratio (%) 25.50	5.69	11.54	5.34	0.00	51.93	0.00	100.00
	Area (1,000 ha) 232.8	51.9	105.4	48.8	0.0	474.1	0.0	912.93
Tibagi	Ratio (%) 40.51	3.80	18.30	9.54	0.00	27.85	0.00	100.00
	Area (1,000 ha) 998.0	93.6	450.8	235.0	0.0	686.1	0.0	2,463.47

Source: SANEPAE GIS Computation (1994)

Table-A2.2 Area Fraction per Rainfall Factor Division and River Basin

No.	Area (km <sup>2</sup> )	River Basin Cuzas			Igaracu			Itacaré			Ivaí			Lit.			P.P.			Piquan			Pra.			Rib.			Total							
		R-4	R-7	R-8	R-1	R-2	R-6	R-7	R-8	R-1	R-2	R-4	R-5	R-6	R-7	NS	NS	NS	R-1	R-6	R-4	R-4	R-4	R-5	R-3	R-3	R-4	R-5		R-7	R-8					
EM-1	5,594.6																																			
EM-2	11,168.3			31				2						4																						
EM-3	4,693.0			61	61	34		11					5																							
EM-4	24,180.4		9	5	17	35																														
EM-5	5,831.5																																			
EM-6	7,366.4						73																													
EM-7	20,455.1						50																													
EM-8	9,462.8						3	32																												
EM-9	7,710.6							61																												
EM-10	14,447.0																																			
EM-11	8,431.6																																			
EM-12	14,375.0																																			
EM-13	12,207.6																																			
EM-14	9,461.4																																			
EM-15	10,099.2																																			
EM-16	6,688.8																																			
EM-17	3,197.8																																			
EM-18	6,905.8																																			
EM-19	7,512.0			28	5																															
EM-20	8,133.5			8	51																															
Total	197,882.0							18																												

R: Inocentent Region, Lit.: Litorânea, P.: Parana, P.P.: Parana Parana, Pra.: Prapo, Rib.: Ribeira, NS: R division is not specified because USLE was not applied in those river basins. Since agriculture in Paranaigua region is not popular compared to other regions, EM-1 is excluded for USLE computation.

Source: adapted and enlarged from GIS computation by SANEPAR for Area Ratio.



Table-A2.3 Area of Land Use by Rainfall Factor Division and River Basin (1/3)

Climate	Land Use	R-4			R-7			R-8			R-8			R-8			R-8			Total		
		Area %	Area U(ha)	Area C(ha)	Area %	Area U(ha)	Area C(ha)	Area %	Area U(ha)	Area C(ha)	Area %	Area U(ha)	Area C(ha)	Area %	Area U(ha)	Area C(ha)	Area %	Area U(ha)	Area C(ha)			
Crop Area	Beans	0	0	0	7	37	13,266	22,588														
	Coffee	3	46	7,068	6	50	13,366	15,366														
	Cotton	3	71	10,910	0	0	0	0														
	Maize	10	61	31,244	19,976	27	47	64,998	73,796													
	*Maize(melinda)	5	80	20,488	5,122	4	51	10,449	10,039													
	Soybean	14	80	57,356	14,342	9	88	40,566	5,532													
	Sugarcane	4	79	16,186	4,302	8	66	27,044	13,922													
	Total					100		512,200														
	Forest	2nd Vegetation	0	0	4,250		0	0	807,760	83,000												
		2nd Vegetation	0	0	318,500		0	0	83,600	124,100												
Pasture		R	4,297	49,419		10	15,288	197,596	206,600													
Igneous	Beans	2	41	17,436	25,092	3	41	26,155	37,607	5	21	22,327	83,990	2	26	11,057	31,471	1	20	4,253	17,011	
	Cassava	1	61	12,971	8,293	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Cassia	1	75	15,948	5,316	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Maize	14	53	157,779	139,917	12	42	107,171	147,997	20	36	153,101	272,179	4	29	24,666	60,390	2	15	6,279	36,149	
	*Maize(melinda)	4	67	56,988	28,068	3	43	27,481	34,361	1	25	5,316	15,948	0	0	0	0	0	0	0	0	
	Soybean	11	87	203,496	30,408	6	74	94,412	33,172	7	82	122,055	26,795	1	84	17,862	3,402	0	0	0	0	
	Total									100												
	Forest	2nd Vegetation	0	0	189,100		0	0	45,000													
		2nd Vegetation	0	0	348,900		0	0	212,400													
		Pasture	7	16,598	230,522		6	9,485	148,495													
Tertiary	Beans	13	35	9,346	17,356	1	6	123	1,931													
	Coffee	6	50	6,162	6,162	0	0	0	0													
	Maize	45	47	43,442	48,988	2	6	246	3,862													
	*Maize(melinda)	5	44	4,519	5,751	0	0	0	0													
	Soybean	20	88	36,150	4,990	0	0	0	0													
	Sugarcane	8	64	10,516	5,916	0	0	0	0													
	Total									100												
	Forest	2nd Vegetation	0	0	119,300		0	0	0													
		2nd Vegetation	0	0	97,900		0	0	6,200	104,100												
		Pasture	11	9,810	79,370		1	18	1,892	91,000												

Source: EMATER (1993) for Ratios of Crop Area and Conserved Area, SAINPAR GIS Computation for Area of Land Use

Table-A2.3 Area of Land Use by Rainfall Factor Division and River Basin (2/3)

Type	Area			Area			Area			Area			Area			Area			Total			
	%	U(ha)	R-1	%	U(ha)	R-2	%	U(ha)	R-3	%	U(ha)	R-4	%	U(ha)	R-5	%	U(ha)	R-6		%	U(ha)	R-7
Crop Area	1	43	5,116	6,781	0	0	0	0	4	35	16,656	30,932	3	29	10,350	25,341	2	32	7,614	16,180	0	0
Cassava	1	63	7,495	4,402	2	76	18,083	5,711	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coffee	1	27	3,212	8,683	2	31	7,376	16,418	2	25	5,949	17,845	0	0	0	0	0	0	0	0	0	0
Cotton	2	69	16,418	7,276	2	77	18,321	5,473	4	67	31,894	15,704	1	64	7,614	4,283	1	64	7,614	4,283	0	0
Maize	3	70	24,984	10,707	2	64	15,228	8,566	14	47	78,282	88,276	8	36	34,263	60,913	7	40	33,312	49,967	0	0
*Maize(mulch)	1	78	9,280	2,617	0	0	0	0	3	63	22,485	13,206	1	46	5,473	6,424	1	46	5,473	6,424	0	0
Soybean	6	86	61,389	9,993	2	85	20,225	3,569	15	84	149,902	28,553	2	84	19,987	3,807	3	84	29,980	5,711	0	0
Sugarcane	1	97	11,540	357	2	97	23,080	714	1	88	10,469	1,428	0	0	0	0	0	0	0	0	0	0
Total																						
Forest			0	17,206			0	19,664			0	0	0	0	0	0	0	0	0	0	0	0
2nd Vegetation			0	178,400			0	245,300			0	0	0	0	0	0	0	0	0	0	0	0
Pasture			19	41,400	176,696			25	98,572	295,716												
Total																						

Physi	Area			Area			Area			Area			Total
	%	U(ha)	R-1	%	U(ha)	R-2	%	U(ha)	R-3	%	U(ha)	R-4	
Crop Area	3	37	11,760	20,025	1	22	2,331	8,264	0	0	0	0	
Cassava	3	69	21,932	9,853	0	0	0	0	0	0	0	0	
Coffee	3	28	8,900	22,885	0	0	0	0	0	0	0	0	
Cotton	9	71	67,702	27,653	0	0	0	0	0	0	0	0	
Maize	24	67	170,568	83,912	3	39	12,396	19,289	0	0	0	0	
*Maize(mulch)	8	87	73,741	11,019	0	0	0	0	0	0	0	0	
Soybean	40	88	372,944	50,856	1	95	10,065	530	0	0	0	0	
*Soybean(mulch)	2	92	19,495	1,695	0	0	0	0	0	0	0	0	
Sugarcane	3	96	30,514	1,271	0	0	0	0	0	0	0	0	
Total													
Forest			0	51,085			0	0	0	0	0	0	
2nd Vegetation			0	459,100			0	0	0	0	0	0	
Pasture			17	139,621	681,678			1	254	25,147	846,700		
Total													

Physi	Area			Area			Area			Total
	%	U(ha)	R-1	%	U(ha)	R-2	%	U(ha)	R-3	
Crop Area	1	82	1,400	307						
Cassava	6	37	3,790	6,462						
Coffee	7	76	9,081	2,968						
Cotton	15	71	18,180	7,425						
Maize	12	71	14,544	5,940						
*Maize(mulch)	48	88	72,104	9,852						
Soybean	11	85	15,960	2,817						
Sugarcane										
Total	100		170,700							
Forest			0	12,500						
2nd Vegetation			0	126,600						
Pasture			22	41,976	148,824					
Total										

Source: ENMATER (1993) for Ratios of Crop Area and Conserved Area, SANEPAR GIS Computation for Area of Land Use

Table-A2.3 Area of Land Use by Rainfall Factor Division and River Basin (3/3)

River/Basin	Area %		Area C(ha)		Area U(ha)		Total	
	R-8	R-8	R-8	R-8	R-7	R-7	R-8	R-8
Crop Area	24	9	5,028	50,844	59	14	19,229	118,125
*Maize (exfruits)	1	48	1,117	1,211	5	8	1,676	19,276
Soybean	7	87	14,178	2,118	100		232,800	
Total							100,700	100,700
Forest			0	0			474,100	474,100
2nd Vegetation					4		4,216	101,134
Pasture								105,400
<b>Total</b>								
Triangl	Area %		Area C(ha)		Area U(ha)		Total	
	R-3	R-3	R-3	R-3	R-4	R-4	R-5	R-5
Crop Area	0	0	0	0	2	45	8,982	10,978
Coffee	1	48	4,790	5,190	2	74	14,770	5,190
Cotton	2	75	7,485	2,495	6	72	43,114	16,766
Maize	2	70	13,972	5,988	3	70	20,938	8,982
*Maize (exfruits)	6	82	49,102	10,778	11	82	90,020	19,760
Soybean	1	79	7,894	2,096	2	79	15,768	4,192
Total								
Total					0	0	3,286	116,600
Forest			0	0	10	9,467	85,201	
2nd Vegetation			0	0			20,600	
Pasture			11	5,455	44,133	11	1,964	16,948
<b>Total</b>								
Total					0	0	243,164	328,600
Total					0	0	398,000	686,100
Total					12	28,130	206,296	
Total					14	7,573	46,523	459,800

Source: EMATER (1993) for Ratios of Crop Area and Conserved Area, SANEPAR GIS Computation for Area of Land Use  
Area C: Conserved Area, Area U: not Conserved Area

Table-A2.4 Computation of Gross Erosion (1/3)

River Basin	R factor	Vegetation	Slope (%)	Terracing	P factor	Slope limit (m)	LS factor	K factor	R factor	C factor	A	Area(ha)	GE(1000 ty)	UT
Cinzas	R-4	Cotton	8	Y	0.10	25	0.896	0.01	7651	0.625	4	10,910	44	
			8	N	0.50	61	1.410	0.01	7651	0.625	34	4,456	152	
		Coffee	8	Y	0.10	25	0.896	0.01	7651	0.375	3	7,068	21	
			8	N	0.50	61	1.410	0.01	7651	0.375	20	8,298	166	
	Others	8	Y	0.10	25	0.896	0.01	7651	0.250	2	125,284	251		
		8	N	0.50	61	1.410	0.01	7651	0.250	13	43,742	569		
	Pasture	8	Y	0.10	25	0.896	0.03	7651	0.125	3	4,297	13		
		8	N	1.00	61	1.410	0.03	7651	0.125	40	49,419	1,977		
	Forest	30	-	1.00	100	10.500	0.06	7651	0.001	5	4,250	21		
	Secondary Veg	30	-	1.00	100	10.500	0.06	7651	0.003	14	38,500	539		
	R-7	Coffee	10	Y	0.12	20	1.110	0.06	7128	0.375	21	15,366	323	
			10	N	0.60	37	1.500	0.06	7128	0.375	144	15,366	2,213	
		Others	10	Y	0.12	20	1.110	0.06	7128	0.250	14	156,323	2,189	
			10	N	0.60	37	1.500	0.06	7128	0.250	96	125,387	12,037	
		Pasture	10	Y	0.12	20	1.110	0.06	7128	0.125	7	15,283	107	
			10	N	1.00	37	1.500	0.06	7128	0.125	80	137,596	11,008	
		Forest	30	-	1.00	100	10.500	0.06	7128	0.001	4	80,750	323	
		Secondary Veg	30	-	1.00	100	10.500	0.06	7128	0.003	13	85,600	1,113	
	Sub-total											927,900	33,066	36
	Iguazu	R-1	Cotton	8	Y	0.10	25	0.896	0.03	11211	0.625	19	28,919	549
8				N	0.50	61	1.410	0.03	11211	0.625	148	13,609	2,014	
Others			8	Y	0.10	25	0.896	0.03	11211	0.250	8	435,699	3,486	
			8	N	0.50	61	1.410	0.03	11211	0.250	59	223,485	13,186	
Pasture			8	Y	0.10	25	0.896	0.03	11211	0.125	4	16,598	66	
			8	N	1.00	61	1.410	0.03	11211	0.125	59	220,522	13,611	
Forest		30	-	1.00	100	10.500	0.06	11211	0.001	7	189,126	1,324		
Secondary Veg		30	-	1.00	100	10.500	0.06	11211	0.003	21	348,900	7,327		
R-2		Others	8	Y	0.10	25	0.896	0.01	11068	0.250	2	255,169	510	
			8	N	0.50	61	1.410	0.01	11068	0.250	20	255,167	5,103	
		Pasture	8	Y	0.10	25	0.896	0.03	11068	0.125	4	9,485	38	
			8	N	1.00	61	1.410	0.03	11068	0.125	59	148,595	8,767	
		Forest	30	-	1.00	100	10.500	0.06	11068	0.001	7	45,030	315	
		Secondary Veg	30	-	1.00	100	10.500	0.06	11068	0.003	21	212,400	4,460	
R-6		Others	6	Y	0.10	30	0.673	0.06	9063	0.250	9	302,799	2,725	
			6	N	0.50	61	0.952	0.06	9063	0.250	65	398,913	25,929	
		Pasture	6	Y	0.10	30	0.673	0.06	9063	0.125	5	8,102	41	
			6	N	1.00	61	0.952	0.06	9063	0.125	65	396,978	25,804	
		Forest	30	-	1.00	100	10.500	0.06	9063	0.001	6	513,342	3,080	
		Secondary Veg	30	-	1.00	100	10.500	0.06	9063	0.003	17	621,800	10,571	
R-7		Others	10	Y	0.12	20	1.110	0.06	6480	0.250	13	53,585	697	
			10	N	0.60	37	1.500	0.06	6480	0.250	87	95,263	8,288	
		Pasture	10	Y	0.12	20	1.110	0.06	6480	0.125	6	39,816	239	
			10	N	1.00	37	1.500	0.06	6480	0.125	73	88,624	6,470	
		Forest	30	-	1.00	100	10.500	0.06	6480	0.001	4	153,102	612	
		Secondary Veg	30	-	1.00	100	10.500	0.06	6480	0.003	12	182,000	2,184	
R-8		Others	10	Y	0.12	20	1.110	0.06	5334	0.250	11	10,632	117	
	10		N	0.60	37	1.500	0.06	5334	0.250	72	53,160	3,828		
	Pasture	10	Y	0.12	20	1.110	0.06	5334	0.125	5	18,377	92		
		10	N	1.00	37	1.500	0.06	5334	0.125	60	40,903	2,454		
	Forest	30	-	1.00	100	10.500	0.06	5334	0.001	3	0	0		
	Secondary Veg	30	-	1.00	100	10.500	0.06	5334	0.003	10	151,700	1,517		
Sub total											5,531,800	154,804	28	
Itararé	R-7	Coffee	6	Y	0.10	30	0.673	0.01	6548	0.375	2	6,162	12	
			6	N	0.50	61	0.952	0.01	6548	0.375	12	6,162	74	
		Others	6	Y	0.10	30	0.673	0.01	6548	0.250	1	103,973	104	
			6	N	0.50	61	0.952	0.01	6548	0.250	8	82,941	664	
	Pasture	6	Y	0.10	30	0.673	0.01	6548	0.125	1	9,810	10		
		6	N	1.00	61	0.952	0.01	6548	0.125	8	79,370	635		
	Forest	10	-	1.00	100	2.470	0.06	6548	0.001	1	119,300	119		
	Secondary Veg	10	-	1.00	100	2.470	0.06	6548	0.003	3	97,900	294		
	R-8	Others	10	Y	0.12	20	1.110	0.06	5167	0.250	10	369	4	
			10	N	0.60	37	1.500	0.06	5167	0.250	70	5,793	406	
		Pasture	10	Y	0.12	20	1.110	0.06	5167	0.125	5	18	0	
			10	N	1.00	37	1.500	0.06	5167	0.125	58	1,802	105	
		Forest	10	-	1.00	100	2.470	0.06	5167	0.001	1	0	0	
		Secondary Veg	10	-	1.00	100	2.470	0.06	5167	0.003	2	6,200	12	
Sub-total											519,800	2,439	5	

Table-A2.4 Computation of Gross Erosion (2/3)

River Basin	R factor	Vegetation	Slope (%)	Terracing	P factor	Slope limit (m)	LS factor	K factor	R factor	C factor	A	Area (ha)	GE (1000 ty)	UT		
Irai	R-1	Cotton	6	Y	0.10	30	0.673	0.01	10534	0.625	4	23,913	96			
			6	N	0.50	61	0.952	0.01	10534	0.625	31	11,778	365			
	Coffee	6	Y	0.10	30	0.673	0.01	10534	0.375	3	3,212	10				
		6	N	0.50	61	0.952	0.01	10534	0.375	19	8,685	165				
	Others	6	Y	0.10	30	0.673	0.01	10534	0.250	2	112,309	225				
		6	N	0.50	61	0.952	0.01	10534	0.250	13	30,455	396				
	Pasture	6	Y	0.10	30	0.673	0.03	10534	0.125	3	41,400	124				
		6	N	1.00	61	0.952	0.03	10534	0.125	38	176,496	6,707				
	Forest	10	-	1.00	100	2.470	0.06	10534	0.001	2	17,206	34				
	Secondary Veg	10	-	1.00	100	2.470	0.06	10534	0.003	5	178,400	892				
	R-4	Cotton	6	Y	0.10	30	0.673	0.01	7419	0.625	3	36,404	109			
			6	N	0.50	61	0.952	0.01	7419	0.625	22	11,184	246			
	Coffee	6	Y	0.10	30	0.673	0.01	7419	0.375	2	7,376	15				
		6	N	0.50	61	0.952	0.01	7419	0.375	13	16,418	213				
	Others	6	Y	0.10	30	0.673	0.01	7419	0.250	1	58,533	59				
		6	N	0.50	61	0.952	0.01	7419	0.250	9	12,849	116				
	Pasture	6	Y	0.10	30	0.673	0.03	7419	0.125	2	98,572	197				
		6	N	1.00	61	0.952	0.03	7419	0.125	26	295,716	7,689				
	Forest	10	-	1.00	100	2.470	0.06	7419	0.001	1	19,664	20				
	Secondary Veg	10	-	1.00	100	2.470	0.06	7419	0.003	3	245,300	736				
	R-5	Cotton	10	Y	0.12	20	1.110	0.03	9612	0.625	24	31,884	765			
			10	N	0.60	37	1.500	0.03	9612	0.625	162	15,704	2,544			
	Coffee	10	Y	0.12	20	1.110	0.03	9612	0.375	14	5,949	83				
		10	N	0.60	37	1.500	0.03	9612	0.375	97	17,845	1,731				
	Others	10	Y	0.12	20	1.110	0.03	9612	0.250	10	277,794	2,778				
		10	N	0.60	37	1.500	0.03	9612	0.250	65	162,395	10,556				
	Pasture	10	Y	0.12	20	1.110	0.03	9612	0.125	5	27,393	137				
		10	N	1.00	37	1.500	0.03	9612	0.125	54	221,631	11,968				
	Forest	30	-	1.00	100	10.500	0.06	9612	0.001	6	58,992	354				
	Secondary Veg	30	-	1.00	100	10.500	0.06	9612	0.003	18	345,600	6,221				
	R-6	Cotton	10	Y	0.12	20	1.110	0.03	8875	0.625	22	7,614	168			
			10	N	0.60	37	1.500	0.03	8875	0.625	150	4,283	642			
	Others	10	Y	0.12	20	1.110	0.03	8875	0.250	9	20,073	631				
		10	N	0.60	37	1.500	0.03	8875	0.250	60	96,485	5,789				
	Pasture	10	Y	0.12	20	1.110	0.03	8875	0.125	4	1,660	7				
		10	N	1.00	37	1.500	0.03	8875	0.125	50	81,348	4,067				
	Forest	30	-	1.00	100	10.500	0.06	8875	0.001	6	56,534	339				
Secondary Veg	30	-	1.00	100	10.500	0.06	8875	0.003	17	144,900	2,463					
R-7	Cotton	20	Y	0.16	15	2.830	0.06	6749	0.625	115	7,614	876				
		20	N	0.80	20	3.270	0.06	6749	0.625	662	4,283	2,835				
Others	20	Y	0.16	15	2.830	0.06	6749	0.250	46	76,379	3,513					
	20	N	0.80	20	3.270	0.06	6749	0.250	265	78,282	20,745					
Pasture	20	Y	0.16	15	2.830	0.06	6749	0.125	23	5,603	129					
	20	N	1.00	20	3.270	0.06	6749	0.125	166	87,781	14,572					
Forest	30	-	1.00	100	10.500	0.06	6749	0.001	4	93,404	374					
Secondary Veg	30	-	1.00	100	10.500	0.06	6749	0.003	13	200,600	2,608					
Sub-total													3,587,900	115,309	32	
Piquiri	R-1	Cotton	6	Y	0.10	30	0.673	0.01	11723	0.625	5	89,634	448			
			6	N	0.50	61	0.952	0.01	11723	0.625	35	37,506	1,313			
	Coffee	6	Y	0.10	30	0.673	0.01	11723	0.375	3	8,900	27				
		6	N	0.50	61	0.952	0.01	11723	0.375	21	22,885	481				
	Others	6	Y	0.10	30	0.673	0.01	11723	0.250	2	678,822	1,358				
		6	N	0.50	61	0.952	0.01	11723	0.250	14	168,778	2,363				
	Pasture	10	Y	0.12	20	1.110	0.03	11723	0.125	6	139,621	838				
		10	N	1.00	37	1.500	0.03	11723	0.125	66	681,678	44,991				
	Forest	30	-	1.00	100	10.500	0.06	11723	0.001	7	51,085	358				
	Secondary Veg	30	-	1.00	100	10.500	0.06	11723	0.003	22	459,100	10,100				
	R-6	Others	10	Y	0.12	20	1.110	0.03	9063	0.250	9	24,792	223			
			10	N	0.60	37	1.500	0.03	9063	0.250	61	28,183	1,719			
	Pasture	10	Y	0.12	20	1.110	0.03	9063	0.125	5	254	1				
		10	N	1.00	37	1.500	0.03	9063	0.125	51	25,147	1,282				
	Forest	30	-	1.00	100	10.500	0.06	9063	0.001	6	9,015	54				
	Secondary Veg	30	-	1.00	100	10.500	0.06	9063	0.003	17	45,400	772				
	Sub-total													2,470,800	66,328	27

Table-A2.4 Computation of Gross Erosion (3/3)

River Basin	R factor	Vegetation	Slope (%)	Terracing	P factor	Slope limit (m)	LS factor	K factor	R factor	C factor	A	Area(ha)	GE(1000 ty)	UT	
Pirapo	R-4	Cotton	6	Y	0.10	30	0.673	0.01	7918	0.625	3	10,481	31		
			6	N	0.50	61	0.952	0.01	7918	0.625	24	3,175	76		
		Coffee	6	Y	0.10	30	0.673	0.01	7918	0.375	2	3,790	8		
			6	N	0.50	61	0.952	0.01	7918	0.375	14	6,452	90		
		Others	6	Y	0.10	30	0.673	0.01	7918	0.250	1	120,788	121		
			6	N	0.50	61	0.952	0.01	7918	0.250	9	26,014	234		
		Pasture	10	Y	0.12	20	1.110	0.03	7918	0.125	4	41,976	168		
			10	N	1.00	37	1.500	0.03	7918	0.125	45	148,824	6,697		
		Forest	30	-	1.00	100	10.500	0.06	7918	0.001	5	12,500	63		
		Secondary Veg	30	-	1.00	100	10.500	0.06	7918	0.003	15	126,600	1,859		
Sub-total												500,600	9,357	19	
Ribeira	R-8	Potato	10	Y	0.12	20	1.110	0.06	5167	0.750	31	1,676	52		
			10	N	0.60	37	1.500	0.06	5167	0.750	209	19,276	4,029		
		Others	10	Y	0.12	20	1.110	0.06	5167	0.250	10	39,552	396		
			10	N	0.60	37	1.500	0.06	5167	0.250	70	172,296	12,061		
		Pasture	10	Y	0.12	20	1.110	0.06	5167	0.125	5	4,216	21		
			10	N	1.00	37	1.500	0.06	5167	0.125	58	101,184	5,859		
		Forest	30	-	1.00	100	10.500	0.06	5167	0.001	3	100,700	302		
		Secondary Veg	30	-	1.00	100	10.500	0.06	5167	0.003	10	474,100	4,741		
Sub-total												913,009	27,471	30	
Tibagi	R-3	Cotton	8	Y	0.10	25	0.896	0.03	8877	0.625	15	7,485	112		
			8	N	0.50	61	1.410	0.03	8877	0.625	117	2,495	292		
			Coffee	8	Y	0.10	25	0.896	0.03	8877	0.375	9	4,790	43	
				8	N	0.50	61	1.410	0.03	8877	0.375	70	5,190	363	
			Others	8	Y	0.10	25	0.896	0.03	8877	0.250	6	85,928	516	
				8	N	0.50	61	1.410	0.03	8877	0.250	47	23,852	1,121	
		Pasture	10	Y	0.12	20	1.110	0.03	8877	0.125	4	5,455	22		
			10	N	1.00	37	1.500	0.03	8877	0.125	50	44,133	2,207		
		Forest	30	-	1.00	100	10.500	0.06	8877	0.001	6	0	0		
		Secondary Veg	30	-	1.00	100	10.500	0.06	8877	0.003	17	61,700	1,049		
	R-4	Cotton	8	Y	0.12	25	0.896	0.03	8128	0.625	16	14,770	235		
			8	N	0.50	61	1.410	0.03	8128	0.625	107	5,190	555		
			Coffee	8	Y	0.12	25	0.896	0.03	8128	0.375	10	8,982	90	
				8	N	0.50	61	1.410	0.03	8128	0.375	64	10,978	703	
			Others	8	Y	0.12	25	0.896	0.03	8128	0.250	7	169,860	1,189	
				8	N	0.50	61	1.410	0.03	8128	0.250	43	49,700	2,137	
			Pasture	10	Y	0.12	20	1.110	0.03	8128	0.125	4	9,467	38	
				10	N	1.00	37	1.500	0.03	8128	0.125	46	85,201	3,919	
			Forest	30	-	1.00	100	10.500	0.06	8128	0.001	5	3,286	16	
			Secondary Veg	30	-	1.00	100	10.500	0.06	8128	0.003	15	116,600	1,749	
	R-5	Others	6	Y	0.10	30	0.673	0.01	9612	0.250	2	22,954	46		
			6	N	0.50	61	0.952	0.01	9612	0.250	11	6,985	77		
			Pasture	6	Y	0.10	30	0.673	0.03	9612	0.125	2	1,984	4	
				6	N	1.00	61	0.952	0.03	9612	0.125	34	15,048	546	
			Forest	10	-	1.00	100	2.470	0.06	9612	0.001	1	0	0	
			Secondary Veg	10	-	1.00	100	2.470	0.06	9612	0.003	4	20,600	82	
	R-7	Cotton	10	Y	0.12	20	1.110	0.03	7128	0.625	18	7,285	131		
			10	N	0.60	37	1.500	0.03	7128	0.625	120	2,695	323		
			Coffee	10	Y	0.12	20	1.110	0.03	7128	0.375	11	4,790	53	
				10	N	0.60	37	1.500	0.03	7128	0.375	72	5,190	374	
			Others	10	Y	0.12	20	1.110	0.03	7128	0.250	7	250,160	1,751	
				10	N	0.60	37	1.500	0.03	7128	0.250	48	199,000	9,552	
			Pasture	10	Y	0.12	20	1.110	0.06	7128	0.125	7	28,130	197	
				10	N	1.00	37	1.500	0.06	7128	0.125	80	206,286	16,503	
		Forest	30	-	1.00	100	10.500	0.06	7128	0.001	4	243,164	973		
		Secondary Veg	30	-	1.00	100	10.500	0.06	7128	0.003	13	398,000	5,174		
	R-8	Others	10	Y	0.12	20	1.110	0.03	5770	0.250	6	67,764	407		
			10	N	0.60	37	1.500	0.03	5770	0.250	39	42,016	1,639		
		Pasture	10	Y	0.12	20	1.110	0.06	5770	0.125	6	7,573	45		
			10	N	1.00	37	1.500	0.06	5770	0.125	65	45,523	3,024		
		Forest	30	-	1.00	100	10.500	0.06	5770	0.001	4	82,150	329		
		Secondary Veg	30	-	1.00	100	10.500	0.06	5770	0.003	11	89,200	981		
Sub-total												2,463,500	58,568	24	
Total												16,915,300	467,372		
Average in the state														28	

A: annual gross erosion per unit area (ton/ha), GE: annual gross erosion (1,000 ton/year)  
 UT: average annual gross erosion (ton/ha)

Table-A2.5 Computation of Gross Erosion with Countermeasures (1/3)

River Basin	R factor	Vegetation	Slope (%)	Non Tillage	P factor	Slope limit (m)	LS factor	K factor	R factor	C factor	A	Area(ha)	GE(1000 t/y)	UT
Cinzas	R-4	Cotton	8	Y	0.1	25	0.896	0.01	7651	0.125	1	7,683	8	
				N	0.1	25	0.896	0.01	7651	0.625	4	7,683	31	
		Coffee	8	-	0.1	25	0.896	0.01	7651	0.375	3	15,366	46	
	Others	8	Y	0.1	25	0.896	0.01	7651	0.05	0	84,513	0		
			N	0.1	25	0.896	0.01	7651	0.25	2	84,513	169		
	Pasture	8	-	0.1	25	0.896	0.03	7651	0.125	3	53,716	161		
	Forest	30	-	1	100	10.5	0.06	7651	0.001	5	4,250	21		
	Secondary Veg.	30	-	1	100	10.5	0.06	7651	0.003	14	38,500	539		
	R-7	Coffee	10	-	0.12	20	1.11	0.06	7128	0.375	21	30,732	645	
		Others	10	Y	0.12	20	1.11	0.06	7128	0.05	3	140,855	423	
				N	0.12	20	1.11	0.06	7128	0.25	14	140,855	1,972	
		Pasture	10	-	0.12	20	1.11	0.06	7128	0.125	7	152,884	1,070	
		Forest	30	-	1	100	10.5	0.06	7128	0.001	4	80,750	323	
		Secondary Veg.	30	-	1	100	10.5	0.06	7128	0.003	13	85,600	1,113	
		Sub-total											927,900	6,521
	Iguacu	R-1	Cotton	8	Y	0.1	25	0.896	0.03	11211	0.125	4	21,264	85
					N	0.1	25	0.896	0.03	11211	0.625	19	21,264	404
Others			8	Y	0.1	25	0.896	0.03	11211	0.05	2	329,592	659	
				N	0.1	25	0.896	0.03	11211	0.25	8	329,592	2,637	
Pasture			8	-	0.1	25	0.896	0.03	11211	0.125	4	237,120	948	
Forest		30	-	1	100	10.5	0.06	11211	0.001	7	189,126	1,324		
Secondary Veg.		30	-	1	100	10.5	0.06	11211	0.003	21	348,900	7,327		
R-2		Others	8	Y	0.1	25	0.896	0.01	11068	0.05	0	255,168	0	
			N	0.1	25	0.896	0.01	11068	0.25	2	255,168	510		
		Pasture	8	-	0.1	25	0.896	0.03	11068	0.125	4	158,080	632	
		Forest	30	-	1	100	10.5	0.06	11068	0.001	7	45,030	315	
Secondary Veg.		30	-	1	100	10.5	0.06	11068	0.003	21	212,400	4,460		
R-6		Others	6	Y	0.1	30	0.673	0.06	9063	0.05	2	350,856	702	
			N	0.1	30	0.673	0.06	9063	0.25	9	350,856	3,158		
		Pasture	6	-	0.1	30	0.673	0.06	9063	0.125	5	405,080	2,025	
		Forest	30	-	1	100	10.5	0.06	9063	0.001	6	513,342	3,080	
Secondary Veg.		30	-	1	100	10.5	0.06	9063	0.003	17	621,800	10,571		
R-7		Others	10	Y	0.12	20	1.11	0.06	6480	0.05	3	74,424	223	
			N	0.12	20	1.11	0.06	6480	0.25	13	74,424	968		
		Pasture	10	-	0.12	20	1.11	0.06	6480	0.125	6	128,440	771	
		Forest	30	-	1	100	10.5	0.06	6480	0.001	4	153,102	612	
	Secondary Veg.	30	-	1	100	10.5	0.06	6480	0.003	12	182,000	2,184		
R-8	Others	10	Y	0.12	20	1.11	0.06	5334	0.05	2	31,896	64		
		N	0.12	20	1.11	0.06	5334	0.25	11	31,896	351			
	Pasture	10	-	0.12	20	1.11	0.06	5334	0.125	5	59,280	296		
	Forest	30	-	1	100	10.5	0.06	5334	0.001	3	0	0		
Secondary Veg.	30	-	1	100	10.5	0.06	5334	0.003	10	151,700	1,517			
Sub-total											5,531,800	45,823	8	
Itarare	R-7	Coffee	6	-	0.1	30	0.673	0.01	6548	0.375	2	12,324	25	
		Others	6	Y	0.1	30	0.673	0.01	6548	0.05	0	93,457	0	
				N	0.1	30	0.673	0.01	6548	0.25	1	93,457	93	
		Pasture	6	-	0.1	30	0.673	0.01	6548	0.125	1	89,180	89	
		Forest	10	-	1	100	2.47	0.06	6548	0.001	1	119,300	119	
	Secondary Veg.	10	-	1	100	2.47	0.06	6548	0.003	3	97,900	294		
	R-8	Others	10	Y	0.12	20	1.11	0.06	5167	0.05	2	3,081	6	
			N	0.12	20	1.11	0.06	5167	0.25	10	3,081	31		
		Pasture	10	-	0.12	20	1.11	0.06	5167	0.125	5	1,820	9	
		Forest	10	-	1	100	2.47	0.06	5167	0.001	1	0	0	
		Secondary Veg.	10	-	1	100	2.47	0.06	5167	0.003	2	6,200	12	
Sub-total											519,800	678	1	

Table-A2.5 Computation of Gross Erosion with Countermeasures (2/3)

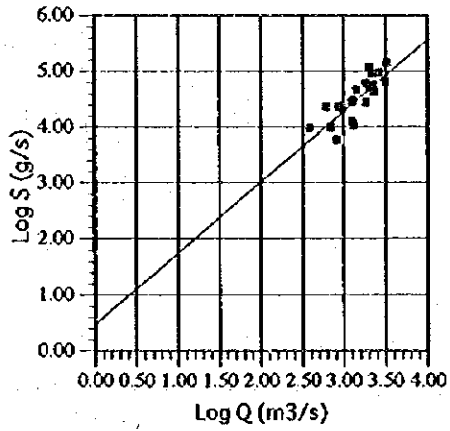
River Basin	R factor	Vegetation	Slope (%)	Non Tillage	P factor	Slope limit (m)	LS factor	K factor	R factor	C factor	A	Area(ha)	GE(1000 ty)	UT
Ivai	R-1	Cotton	6	Y	0.1	30	0.673	0.01	10534	0.125	1	17,845	18	
				N	0.1	30	0.673	0.01	10534	0.625	4	17,845	71	
		Coffee	6	-	0.1	30	0.673	0.01	10534	0.375	3	11,897	36	
	Others	6	Y	0.1	30	0.673	0.01	10534	0.05	0	71,382	0		
				N	0.1	30	0.673	0.01	10534	0.25	2	71,382	143	
	Pasture	6	-	0.1	30	0.673	0.03	10534	0.125	3	217,896	654		
	Forest	10	-	1	100	2.47	0.06	10534	0.001	2	17,206	34		
	Secondary Veg.	10	-	1	100	2.47	0.06	10534	0.003	5	178,400	892		
	R-4	Cotton	6	Y	0.1	30	0.673	0.01	7419	0.125	1	23,794	24	
				N	0.1	30	0.673	0.01	7419	0.625	3	23,794	71	
		Coffee	6	-	0.1	30	0.673	0.01	7419	0.375	2	23,794	48	
	Others	6	Y	0.1	30	0.673	0.01	7419	0.05	0	35,691	0		
				N	0.1	30	0.673	0.01	7419	0.25	1	35,691	36	
	Pasture	6	-	0.1	30	0.673	0.03	7419	0.125	2	394,288	789		
	Forest	10	-	1	100	2.47	0.06	7419	0.001	1	19,664	20		
	Secondary Veg.	10	-	1	100	2.47	0.06	7419	0.003	3	245,300	736		
	R-5	Cotton	10	Y	0.12	20	1.11	0.03	9612	0.125	5	23,794	119	
				N	0.12	20	1.11	0.03	9612	0.625	24	23,794	571	
		Coffee	10	-	0.12	20	1.11	0.03	9612	0.375	14	23,794	333	
	Others	10	Y	0.12	20	1.11	0.03	9612	0.05	2	220,094	440		
				N	0.12	20	1.11	0.03	9612	0.25	10	220,095	2,201	
	Pasture	10	-	0.12	20	1.11	0.03	9612	0.125	5	249,024	1,245		
	Forest	30	-	1	100	10.5	0.06	9612	0.001	6	58,992	354		
	Secondary Veg.	30	-	1	100	10.5	0.06	9612	0.003	18	345,600	6,221		
R-6	Cotton	10	Y	0.12	20	1.11	0.03	8875	0.125	4	5,949	24		
			N	0.12	20	1.11	0.03	8875	0.625	22	5,948	131		
	Others	10	Y	0.12	20	1.11	0.03	8875	0.05	2	83,279	167		
Others			N	0.12	20	1.11	0.03	8875	0.25	9	83,279	750		
	Pasture	10	-	0.12	20	1.11	0.03	8875	0.125	4	83,008	332		
Forest	30	-	1	100	10.5	0.06	8875	0.001	6	56,534	339			
Secondary Veg.	30	-	1	100	10.5	0.06	8875	0.003	17	144,900	2,463			
R-7	Cotton	20	Y	0.16	15	2.83	0.06	6749	0.125	23	5,949	137		
			N	0.16	15	2.83	0.06	6749	0.625	115	5,948	684		
	Others	20	Y	0.16	15	2.83	0.06	6749	0.05	9	77,331	696		
Others			N	0.16	15	2.83	0.06	6749	0.25	46	77,330	3,557		
	Pasture	20	-	0.16	15	2.83	0.06	6749	0.125	23	93,384	2,148		
Forest	30	-	1	100	10.5	0.06	6749	0.001	4	93,404	374			
Secondary Veg.	30	-	1	100	10.5	0.06	6749	0.003	13	200,600	2,608			
Sub-total												3,587,900	29,466	8
Piquiri	R-1	Cotton	6	Y	0.1	30	0.673	0.01	11723	0.125	1	63,570	64	
				N	0.1	30	0.673	0.01	11723	0.625	5	63,570	318	
		Coffee	6	-	0.1	30	0.673	0.01	11723	0.375	3	31,785	95	
	Others	6	Y	0.1	30	0.673	0.01	11723	0.05	0	423,800	0		
				N	0.1	30	0.673	0.01	11723	0.25	2	423,800	848	
	Pasture	10	-	0.12	20	1.11	0.03	11723	0.125	6	821,299	4,928		
	Forest	30	-	1	100	10.5	0.06	11723	0.001	7	51,085	358		
	Secondary Veg.	30	-	1	100	10.5	0.06	11723	0.003	22	459,100	10,100		
	R-6	Others	10	Y	0.12	20	1.11	0.03	9063	0.05	2	26,488	53	
				N	0.12	20	1.11	0.03	9063	0.25	9	26,487	238	
		Pasture	10	-	0.12	20	1.11	0.03	9063	0.125	5	25,401	127	
Forest	30	-	1	100	10.5	0.06	9063	0.001	6	9,015	54			
Secondary Veg.	30	-	1	100	10.5	0.06	9063	0.003	17	45,400	772			
Sub-total												2,470,800	17,955	7



Table-A2.5 Computation of Gross Erosion with Countermeasures (3/3)

River Basin	R factor	Vegetation	Slope (%)	Non Tillage	P factor	Slope limit (m)	LS factor	K factor	R factor	C factor	A	Area(ha)	GE(1000 t/y)	UT	
Pirapo	R-4	Cotton	6	Y	0.1	30	0.673	0.01	7918	0.125	1	6,828	7		
			6	N	0.1	30	0.673	0.01	7918	0.625	3	6,828	20		
		Coffee	6	-	0.1	30	0.673	0.01	7918	0.375	2	10,242	20		
			6	Y	0.1	30	0.673	0.01	7918	0.05	0	73,401	0		
		Others	6	N	0.1	30	0.673	0.01	7918	0.25	1	73,401	73		
			10	N	0.12	20	1.11	0.03	7918	0.125	4	190,800	763		
		Forest	30	-	1	100	10.5	0.06	7918	0.001	5	12,500	63		
		Secondary Veg.	30	-	1	100	10.5	0.06	7918	0.003	15	126,600	1,899		
	Sub-total												500,600	2,845	6
	Ribeira	R-8	Potato	10	Y	0.12	20	1.11	0.06	5167	0.15	6	10,476	63	
10				N	0.12	20	1.11	0.06	5167	0.75	31	10,476	325		
		Others	10	Y	0.12	20	1.11	0.06	5167	0.05	2	105,924	212		
			10	N	0.12	20	1.11	0.06	5167	0.25	10	105,924	1,059		
		Pasture	10	-	0.12	20	1.11	0.06	5167	0.125	5	105,400	527		
		Forest	30	-	1	100	10.5	0.06	5167	0.001	3	100,700	302		
		Secondary Veg.	30	-	1	100	10.5	0.06	5167	0.003	10	474,100	4,741		
Sub-total												913,000	7,229	8	
Tibagi	R-3	Cotton	8	Y	0.1	25	0.896	0.03	8877	0.125	3	4,990	15		
			8	N	0.1	25	0.896	0.03	8877	0.625	15	4,990	75		
			Coffee	8	-	0.1	25	0.896	0.03	8877	0.375	9	9,980	90	
				8	Y	0.1	25	0.896	0.03	8877	0.05	1	54,890	55	
			Others	8	N	0.1	25	0.896	0.03	8877	0.25	6	54,890	329	
				10	-	0.12	20	1.11	0.03	8877	0.125	4	49,588	198	
			Pasture	10	-	0.12	20	1.11	0.03	8877	0.125	4	49,588	198	
			Forest	30	-	1	100	10.5	0.06	8877	0.001	6	0	0	
			Secondary Veg.	30	-	1	100	10.5	0.06	8877	0.003	17	61,700	1,049	
		R-4	Cotton	8	Y	0.12	25	0.896	0.03	8128	0.125	3	9,980	30	
	8			N	0.12	25	0.896	0.03	8128	0.625	16	9,980	160		
			Coffee	8	-	0.12	25	0.896	0.03	8128	0.375	10	19,960	200	
				8	Y	0.12	25	0.896	0.03	8128	0.05	1	109,780	110	
			Others	8	N	0.12	25	0.896	0.03	8128	0.25	7	109,780	768	
				10	-	0.12	20	1.11	0.03	8128	0.125	4	94,668	379	
			Pasture	10	-	0.12	20	1.11	0.03	8128	0.125	4	94,668	379	
			Forest	30	-	1	100	10.5	0.06	8128	0.001	5	3,286	16	
			Secondary Veg.	30	-	1	100	10.5	0.06	8128	0.003	15	116,600	1,749	
	R-5		Others	6	Y	0.1	30	0.673	0.01	9612	0.05	0	14,970	0	
		6		N	0.1	30	0.673	0.01	9612	0.25	2	14,970	30		
			Pasture	6	-	0.1	30	0.673	0.03	9612	0.125	2	18,032	36	
			Forest	10	-	1	100	2.47	0.06	9612	0.001	1	0	0	
			Secondary Veg.	10	-	1	100	2.47	0.06	9612	0.003	4	20,660	82	
	R-7	Cotton	10	Y	0.12	20	1.11	0.03	7128	0.125	4	4,990	20		
			10	N	0.12	20	1.11	0.03	7128	0.625	18	4,990	90		
			Coffee	10	-	0.12	20	1.11	0.03	7128	0.375	11	9,980	110	
				10	Y	0.12	20	1.11	0.03	7128	0.05	1	224,550	225	
			Others	10	N	0.12	20	1.11	0.03	7128	0.25	7	224,550	1,572	
				10	-	0.12	20	1.11	0.06	7128	0.125	7	234,416	1,641	
			Pasture	10	-	0.12	20	1.11	0.06	7128	0.125	7	234,416	1,641	
		Forest	30	-	1	100	10.5	0.06	7128	0.001	4	243,164	973		
		Secondary Veg.	30	-	1	100	10.5	0.06	7128	0.003	13	398,000	5,174		
R-8		Others	10	Y	0.12	20	1.11	0.03	5770	0.05	1	54,890	55		
	10		N	0.12	20	1.11	0.03	5770	0.25	6	54,890	329			
		Pasture	10	-	0.12	20	1.11	0.06	5770	0.125	6	54,096	325		
		Forest	30	-	1	100	10.5	0.06	5770	0.001	4	82,150	329		
	Secondary Veg.	30	-	1	100	10.5	0.06	5770	0.003	11	89,200	981			
Sub-total												2,463,500	17,195	7	
Total												16,915,300	127,712		
Average in the state														8	

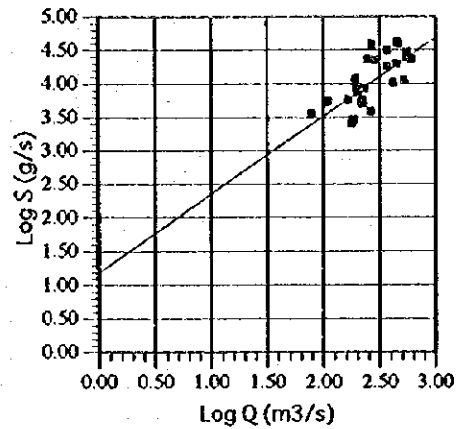
A: annual gross erosion per unit area (ton/ha), GE: annual gross erosion (1,000 ton/ha)  
 UT: average annual gross erosion (ton/ha)



$$f(x) = 1.269288E+0x + 4.865622E-1$$

$$R^2 = 6.673801E-1$$

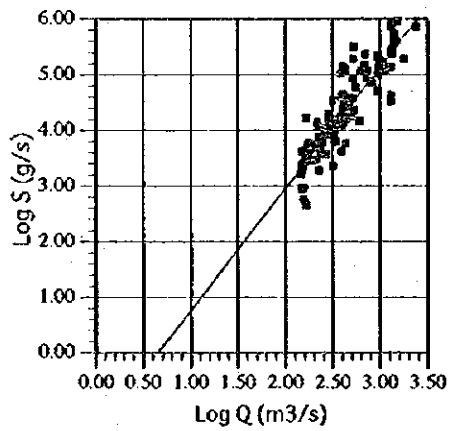
Iguacu



$$f(x) = 1.166726E+0x + 1.193070E+0$$

$$R^2 = 5.260556E-1$$

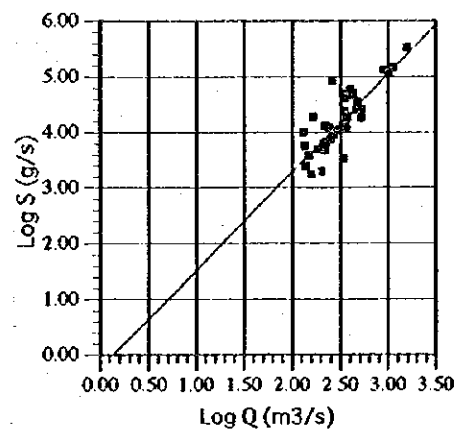
Tibagi



$$f(x) = 2.190701E+0x - 1.423232E+0$$

$$R^2 = 7.943679E-1$$

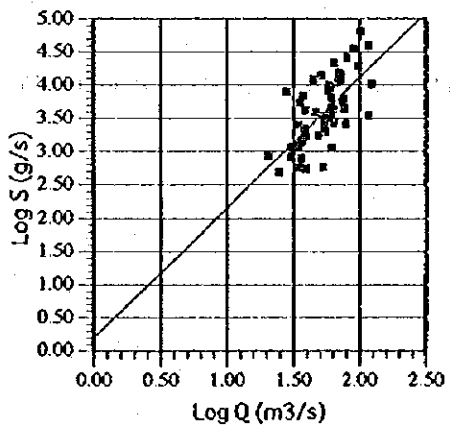
Ivai



$$f(x) = 1.761587E+0x - 2.292786E-1$$

$$R^2 = 6.908003E-1$$

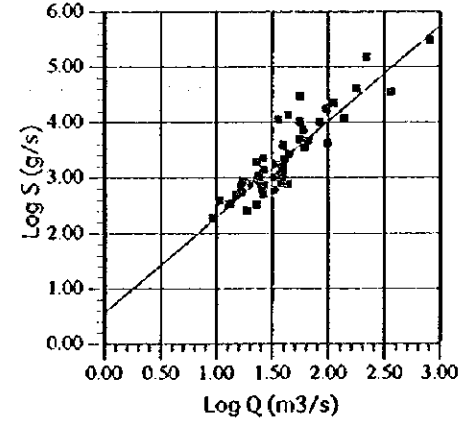
Piquiri



$$f(x) = 1.956650E+0x + 2.081425E-1$$

$$R^2 = 4.456759E-1$$

Pirapo

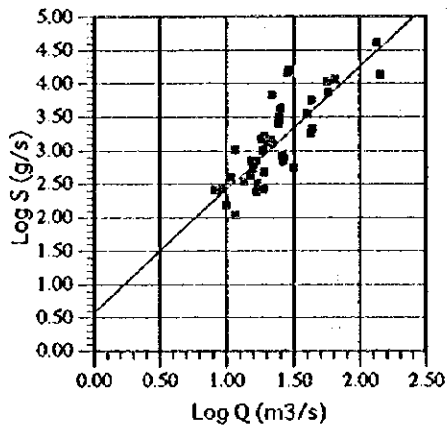


$$f(x) = 1.727807E+0x + 5.688718E-1$$

$$R^2 = 8.150719E-1$$

Cinzas

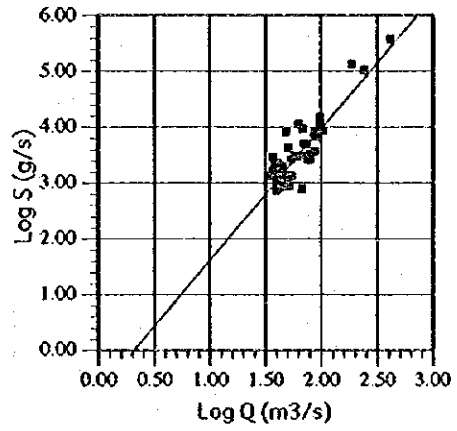
Figure-A2.1 Relation between Discharge and Suspended Sediment (1/2)



$$f(x) = 1.839240E+0x + 5.894401E-1$$

$$R^2 = 6.631285E-1$$

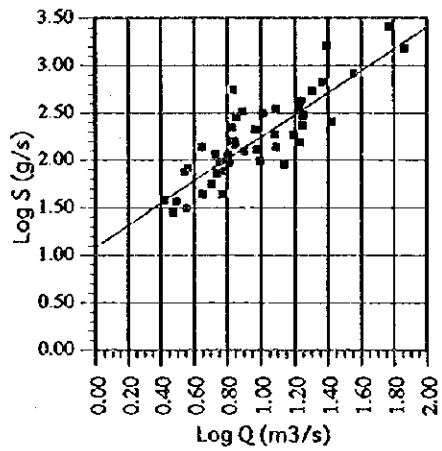
Itarare



$$f(x) = 2.359592E+0x + -7.340022E-1$$

$$R^2 = 7.770516E-1$$

Ribeira



$$f(x) = 1.162025E+0x + 1.088641E+0$$

$$R^2 = 7.298411E-1$$

Litoranea

Figure-A2.1 Relation between Discharge and Suspended Sediment (2/2)

**Appendix-3**  
**Landuse and Agricultural Data of Pilot River Basins**



Table A3.1 Landuse of Iguacu River Basin (1/2)

No.	Municipality	Area involved (km <sup>2</sup> )	Forest (km <sup>2</sup> )	2nd Vegetation (km <sup>2</sup> )	Reforestation (km <sup>2</sup> )	Pasture (km <sup>2</sup> )	Crop (km <sup>2</sup> )	Others (km <sup>2</sup> )	Forest (%)	2nd Vegetation (%)	Reforestation (%)	Pasture (%)	Crop (%)	Others (%)	Total
I-017	Aguaes de Sul	259.6	0.4	88.2	17.6	22	134.6	16.6	0.2	34.0	6.6	0.8	51.6	6.4	100.0
I-007	Almirante Tamandaré	189.3		90.9		45.3	37.3	15.8		46.0		23.9	19.7	8.4	100.0
I-078	Ampere	307.9		82.3		100.3	125.3			26.7		32.6	40.7	0.0	100.0
I-025	Antonio Olinto	492.5	60.3	216.2			482.5	50.8	12.5	44.8		0.0	32.2	10.5	100.0
I-010	Araucária	503.7		113.5			244.4	77.9		22.5		13.5	48.5	15.5	100.0
I-014	Balsa Nova	319.7		83.4		67.9	72.0			26.1		50.7	22.5	0.0	100.0
I-073	Barraço	386.3		74.5		91.6	149.4	70.8		19.3		23.7	38.7	18.3	100.0
I-036	Bituruna	1,209.7	447.4	446.3		16.0	269.1	30.9	37.0	36.9		1.3	22.2	2.6	100.0
I-057	Boa Esperança do Iguacu	249.4	1.2	39.1		73.8	135.3		0.5	15.7		29.6	54.2	0.0	100.0
I-091	Boa Vista de Aparicida	232.2		48.9		53.2	119.6	12.5		20.2		22.9	51.5	5.4	100.0
I-055	Bom Sucesso do Sul	135.3		36.0		31.7	68.6			0.0		25.9	0.0	0.0	100.0
I-001	Campana Grande do Sul	79.2		36.7		20.0	10.0	2.8		46.3		12.2	25.3	3.6	100.0
I-020	Campo do Tenente	314.0	8.5	118.2		37.6	131.2		2.7	37.6		12.0	41.8	0.0	100.0
I-009	Campo Largo	297.2		97.2		28.4	151.7	19.5		32.7		9.6	61.0	6.6	100.0
I-045	Candói	999.8	99.5	240.7		201.6	384.9	73.1	10.5	27.0		20.2	38.5	7.2	100.0
I-046	Cantagelo	774.1	80.9	209.1		179.1	302.6	2.4		4.1		31.0	56.6	8.1	100.0
I-056	Caparnaíba	403.9	1.0	16.6		126.4	228.7	32.2	0.2	2.1		30.0	55.9	7.0	100.0
I-022	Capitão Leônidas Marques	279.8	13.9	5.8		84.0	156.5	19.6		5.0		21.4	48.7	1.6	100.0
I-090	Cascaiavel	1,198.9	9.7	308.8		286.9	533.5	19.7	0.8	25.8		1.7	21.4	41.8	100.0
I-088	Catanduvas	593.9	23.6	192.6		120.4	248.4	19.7	4.0	32.4	1.5	20.3	44.3	0.0	100.0
I-096	Cau Azul	597.2	818.0	25.1		31.0	41.0	22.1	87.3	2.7		3.3	4.4	2.3	100.0
I-049	Chopinzinho	592.5	40.1	247.2		245.6	416.8	37.1	4.0	24.9		24.7	42.0	3.8	100.0
I-042	Clevalândia	708.4	30.0	163.5		155.2	318.4	41.3	4.2	23.1		21.9	44.9	5.9	100.0
I-005	Colombo	222.2		56.3		31.6	45.4	22.3		26.3		24.8	12.4	17.4	100.0
I-015	Contenda	681.5	3.3	214.2		59.0	289.4	3.2		0.0		17.6	55.7	1.4	100.0
I-050	Coronel Vivida	1,500.5	274.1	429.3		143.7	587.6	69.8	18.3	28.3		23.4	42.5	2.0	100.0
I-037	Cruz Machado	96.6	2.9	13.0		25.9	47.6	4.6	3.0	13.5		26.8	49.3	4.6	100.0
I-066	Chuzinho do Iguacu	431.7		23.2		109.6	200.7	7.5		14.7		29.4	53.9	2.0	100.0
I-068	Dois Vizinhos	372.7		54.9		70.4	97.2			28.6		30.0	41.4	0.0	100.0
I-069	Eneas Marques	234.7		67.1		26.8	54.0	10.7		17.5		24.2	47.7	9.6	100.0
I-011	Fazenda Rio Grande	110.9		19.4		5.4	32.2	31.3		27.2		5.7	34.0	33.1	100.0
I-072	Fior da Serra do Sul	94.7		25.8		46.9	86.9	56.2		10.0		15.0	27.8	18.0	100.0
I-01	Foz de Iguacu	312.2	91.1	31.1		180.9	359.9	8.4	1.5	19.7		26.0	51.7	1.1	100.0
I-070	Francisco Beltrão	696.7	10.2	137.3											100.0
I-035	General Carneiro	371.5	371.5	342.6											100.0
I-063	Guarniaçu	495.0	12.2	222.0		54.2	243.3	52.1	34.9	32.2		5.1	22.9	4.9	100.0
I-039	Guatapava	3,402.7	464.8	493.2		141.4	117.6	1.8	2.5	44.8		28.6	23.8	0.3	100.0
I-043	Honório Serpa	606.6	22.2	267.5		805.4	1,545.4	42.4	13.7	14.2		23.7	45.4	1.2	100.0
I-049	Ibema	148.3	4.2	71.5		160.4	353.6	2.9	2.8	33.2		19.9	43.8	0.3	100.0
I-038	Inacio Martins	879.9	325.8	256.3		22.9	42.0	0.9	2.8	48.2		15.4	28.3	0.7	100.0
I-028	Iraí	408.1	33.5	146.8		79.2	220.4	0.2	8.2	36.0		9.0	24.6	0.0	100.0
I-056	Itaipava D'Oeste	246.0		45.2		67.5	129.6	3.7		18.4		27.4	52.7	7.5	100.0
I-021	Lapa	2,203.9	26.0	874.8		264.9	879.1	13.6	1.2	39.7		12.0	39.9	0.6	100.0
I-048	Laranjeiras do Sul	1,052.7	63.1	281.6		234.8	359.5	113.7	6.0	26.8		22.3	34.2	10.7	100.0
I-034	Lindóiate	273.2	23.3	16.9		71.3	159.7		8.5	7.0		26.1	58.4	0.0	100.0
I-030	Mallet	672.8	139.3	249.3					29.7	37.1		0.0	42.2	0.0	100.0
I-012	Manduri	392.3		80.4		97.9	188.3	2.2	0.0	20.5		25.0	48.0	0.5	100.0
I-044	Mangueirinha	801.3	66.5	270.2		116.7	338.6	7.3	8.5	33.7		14.6	42.3	0.9	100.0
I-052	Manoel	232.1	1.6	61.5		26.3	113.4	29.3	0.7	26.5		11.3	48.9	12.6	100.0
I-071	Marmeleiro	449.9	7.0	132.9		63.3	205.1	40.2	1.6	29.5		14.1	45.6	8.9	100.0
I-057	Matelandia	601.4	306.0	143.5		84.2	59.4	8.3	60.9	23.9		14.0	9.9	1.3	100.0
I-098	Medianeira	621.1	241.0	73.5		103.6	165.5	37.5	38.8	11.8		16.7	26.6	6.1	100.0
I-079	Nova Esperança do Sudoeste	176.9	4.4	176.9		51.7	94.4	2.6	2.5	14.9		29.2	53.4	0.0	100.0
I-062	Nova Laranjeiras	576.8	196.3	202.5		88.0	80.7		33.9	35.1		16.9	13.9	0.0	100.0
I-082	Nova Prata do Iguacu	333.0	5.9	37.3		105.6	178.7	5.5	1.8	11.2		31.7	53.7	1.6	100.0

Table A3.1 Landuse of Iguacu River Basin (2/2)

No	Municipality	Area Involved (km <sup>2</sup> )	2nd			2nd			Crop (km <sup>2</sup> )	Others (km <sup>2</sup> )	Forest (km <sup>2</sup> )	Vegetation (km <sup>2</sup> )	Reforestation (km <sup>2</sup> )	Pasture (km <sup>2</sup> )	Crop (%)	Others (%)	Total
			Forest (km <sup>2</sup> )	Vegetation (km <sup>2</sup> )	Reforestation (km <sup>2</sup> )	Pasture (km <sup>2</sup> )	Forest (%)	Vegetation (%)									
I-001	Palmeira	3,125.5	753.7	781.1	509.7	121	24.1	25.3	0.0	31.3	16.9	2.4	100.0				
I-002	Palmeira	273.4	2.5	139.2	100.7	0.5	0.9	50.9	1.7	9.5	36.8	0.2	100.0				
I-003	Pato Branco	570.2	3.3	176.5	251.3	9.0	0.6	31.0	0.0	22.8	44.1	1.5	100.0				
I-004	Paula Freitas	417.0	42.5	153.8	161.7	49.9	10.2	36.9	2.2	0.0	38.8	11.9	100.0				
I-005	Paulo Frontin	377.5	20.8	135.2	204.7	16.4	5.5	35.8	0.1	0.0	54.2	4.4	100.0				
I-006	Perola do Oeste	330.1	5.1	45.1	159.3	21.3	1.5	13.7	0.0	30.1	48.3	6.4	100.0				
I-007	Pian	261.7	13.0	62.4	123.0	15.1	5.0	31.5	6.9	1.6	49.3	5.7	100.0				
I-008	Pinhal de Sao Bento	107.6	98.2	11.1	38.4	27.5	0.0	11.3	0.0	21.6	39.1	28.0	100.0				
I-009	Pinhal	2,875.2	758.4	708.4	1,007.5	62.4	26.4	24.6	0.0	11.8	35.0	2.2	100.0				
I-010	Piraquara	171.9	63.1	14.9	54.5	8.7	36.7	8.7	0.0	17.3	54.0	2.1	100.0				
I-011	Planalto	337.1	35.6	112.1	181.9	7.3	0.0	10.6	0.0	33.3	31.4	0.0	100.0				
I-012	Porto Amazonas	153.0	49.3	35.8	48.0	28.0	0.0	32.2	6.6	29.8	31.4	0.0	100.0				
I-013	Porto Vitoria	220.2	32.7	103.2	56.3	21.7	0.0	16.3	0.0	29.4	47.1	7.2	100.0				
I-014	Pranchita	297.1	99.5	7.4	139.9	5.8	25.8	7.4	0.1	34.6	26.2	5.9	100.0				
I-015	Quebro Barras	1,192.9	275.1	370.9	245.2	55.7	23.1	31.1	9.1	11.5	20.6	4.6	100.0				
I-016	Quitandinha	419.4	19.8	142.9	216.0	2.7	4.7	34.1	0.7	8.4	51.5	0.8	100.0				
I-017	Realeza	351.9	13.4	11.0	206.7	7.4	3.0	3.1	0.0	32.2	58.7	2.2	100.0				
I-018	Rebouças	498.9	18.0	190.2	290.7	3.6	3.6	38.1	0.0	0.0	58.3	0.0	100.0				
I-019	Renascanca	434.7	5.7	125.9	185.0	27.5	1.3	29.0	6.2	14.7	42.8	6.2	100.0				
I-020	Rio Azul	642.6	76.4	249.6	316.0	0.6	0.6	316.0	0.0	0.1	49.2	0.0	100.0				
I-021	Rio Bonito do Iguacu	499.3	323.8	22.7	58.6	24.3	70.5	4.9	0.0	6.5	12.8	5.3	100.0				
I-022	Rio Negro	603.2	177.3	272.8	140.7	42.9	0.0	29.4	0.0	28.9	23.3	7.1	100.0				
I-023	Salgado Filho	506.4	67.4	67.4	83.0	4.2	0.0	53.9	0.0	20.0	48.6	0.8	100.0				
I-024	Salto de Lontra	336.9	4.6	56.6	163.6	2.6	1.4	20.0	0.8	32.0	47.2	1.1	100.0				
I-025	Santa Lucia	330.5	5.9	56.6	155.9	3.7	1.8	17.1	0.0	34.6	64.4	0.0	100.0				
I-026	Santa Tereza do Oeste	137.1	1.4	11.2	88.2	0.5	6.4	4.7	1.8	30.3	56.8	0.0	100.0				
I-027	Santa Tereza do Oeste	255.5	15.0	23.3	84.3	5.1	2.2	14.4	0.0	28.3	52.0	3.1	100.0				
I-028	Santa Tereza do Oeste	162.1	3.6	42.4	159.0	23.9	0.0	13.5	0.0	28.2	50.7	7.6	100.0				
I-029	Santo Antonio do Sudoeste	313.8	1.7	41.7	228.9	12.3	0.4	10.2	0.0	30.4	56.0	3.0	100.0				
I-030	Sao Jose	408.9	158.1	340.8	142.8	0.5	22.3	48.1	9.3	0.0	20.2	0.1	100.0				
I-031	Sao Jose do Triunfo	708.1	137.1	176.9	176.9	29.2	0.4	20.1	0.0	26.0	45.9	7.6	100.0				
I-032	Sao Jose do Oeste	385.1	1.6	71.4	293.8	53.6	13.0	11.5	0.3	23.8	43.6	4.5	100.0				
I-033	Sao Jose dos Pinhais	674.2	87.6	77.3	438.2	60.1	15.4	44.7	2.5	0.0	32.9	4.5	100.0				
I-034	Sao Mateus do Sul	1,332.8	205.4	505.5	186.9	10.5	16.0	16.6	0.0	24.1	41.0	2.3	100.0				
I-035	Sao Miguel do Iguacu	455.7	73.1	75.3	78.1	4.7	2.9	13.7	0.0	27.3	52.8	3.3	100.0				
I-036	Saudade do Iguacu	147.8	4.3	20.3	40.4	78.1	0.0	15.0	0.0	30.0	55.0	0.0	100.0				
I-037	Sulina	158.5	26.3	107.7	80.3	13.0	6.2	25.5	19.7	26.5	19.0	3.1	100.0				
I-038	Tijucas do Sul	422.6	24.1	123.6	242.9	20.9	4.6	23.7	0.2	20.9	46.6	4.0	100.0				
I-039	Tres Barras do Parana	521.7	243.7	296.9	150.8	82.0	31.5	38.4	0.0	0.1	19.5	10.5	100.0				
I-040	Uniao da Vitoria	187.5	51.1	102.3	167.5	4.7	0.0	14.8	0.0	29.6	54.3	1.3	100.0				
I-041	Veré	345.6	0.2	56.8	50.4	91.0	0.1	28.6	0.0	25.4	45.9	0.0	100.0				
I-042	Virmond	198.4	0.8	96.1	144.6	55.9	0.2	28.2	0.0	9.1	44.3	17.2	100.0				
I-043	Vitorino	326.1	7.6431	14,701.3	2,370.9	916.5	9,583.5	20,581.7	2,370.9	13.7	26.4	36.8	4.3	100.0			
Total		55,776.0	7,643.1	14,701.3	916.5	9,583.5	20,581.7	2,370.9	13.7	26.4	36.8	4.3	100.0				

Source: SANEPA GIS Computation based on IAP Satellite Imagery Analysis  
 Note: Although the summation of landuse with municipality wise deviates from one computed for the whole river basin due to the different scale of computation, the difference is several %.

Table-A3.2 Landuse of Tibagi River Basin

No	Municipality	Area Involved (km <sup>2</sup> )	2nd Vegetation (km <sup>2</sup> )					Others (km <sup>2</sup> )	2nd Vegetation (km <sup>2</sup> )					Total (%)
			Forest (km <sup>2</sup> )	Reforestation (km <sup>2</sup> )	Pasture (km <sup>2</sup> )	Crop (km <sup>2</sup> )	Others (km <sup>2</sup> )		Forest (%)	Reforestation (%)	Pasture (%)	Crop (%)	Others (%)	
T-022	Apucarana	182.2	31.8	75.6	0.1	74.7	17.5	41.4	0.0	0.1	41.0	0.0	100.0	
T-023	Araçongas	191.9	4.6	67.3	4.6	94.0	12.5	35.1	0.0	2.4	49.0	1.0	100.0	
T-031	Assai	450.5	0.3	33.9	39.8	363.1	0.1	7.5	0.0	8.8	80.6	3.0	100.0	
T-021	California	97.2	22.7	48.7	1.3	24.5	23.4	50.1	0.0	1.3	25.2	0.0	100.0	
T-038	Cambe	143.5		50.2		93.3		95.0	0.0		65.0	0.0	100.0	
T-008	Castro	2,278.4	54.6	734.7	20.7	725.7	739.4	3.3	2.4	31.9	32.5	0.1	100.0	
T-028	Congonhinhas	104.6		6.7		17.9		80.0			17.1		100.0	
T-033	Coronel Procopio	336.7	2.6	49.2	112.9	166.2	5.8	14.6	0.0	33.5	49.4	1.7	100.0	
T-016	Curuva	361.8	9.6	89.4	74.9	127.2	0.8	2.7	24.7	16.6	35.2	0.1	100.0	
T-036	Ibipora	295.4		94.7		185.6		32.1		1.0	62.8		100.0	
T-006	Imbituva	811.3	109.4	391.2	67.5	237.4	13.6	41.8	8.3	0.7	28.3	0.0	100.0	
T-005	Jaraguá	932.0	71.0	388.5	72.8	310.7	7.6	13.3	7.8	9.5	33.3	0.0	100.0	
T-004	Itaiti	139.6	2.0	53.5	2.0	78.2	5.9	38.3	1.4	0.0	54.6	4.3	100.0	
T-009	Ivaí	212.2	9.3	113.5		76.5	4.4	53.4	0.0	6.1	36.1	0.0	100.0	
T-035	Jatuzinho	199.1	0.8	6.4		107.8	0.4	3.2	0.0	36.0	54.0	6.4	100.0	
T-041	Leópolis	68.9	0.5	5.0		56.5	0.7	7.3	0.0	11.5	80.5	0.0	100.0	
T-024	Londrina	2,085.6	120.0	841.8	310.3	772.7	50.8	40.2	0.0	14.8	36.9	2.4	100.0	
T-020	Mariandia do Sul	152.2	16.0	60.8	9.2	66.2	10.5	40.0	0.0	6.0	43.5	0.0	100.0	
T-019	Maua da Serra	48.0	11.0	21.5	10.4	10.4	10.8	44.8	0.0	21.7	22.9	0.0	100.0	
T-032	Nova America da Colina	133.3	5.1	10.7		88.9	0.0	8.0	0.0	31.3	60.2	0.0	100.0	
T-029	Nova Fátima	83.5		7.1		50.3		8.5		5.2	89.7		100.0	
T-025	Nova Santa Barbara	112.2		5.7		100.7		5.1		0.0	94.9		100.0	
T-015	Oribiguera	1,588.5	6.3	508.0	138.7	271.6	62.7	32.0	8.7	17.1	41.3	0.5	100.0	
T-002	Palmeira	1,227.4	11.6	401.4	50.4	208.7	2.6	32.7	4.1	17.0	45.0	0.3	100.0	
T-012	Piraí do Sul	965.2	19.2	285.1	10.5	219.5	2.9	29.5	1.1	44.3	22.7	0.4	100.0	
T-007	Ponta Grossa	1,870.8	5.3	329.8	75.0	828.4	53.7	17.6	4.0	31.0	44.2	2.9	100.0	
T-001	Porto Amazonas	53.8		5.9		20.1		11.0		51.6	37.4		100.0	
T-043	Primeiro de Maio	142.8		23.4		96.2		16.4		0.0	67.4		100.0	
T-040	Rancho Alegre	187.4		0.2		150.6		0.1		0.0	80.5		100.0	
T-010	Reserva	555.9	3.3	104.0	66.5	245.7	0.8	18.7	12.0	24.5	44.2	0.0	100.0	
T-037	Rolândia	57.4		19.8		36.8		34.5		0.0	64.1		100.0	
T-026	Santa Cecilia do Pavão	68.5		68.5		68.5		0.0		0.0	100.0		100.0	
T-027	Santo Antonio do Paraíso	151.9	2.0	7.3	33.9	108.7	1.3	4.8	0.0	22.3	71.6	0.0	100.0	
T-018	São Jerônimo da Serra	851.3	8.0	100.7	136.9	601.3	4.4	11.8	0.0	16.1	70.6	0.6	100.0	
T-030	São Sebastião da Amoreira	217.4		10.6		160.5		3.7		17.6	73.9		100.0	
T-017	Sapopema	531.9	50.7	161.2	99.9	220.1	9.5	30.3	0.0	16.8	41.4	0.0	100.0	
T-042	Sertãozinho	226.7	0.9	1.2		152.5		72.1		0.0	67.3		100.0	
T-039	Sertãozinho	478.9	6.0	140.4	23.7	296.0	12.8	29.3	0.0	4.9	61.8	2.7	100.0	
T-003	Teixeira Soares	1,303.5	192.3	522.7	119.6	407.9	41.6	40.0	9.2	4.7	31.3	0.0	100.0	
T-014	Telemaco Borba	1,625.3	130.5	107.8	1,331.2	97.9	30.1	6.6	8.9	2.9	6.0	2.6	100.0	
T-011	Tibagi	2,926.6		894.2	256.3	856.6		30.1		8.8	25.9		100.0	
T-034	Uruí	209.6	2.1	0.8		181.4		25.3		0.4	86.5		100.0	
T-013	Ventania	380.1	12.2	65.1	68.5	144.0	2.2	17.1	18.0	23.8	37.9	0.0	100.0	
		25,051.0	938.1	6,845.7	2,364.6	4,516.2	10,001.0	386.4	3.7	27.4	18.0	1.6	100.0	

Source: SANEPAR GIS Computation based on IAP Satellite Imagery Analysis  
 Note: Although the summation of landuse with municipality wise deviates from one computed for the whole river basin due to the different scale of computation, the difference is several %.



Table-A3.3 Area of Dominant Crops in Iguacu River Basin (1/2)

No.	Municipality	Total Crop Area (ha)	Cotton (ha)	Sugarcane (ha)	Beans (ha)	Maize (ha)	Soybean (ha)	Cassava (ha)	Potato (ha)	Coffee (ha)	Wheat (ha)
I-17	Aquidaua do Sul	13,500	0	0	0	2200	10800	400	100	0	0
I-7	Almirante Tamandare	3,700	0	0	0	1200	2200	0	300	0	0
I-78	Ampere	12,500	0	300	0	1100	7300	500	0	0	1500
I-25	Antonio Olinto	15,500	0	0	0	7400	7400	200	500	0	0
I-10	Araucaria	24,400	0	0	0	4100	15500	0	4600	0	220
I-14	Balsa Nova	7,200	0	0	0	2300	3300	0	1600	0	0
I-73	Barraeca	14,900	0	600	0	1600	12200	400	0	0	1000
I-36	Bitununa	26,900	0	300	0	5900	18800	0	1900	0	0
I-67	Boa Esperanca do Iguacu	13,500	0	0	0	2700	8100	500	0	0	1000
I-91	Boca Vista da Aparecida	12,000	1000	100	0	2300	5000	2300	0	0	200
I-55	Bom Sucesso do Sul	6,900	0	0	0	1500	3300	2100	0	0	1500
I-1	Campina Grande do Sul	1,000	0	0	0	300	700	0	0	0	0
I-20	Campo do Tenente	13,100	0	0	0	3000	8600	500	1000	0	0
I-9	Campo Largo	15,200	0	0	0	3300	9200	0	2700	0	0
I-45	Candoi	38,500	0	0	0	3100	24200	0	0	0	3540
I-46	Cantagato	30,300	0	0	0	2700	24600	600	0	0	420
I-96	Capinema	22,900	0	200	0	5300	7500	700	0	0	3000
I-92	Capitao Leonidas Marques	15,700	1100	200	0	1700	6300	5800	0	0	700
I-90	Cascavel	58,400	0	600	0	600	18600	1200	0	0	6668
I-88	Catanduvas	24,800	1000	0	0	500	17800	4500	1000	0	350
I-98	Cau Azul	4,100	200	0	0	0	1700	100	0	0	2768
I-49	Chopininho	41,700	0	0	0	3900	24600	400	0	0	5000
I-2	Clelandia	31,800	0	0	0	2900	12100	300	0	0	1200
I-5	Colombo	1,800	0	0	0	700	900	0	0	0	0
I-15	Contenda	12,400	0	0	0	3200	6000	0	3200	0	0
I-50	Coronel Vidua	28,900	0	0	0	1200	19000	600	0	0	0
I-37	Cruz Machado	59,800	0	0	0	28800	28800	1200	0	0	250
I-68	Cruzeiro do Iguacu	4,800	0	0	0	600	2700	1400	100	0	2000
I-8	Curitiba	4,500	0	0	0	0	4000	0	500	0	0
I-68	Dois Vizinhos	20,100	0	400	0	1800	13500	3600	800	0	2000
I-69	Enses Marques	9,700	0	0	0	4200	5100	0	400	0	350
I-11	Fazenda Rio Grande	5,400	0	0	0	1400	3100	700	200	0	0
I-72	Flor da Serra do Sul	3,200	0	0	0	300	2700	100	0	0	150
I-101	Foz do Iguacu	6,700	0	0	0	0	1900	6900	0	0	525
I-70	Francisco Beltrao	36,000	0	0	0	5400	26300	3200	1100	0	1500
I-35	General Carneiro	24,300	0	0	0	2700	21600	0	0	0	0
I-63	Guaraniasu	11,800	200	0	0	900	9000	1500	200	0	1270
I-39	Guarapuava	154,500	0	0	0	10800	78800	64900	0	0	4278
I-43	Honorio-Serpa	35,400	0	0	0	2800	18800	13800	0	0	1600
I-89	Ibema	4,200	0	100	0	100	3100	800	100	0	0
I-38	Inacio Martins	21,700	0	0	0	7400	14300	0	0	0	0
A28	Ireti	22,000	0	0	0	10100	11200	700	0	0	46
I-66	Itapejara D'Oeste	13,000	0	0	0	1000	6100	5900	0	0	800
I-21	Lapa	87,900	0	0	0	30800	36000	14100	7000	0	1200
I-48	Laranjeiras do Sul	36,000	0	0	0	5000	26300	4700	0	0	1941
I-94	Lindoeste	16,000	2900	300	0	500	11300	500	0	0	230
I-30	Mallet	28,400	0	0	0	13100	13300	1400	300	0	0
I-12	Mandirituba	18,800	0	0	0	5300	12700	0	800	0	150
I-44	Manguelinhos	33,900	0	0	0	2400	13900	14900	300	0	1200
I-52	Manoapolis	11,300	0	0	0	1200	3900	6100	100	0	500
I-71	Marmeleiro	20,500	0	0	0	4700	12900	2100	600	0	100
I-97	Matelandia	5,900	100	0	0	2500	3000	300	0	0	1967
I-98	Medianeira	16,600	200	0	0	0	4900	11000	500	0	4663

Table-A3.3 Area of Dominant Crops in Iguacu River Basin (2/2)

No.	Municipality	Total Crop Area (ha)	Comon (ha)	Sugarcane (ha)	Beans (ha)	Maize (ha)	Soybean (ha)	Cassava (ha)	Potato (ha)	Coffee (ha)	Wheat (ha)
I-79	Nova Esperanca do Sudoeste	9,400	0	0	2100	6900	100	300	0	0	150
I-82	Nova Laranjeiras	8,100	0	0	1100	6800	200	0	0	0	135
I-82	Nova Preta do Iguacu	17,900	0	0	5000	7400	5000	500	0	0	1000
I-41	Palmas	53,000	0	0	2700	24900	24400	500	500	0	555
I-23	Palmeira	10,100	0	0	500	4200	5300	0	100	0	456
I-51	Pato Branco	25,100	0	0	2500	9000	13300	300	0	0	700
I-32	Paula Freitas	16,200	0	0	3900	6800	5000	500	0	0	0
I-31	Paulo Frontin	20,500	0	0	7200	9800	3500	0	0	0	0
I-83	Penola do Oeste	15,900	600	0	2100	7600	4800	800	0	0	4570
I-18	Pian	12,900	0	0	2300	10200	0	0	400	0	230
I-6	Pinhais	3,800	0	0	0	2600	0	0	1300	0	0
I-77	Pinhal de Sao Bento	1,600	0	0	300	1200	100	0	0	0	450
I-40	Pinhao	100,800	0	0	6000	49400	45400	0	0	0	3300
I-3	Piraquara	5,500	0	0	0	4700	0	0	800	0	0
I-84	Planalto	18,200	0	0	2000	5800	10000	400	0	0	3000
I-22	Ponto Anazonas	4,800	0	0	700	2900	1100	0	100	0	0
I-34	Porto Vitória	5,600	0	100	1200	3800	6600	100	0	0	0
I-76	Pranchita	14,000	0	0	2200	5000	6600	0	0	0	5000
I-2	Quatro Barras	2,600	0	0	1200	1400	0	0	0	0	0
I-64	Quedas do Iguacu	24,500	0	0	2700	17900	3900	0	0	0	500
I-16	Quilandinha	21,600	0	0	6700	11700	0	0	3200	0	210
I-85	Realiza	20,700	0	200	1700	8900	9300	600	0	0	4658
I-27	Rebouças	29,100	0	0	10500	14800	2600	300	900	0	198
I-24	Renascerca	18,500	0	0	1100	7000	10000	400	0	0	2000
I-29	Rio Azul	31,600	0	0	13900	16200	900	0	600	0	100
I-61	Rio Bonito do Iguacu	5,900	0	0	700	4400	800	0	0	0	600
I-19	Rio Negro	14,100	0	0	5100	8500	300	0	100	0	0
I-74	Saigado Filho	8,300	0	100	1300	6700	0	100	0	100	350
I-80	Saio do Lontra	16,400	700	0	4400	9500	1500	300	0	0	1500
I-81	Santa Izabel do Oeste	15,600	0	200	1100	6500	7200	600	0	0	4000
I-93	Santa Lucia	8,800	400	0	1200	3900	2900	400	0	0	130
I-95	Santa Tereza do Oeste	13,400	400	100	0	5100	7500	300	0	0	1669
I-100	Santa Tereza de Itaipu	8,400	100	0	1700	0	6300	200	0	0	839
I-75	Santo Antonio do Sudoeste	15,900	0	0	4800	8400	2400	300	0	0	1500
I-88	Sao Joao	22,900	0	200	900	11900	9400	500	0	0	3300
I-24	Sao Joao do Triunfo	14,300	0	0	3600	9800	600	0	300	0	0
I-65	Sao Jorge do Oeste	17,700	0	500	1900	14300	500	500	0	0	484
I-4	Sao Jose dos Pinhais	29,400	0	0	6600	21700	0	0	1200	0	400
I-26	Sao Mateus do Sul	43,800	0	0	17100	18900	6600	2100	1300	0	548
I-99	Sao Miguel do Iguacu	16,700	400	0	0	3700	12500	0	0	0	0
I-60	Sauaude do Iguacu	7,800	0	200	1000	6000	400	200	0	0	0
I-59	Sulina	8,700	0	200	400	8100	1600	400	0	0	750
I-13	Tiucas do Sul	8,000	0	0	700	7100	0	0	200	0	0
I-87	Tres Barras do Parana	24,300	700	0	3600	16900	1900	1200	0	0	400
I-33	Uniao da Vitoria	15,100	0	0	4100	9600	500	0	0	0	0
I-57	Vare	18,800	0	0	3000	11100	4300	400	0	0	5000
I-47	Vermound	9,100	0	0	1800	7300	0	0	0	0	100
I-53	Vitorino	14,500	0	0	700	8000	7800	0	0	0	700
Total		2,056,700	9,400	5,800	349,400	1,116,300	507,000	34,600	34,100	100	106,168

Note: EMATER crop area in 1994 was adjusted to the result of landuse computation (GIS) by SANEPAR based on the satellite imagery analysis (AP, 1990 & 1994), multiplying the area fraction of each crop from EMATER data with total crop area computed by SANEPAR.

Table-A3.4 Area of Dominant Crops in Tibagi River Basin

No	Municipality	Total Crop Area (ha)	Cotton (ha)	Sugarcane (ha)	Beans (ha)	Maize (ha)	Soybean (ha)	Cassava (ha)	Potato (ha)	Coffee (ha)	Wheat (ha)
T-22	Apucarana	7,500	100	0	200	3600	2200	0	0	1400	657
T-23	Arapongas	9,400	100	100	100	2500	5500	0	0	1100	2187
T-31	Assai	36,300	2200	0	400	9000	24300	0	0	400	12000
T-21	California	2,500	100	0	400	1900	0	0	0	100	0
T-38	Cambe	9,300	0	100	0	2000	6400	0	0	800	5093
T-8	Castro	73,900	0	0	4400	28100	41400	0	0	0	11798
T-28	Congonhinhas	8,000	300	900	200	2400	3200	0	0	1000	196
T-33	Cornelio Procopio	16,600	300	700	0	1800	11300	600	0	2500	2683
T-16	Cunuba	12,700	0	0	3600	7100	0	0	0	1400	0
T-36	Ibipora	18,600	0	0	0	300	16600	0	0	1700	2000
T-5	Imbituva	23,700	0	0	5700	11400	6200	200	0	0	680
T-6	Ipiranga	31,100	0	0	2200	22100	6500	300	0	0	1939
T-4	Iratí	7,600	0	0	3500	3900	200	0	0	0	16
T-9	Ivaí	7,700	0	0	3100	4100	200	100	0	0	87
T-35	Jataizinho	10,800	500	0	0	4400	5900	0	0	0	1860
T-41	Leópolis	5,600	200	0	0	2000	3400	0	0	0	999
T-24	Londrina	77,300	800	0	1500	27800	40200	0	0	7000	12000
T-20	Marilandia do Sul	6,600	0	0	300	3800	2400	0	0	100	593
T-19	Maus da Serra	1,100	0	0	0	600	500	0	0	0	215
T-32	Nova America da Colina	8,900	400	3600	300	1100	3000	0	0	500	1800
T-29	Nova Fátima	5,000	200	0	100	1200	2600	0	0	700	792
T-25	Nova Santa Barbara	10,100	4000	0	0	1600	4500	0	0	0	1500
T-15	Ortigueira	65,600	0	0	14400	46600	2600	2000	0	0	771
T-2	Palmeira	55,300	0	0	2600	23100	28600	0	600	0	2045
T-12	Piraí do Sul	22,000	0	0	2600	12000	6800	200	400	0	600
T-7	Ponta Grossa	82,600	0	0	5800	36300	40500	0	0	0	6594
T-1	Porto Amazonas	2,000	0	0	300	1100	500	0	100	0	0
T-48	Primeiro de Maio	9,600	100	0	0	900	8500	0	0	100	461
T-40	Rancho Alegre	15,100	200	0	0	2500	12400	0	0	0	6000
T-10	Reserva	24,600	0	0	9100	15000	500	0	0	0	377
T-37	Rolandia	3,700	0	600	0	700	2000	0	0	400	1211
T-26	Santa Cecilia do Pavão	6,900	0	0	200	2100	4600	0	0	0	1200
T-27	Santo Antonio do Paraíso	10,900	300	0	0	2300	8300	0	0	0	4000
T-18	Sao Jeronimo da Serra	60,100	9000	0	2400	23500	7800	0	0	17400	1209
T-30	Sao Sebastiao de Amoreira	16,100	500	6900	0	1500	6900	0	0	300	3566
T-17	Sapopema	22,000	0	0	4800	16500	0	0	0	700	0
T-42	Sertaneja	15,300	0	0	3200	0	12100	0	0	0	2199
T-39	Sertanópolis	29,600	0	0	0	2100	26500	0	0	900	2914
T-3	Texeira Soares	40,800	0	0	9800	16300	13900	0	800	0	1164
T-14	Telemaco Borba	9,800	0	0	1200	7700	400	500	0	0	0
T-11	Tibagi	85,700	0	0	2600	26500	55700	900	0	0	13945
T-34	Uraí	18,100	1400	0	0	5000	11000	0	0	700	3100
T-13	Ventania	14,400	0	0	600	5200	8600	0	0	0	1845
Total		1,000,500	20,700	12,900	82,600	392,800	445,400	4,800	2,100	39,200	112,358

Note: EMATER crop area in 1994 was adjusted to the result of landuse computation (GIS) by SANEPAR based on the satellite imagery analysis (AP, 1990 & 1994).  
 multiplying the area fraction of each crop from EMATER data with total crop area computed by SANEPAR.

Table-A3.5 Application of Mechanization and Soil Conservation in Iguape River Basin (1/2)

No	Municipality	Cotton Area		Sugarcane Area		Beans Area		Maize Area		Soybean Area		Cassava Area		Pinto Area		Coffee Area		Wheat Area		
		Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	
I-17	Aguape do Sul																			
I-7	Almirante Tamandare																			
I-78	Amperis																			
I-25	Antonio Olinto																			
I-10	Arucaia																			
I-14	Balsa Nova																			
I-73	Barracao																			
I-36	Bitorum																			
I-67	Boa Esperanca do Iguacu																			
I-91	Boa Vista da Aparecida																			
I-65	Bom Sucesso do Sul																			
I-1	Campina Grande do Sul																			
I-20	Campo do Tenente																			
I-9	Campo Largo																			
I-45	Candoi																			
I-46	Canibal																			
I-86	Capanema																			
I-92	Capiao Leonidas Marques																			
I-90	Casavel																			
I-85	Catandunas																			
I-86	Cau Azul																			
I-49	Chopininho																			
I-42	Civelandia																			
I-5	Colombo																			
I-15	Cordeira																			
I-60	Coronel Vinha																			
I-37	Cruz Machado																			
I-66	Cruzeiro do Iguacu																			
I-5	Curitiba																			
I-68	Dois Vizinhos																			
I-69	Ereosa Marques																			
I-11	Fazenda Rio Grande																			
I-72	Fior da Serra do Sul																			
I-101	Foz do Iguacu																			
I-70	Francisco Beltrao																			
I-35	General Carneiro																			
I-63	Guaranacu																			
I-39	Guarapuava																			
I-43	Honoro-Serpa																			
I-69	Ibema																			
I-38	Inacio Martins																			
I-28	Itait																			
I-66	Itapejara D'Oeste																			
I-21	Lapa																			
I-48	Laranjeiras do Sul																			
I-84	Lincoeste																			
I-30	Mallet																			
I-12	Mandrituba																			
I-44	Mangueirinha																			
I-32	Marfopole																			
I-71	Marmeleiro																			
I-97	Matlandia																			
I-65	Medianeira																			

Table-A3.5 Application of Mechanization and Soil Conservation in Iguazu River Basin (2/2)

No	Municipality	Cotton Area		Sugarcane Area		Beans Area		Maize Area		Soybean Area		Cassava Area		Potato Area		Coffee Area		Wheat Area		
		Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	Mechanized (%)	Conserved (%)	
1-79	Nova Esperança do Sul																			
1-82	Nova Laranjeiras																			
1-82	Nova Preta do Iguazu																			
1-41	Palmas																			
1-23	Palmeira																			
1-51	Peto Branco																			
1-32	Paula Freitas																			
1-31	Paulo Frontin																			
1-83	Pereis do Oeste																			
1-18	Pien																			
1-18	Pien																			
1-77	Pinhal de São Bento																			
1-40	Pinhal																			
1-3	Pinheiro																			
1-3	Pinheiro																			
1-84	Planaltina																			
1-22	Porto Amazonas																			
1-34	Porto Vitória																			
1-76	Pranchita																			
1-2	Quatro Barras																			
1-64	Quedas do Iguazu																			
1-16	Quitandinha																			
1-85	Resolva																			
1-27	Rebouças																			
1-54	Renasçença																			
1-29	Rio Açu																			
1-61	Rio Bonito do Iguazu																			
1-19	Rio Negro																			
1-74	Salgado Filho																			
1-80	Saibo do Lontar																			
1-81	Santa Izabel do Oeste																			
1-93	Santa Lucia																			
1-86	Santa Tereza do Oeste																			
1-100	Santa Teresinha de Itaipu																			
1-75	Santo Antonio do Sulcoteo																			
1-58	Sao João																			
1-24	Sao João do Triunfo																			
1-65	Sao Jorge do Oeste																			
1-4	Sao José das Pinheiras																			
1-26	Sao Mateus do Sul																			
1-99	Sao Miguel do Iguazu																			
1-60	Saude do Iguazu																			
1-39	Sulina																			
1-13	Tijucas do Sul																			
1-87	Treze Barras do Paraná																			
1-33	União da Vitória																			
1-67	Vere																			
1-47	Virmond																			
1-53	Vitorino																			

Since the area of mechanization and conservation of potato for each municipality in 1984 is not available in EMATER data base, the state average based on 1983 data was adopted.  
Source: EMATER (1984)

Table-A3.6 Application of Mechanization and Soil Conservation in Tibagi River Basin

No	Municipality	Cotton Area Mechanized (%)	Cotton Area Conserved (%)	Sugarcane Area (%)	Sugarcane Mechanized (%)	Sugarcane Conserved (%)	Beans Area Mechanized (%)	Beans Area Conserved (%)	Maize Area Mechanized (%)	Maize Area Conserved (%)	Soybean Area (%)	Soybean Mechanized (%)	Soybean Conserved (%)	Cassava Area (%)	Cassava Mechanized (%)	Cassava Conserved (%)	Potato Area Mechanized (%)	Potato Area Conserved (%)	Coffee Area Mechanized (%)	Coffee Area Conserved (%)	Wheat Area Mechanized (%)	Wheat Area Conserved (%)
T-22	Apuacarina	100	100				56	26	64	27	100	100							75	15	100	100
T-23	Arapongas	100	93	100	100		49	79	97	97	100	100							37	77	100	91
T-31	Assai	94	33				92	24	63	45	100	65							98	16	100	67
T-21	California	36	25				93	37	30	20	100	100							16	2	100	100
T-38	Cambe			100	100		60	40	86	86	100	92							75	100	100	94
T-3	Castro	93	93	100	100		56	42	74	51	100	97							34	45	100	100
T-28	Congonhas	100	60	100	100		41	59	41	59	100	100							0	0	100	76
T-33	Cornelio Procopio						77	37	68	62	100	100							0	0	100	100
T-16	Curitiba						77	37	68	62	100	100							0	0	100	100
T-36	Ibipora						69	50	71	43	100	88							81	25	100	89
T-5	Imbuva						91	31	80	35	100	60							56	50	100	85
T-6	Ipiranga						60	32	33	20	100	70							100	0	100	83
T-4	Ireti						100	100	90	90	100	100							0	0	100	100
T-9	Itai						57	43	86	58	100	82							0	0	100	100
T-35	Jatuzinho	100	100				80	68	61	56	81	72							0	0	100	91
T-41	Leopoldo	100	0				74	58	88	75	100	91							56	81	100	86
T-24	Londrina						59	27	78	22	90	75							0	0	100	67
T-20	Martanda do Sul	62	43	96	63		100	100	86	58	100	100							54	79	100	100
T-19	Maus da Serra	100	100				57	43	86	58	100	100							78	14	100	100
T-32	Novo America da Colina						80	68	61	56	81	72							0	0	100	89
T-29	Nova Palma	100	49				74	58	88	75	100	91							56	81	100	86
T-25	Nova Santa Barbara	88	69				59	27	78	22	90	75							0	0	100	67
T-15	Ostigueira						100	20	96	80	100	80							0	0	100	60
T-2	Palmeira						100	56	94	63	100	88							0	0	100	84
T-12	Prai do Sul						100	17	86	81	100	75							0	0	100	94
T-7	Ponta Grossa						100	10	100	5	100	0							0	0	100	94
T-1	Porto Amazonas	100	100				76	25	100	100	100	100							0	0	100	100
T-43	Primeiro de Maio	100	100				85	53	80	55	100	97							0	0	100	100
T-40	Rancho Alegre						85	53	80	55	100	97							100	41	100	96
T-10	Reserva						45	16	77	65	100	97							0	0	100	95
T-37	Rolândia			100	100		14	19	12	23	100	88							13	13	100	100
T-26	Santa Cecília do Pavão						80	50	60	50	100	95							52	41	100	81
T-27	Santo Antonio do Paraiso	100	90				80	50	60	50	100	95							52	41	100	81
T-18	Sao Jeronimo da Serra	0	0				79	57	68	45	100	77							13	13	100	100
T-30	Sao Sebastiao da Amoreira	83	67	100	100		70	53	83	67	100	83							55	28	100	100
T-17	Sapopema						56	24	78	39	100	87							52	41	100	81
T-42	Sertãozinho						56	24	78	39	100	87							52	41	100	81
T-39	Sertãozinho						56	24	78	39	100	87							52	41	100	81
T-3	Tebaltes Soares						80	50	60	50	100	95							63	37	100	100
T-14	Telamaco Borba						79	57	68	45	100	77							0	0	100	100
T-11	Tibagi						70	53	83	67	100	83							0	0	100	80
T-34	Urai	79	57				56	24	78	39	100	87							0	0	100	58
T-13	Ventania						56	24	78	39	100	87							0	0	100	100

Since the area of mechanization and conservation of potato for each municipality in 1994 is not available in EMATER data base, the state average based on 1993 data was adopted. Source: EMATER (1994)

Table-A3.7 Productivity of Dominant Crops and Number of Farmers Involved in Iguacu River Basin

(1/2)

No.	Municipality	Cotton P. (ton/ha)	Sugarcane No. of Farmers	Sugarcane P. (ton/ha)	Beans No. of Farmers	Beans P. (ton/ha)	Maize No. of Farmers	Maize P. (ton/ha)	Soybean No. of Farmers	Soybean P. (ton/ha)	Cassava No. of Farmers	Cassava P. (ton/ha)	Potato No. of Farmers	Potato P. (ton/ha)	Coffee No. of Farmers	Coffee P. (ton/ha)	Wheat No. of Farmers	Wheat P. (ton/ha)
1-17	Aguados do Sul	0	0	0.00	1400	3.10	1400	0.00	0	0.00	400	13.00	90	11.00	0	0.00	0	0.00
1-7	Almirante Tamandare	0	0	0.00	526	1.33	635	0.00	0	0.00	0	0.00	65	12.00	0	0.00	0	0.00
1-78	Ampere	0	1200	15.00	1200	0.70	1450	2.20	200	2.20	1200	15.00	0	0.00	0	0.00	600	1.70
1-25	Antonio Otonio	0	0	0.00	1575	1.10	1300	2.10	0	0.00	600	14.00	55	17.00	0	0.00	0	0.00
1-1	Avacuana	0	0	0.00	1750	1.20	1700	2.70	12	2.20	0	0.00	1060	15.00	0	0.00	105	1.08
1-14	Balsa Nova	0	0	0.00	429	0.99	422	0.00	0	0.00	0	0.00	248	15.00	0	0.00	0	0.00
1-73	Barracao	0	1350	40.00	1800	0.70	1900	2.20	15	1.80	1750	18.00	450	5.00	0	0.00	900	0.85
1-36	Biturata	0	150	28.00	1000	1.00	1100	2.30	0	0.00	800	18.00	0	0.00	0	0.00	0	0.00
1-67	Boa Esperanca do Iguacu	0	0	0.00	350	1.58	615	3.20	80	1.80	600	20.00	0	0.00	0	0.00	98	1.24
1-91	Boa Vista da Aparecida	300	600	40.00	1800	0.60	1000	2.50	150	2.10	1000	30.00	0	0.00	0	0.00	20	1.50
1-55	Bom Sucesso do Sul	0	0	0.00	400	2.10	700	4.50	350	2.20	0	0.00	0	0.00	0	0.00	70	1.50
1-1	Campina Grande do Sul	0	0	0.00	57	0.42	66	1.50	0	0.00	0	0.00	3	7.00	0	0.00	0	0.00
1-2	Campo do Tenente	0	0	0.00	315	1.00	295	2.40	4	2.40	0	0.00	90	12.00	0	0.00	0	0.00
1-9	Campo Largo	0	0	0.00	588	0.90	612	2.00	0	0.00	0	0.00	212	12.00	0	0.00	0	0.00
1-45	Candi	0	0	0.00	2148	0.94	2069	4.05	425	2.40	0	0.00	0	0.00	0	0.00	125	2.82
1-45	Cantagalo	19	210	42.00	1049	0.86	1721	2.30	21	2.30	1343	15.00	3	15.00	0	0.00	13	1.60
1-66	Caporama	100	1350	50.00	1600	1.20	1500	3.20	1500	2.00	1500	20.00	0	0.00	0	0.00	300	1.20
1-92	Capitao Leonidas Marques	200	1000	55.00	800	1.60	1000	3.70	300	2.60	1025	30.00	0	0.00	0	0.00	70	1.10
1-9	Castelvel	47	722	45.00	417	1.10	722	5.00	1233	2.56	1167	30.00	0	0.00	0	0.00	192	0.90
1-66	Catanduvas	155	0	0.00	220	0.90	1100	4.86	150	2.70	1030	30.00	0	0.00	0	0.00	25	2.50
1-96	Ceu Azul	79	0	0.00	79	1.00	593	5.00	395	2.80	356	25.00	0	0.00	0	0.00	119	0.00
1-49	Chopinzinho	0	0	0.00	1500	1.20	1890	3.70	890	2.40	1200	20.00	60	10.00	0	0.00	250	0.00
1-42	Clelandia	0	0	0.00	700	0.90	650	0.90	500	2.30	800	20.00	0	0.00	0	0.00	60	0.00
1-5	Colombo	0	0	0.00	338	0.60	538	2.25	0	0.00	0	0.00	13	8.00	0	0.00	0	0.00
1-15	Condom	0	0	0.00	1393	1.24	1393	3.72	0	0.00	0	0.00	1170	16.00	0	0.00	0	0.00
1-5	Coronel Vivida	0	0	0.00	2540	0.40	2540	2.80	1250	2.89	2150	17.50	0	0.00	0	0.00	0	0.00
1-37	Cruz Machado	0	0	0.00	2076	0.90	2276	1.60	0	0.00	900	9.00	200	12.00	0	0.00	200	1.20
1-66	Cruzeiro do Iguacu	0	0	0.00	550	1.00	510	2.80	100	2.00	100	32.00	0	0.00	0	0.00	100	1.50
1-8	Curitiba	0	0	0.00	0	0.00	270	2.00	0	0.00	0	0.00	18	12.00	0	0.00	0	0.00
1-68	Dois Vizinhos	0	1200	18.00	1700	3.26	1700	3.26	250	2.10	1500	35.00	0	0.00	0	0.00	166	1.80
1-69	Engesa Marques	0	0	0.00	1007	2.40	1007	2.40	0	0.00	800	20.00	0	0.00	0	0.00	150	1.10
1-11	Fazenda Rio Grande	0	0	0.00	250	1.00	360	3.20	4	1.80	0	0.00	30	15.00	0	0.00	0	0.00
1-72	Fior da Serra do Sul	0	0	0.00	950	0.90	1100	2.60	20	2.50	770	20.00	0	0.00	0	0.00	20	1.50
1-11	Foz do Iguacu	0	0	0.00	177	4.80	177	4.80	308	2.30	249	25.00	0	0.00	0	0.00	37	1.35
1-7	Francisco Beltrao	0	1200	45.00	2350	2.80	2350	2.80	92	2.40	2050	27.00	480	6.00	0	0.00	380	1.10
1-35	General Carneiro	0	0	0.00	489	0.80	489	1.50	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1-63	Guaranicua	94	0	0.00	1317	0.80	1458	2.50	235	2.50	1270	30.00	0	0.00	0	0.00	108	0.80
1-39	Guaporuba	0	0	0.00	1844	0.70	2524	4.50	285	2.85	0	0.00	34	24.00	0	0.00	123	2.24
1-43	Honorio-Serpa	0	0	0.00	960	1.10	960	2.45	390	2.40	0	0.00	0	0.00	0	0.00	120	1.78
1-89	Ibema	0	45	45.00	186	1.30	290	4.50	22	2.45	147	30.00	0	0.00	0	0.00	0	0.00
1-38	Inacio Martins	0	0	0.00	691	0.65	691	1.60	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1-28	Irati	0	0	0.00	1252	0.90	1274	2.80	14	2.50	0	0.00	32	12.00	0	0.00	20	1.60
1-56	Japelema D'Oeste	0	0	0.00	500	1.20	1000	2.80	750	1.80	0	0.00	0	0.00	0	0.00	100	1.50
1-21	Lapa	0	0	0.00	2000	1.20	2500	3.60	150	2.35	2000	30.00	500	15.00	0	0.00	20	1.50
1-46	Laranjeiras do Sul	0	1317	50.00	1789	2.75	1789	2.75	107	2.35	810	18.00	0	0.00	0	0.00	73	1.39
1-84	Limoes	450	200	30.00	300	0.60	930	2.15	15	2.00	400	22.00	0	0.00	0	0.00	10	1.45
1-3	Maier	0	0	0.00	1400	1.05	1400	2.90	20	2.50	338	13.00	150	12.00	0	0.00	0	0.00
1-12	Mandububa	0	0	0.00	850	1.10	950	3.40	0	0.00	0	0.00	160	15.00	0	0.00	120	1.00
1-44	Mangueirinha	0	0	0.00	1430	1.10	1650	3.40	750	2.10	1500	15.00	1430	15.00	0	0.00	20	1.70
1-52	Matozola	0	800	0.00	500	1.50	570	3.00	480	2.35	310	17.00	0	0.00	0	0.00	60	2.24
1-71	Marmeleiro	0	0	0.00	2000	2.75	2000	2.75	35	2.50	1900	20.00	0	0.00	0	0.00	15	1.50
1-97	Matalandia	76	0	0.00	895	5.50	895	5.50	521	2.70	605	25.00	0	0.00	0	0.00	106	0.70
1-98	Medianeira	33	0	0.00	505	2.23	505	2.23	669	2.23	622	25.00	0	0.00	0	0.00	303	1.00
1-79	Nova Esperanca do Sul	0	0	0.00	498	1.00	882	2.80	5	2.40	530	27.00	0	0.00	0	0.00	86	1.20
1-42	Nova Laranjeiras	0	0	0.00	586	0.70	812	2.00	9	2.20	0	0.00	0	0.00	0	0.00	4	1.50
1-82	Nova Prata do Iguacu	0	1080	25.00	1280	3.50	1280	3.50	350	2.40	1050	30.00	0	0.00	0	0.00	65	1.60
1-41	Paimos	0	0	0.00	650	3.50	900	3.50	90	2.25	500	20.00	10	20.00	0	0.00	15	1.60

Table A3.7 Productivity of Dominant Crops and Number of Farmers Involved in Iguazu River Basin  
(2/2)

No.	Municipality	Cotton P. (ton/ha)	Sugarcane No. of Farmers	Sugarcane P. (ton/ha)	Beans No. of Farmers	Beans P. (ton/ha)	Maize No. of Farmers	Maize P. (ton/ha)	Soybean No. of Farmers	Soybean P. (ton/ha)	Cassava No. of Farmers	Cassava P. (ton/ha)	Potato No. of Farmers	Potato P. (ton/ha)	Coffee No. of Farmers	Coffee P. (ton/ha)	Wheat No. of Farmers	Wheat P. (ton/ha)
I-23	Piñeros	0	0	0.00	228	0.75	384	3.60	87	2.70	0	0.00	7	15.00	0	0.00	15	1.80
I-21	Palo Blanco	0	0	0.00	900	1.24	1600	3.77	950	2.50	800	20.00	200	17.00	0	0.00	80	1.86
I-32	Paula Freitas	0	0	0.00	500	1.20	500	2.20	50	1.90	300	30.00	3	15.00	0	0.00	0	0.00
I-31	Paulo Frontin	0	0	0.00	1300	0.89	1235	2.50	63	1.98	0	0.00	4	12.00	0	0.00	0	0.00
I-33	Perola do Oeste	0	1950	0.75	1900	0.85	2250	3.60	1300	2.00	2000	20.00	0	0.00	0	0.00	1600	1.70
I-18	Pian	0	0	0.00	990	0.85	1310	2.82	0	0.00	0	0.00	0	15.00	0	0.00	280	1.05
I-6	Pinhais	0	0	0.00	0	0.00	72	1.60	0	0.00	0	0.00	4	11.50	0	0.00	0	0.00
I-77	Pinhal de São Bento	0	0	0.00	210	0.75	380	2.50	7	1.50	0	0.00	0	0.00	0	0.00	20	1.20
I-4	Pinheiro	0	0	0.00	2700	0.55	3200	4.25	100	2.70	0	0.00	15	25.00	0	0.00	35	2.23
I-3	Piraquara	0	0	0.00	0	0.00	128	1.60	0	0.00	0	0.00	6	11.50	0	0.00	0	0.00
I-84	Planalto	0	0	0.00	2182	1.00	2182	3.00	1055	1.80	1302	25.00	0	0.00	0	0.00	250	1.50
I-22	Ponte Amazonas	0	0	0.00	22	1.20	111	2.50	11	2.50	0	0.00	7	18.00	0	0.00	0	0.00
I-34	Porto Vitória	0	0	0.00	290	1.50	315	2.00	0	0.00	155	25.00	0	0.00	0	0.00	0	0.00
I-76	Prencibla	0	300	0.00	500	1.20	850	3.00	30	2.50	30	20.00	0	0.00	0	0.00	30	2.20
I-2	Quatro Barras	0	0	0.00	108	0.72	136	1.80	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
I-64	Quevedos do Iguazu	0	0	0.00	1650	0.90	2700	2.70	165	2.46	0	0.00	0	0.00	0	0.00	100	1.10
I-16	Quitandinha	0	0	0.00	1600	0.92	1900	2.60	0	0.00	0	0.00	490	15.00	0	0.00	260	0.90
I-85	Realiza	0	705	10.00	750	1.00	1100	3.80	720	2.30	430	24.00	0	0.00	0	0.00	530	2.10
I-27	Rebouças	0	0	0.00	1829	1.20	1858	3.00	30	2.40	623	16.00	55	16.50	0	0.00	49	1.85
I-54	Ranocenda	0	0	0.00	700	1.00	900	4.50	300	2.40	700	28.00	0	0.00	0	0.00	100	1.50
I-29	Rio Azul	0	0	0.00	1964	0.99	1964	2.50	15	2.30	0	0.00	50	12.00	0	0.00	65	1.60
I-61	Rio Bonito do Iguazu	0	0	0.00	500	0.90	740	3.30	80	2.35	0	0.00	0	0.00	0	0.00	35	1.20
I-19	Rio Negro	0	0	0.00	653	1.20	905	2.80	1	2.40	0	0.00	30	18.00	0	0.00	0	0.00
I-74	Salgado Filho	0	800	30.00	850	1.00	1300	2.60	0	0.00	1300	20.00	0	0.00	65	1.80	800	1.20
I-8	Salto de Linha	70	0	0.00	1800	1.30	1800	3.00	100	2.50	1500	25.00	0	0.00	0	0.00	100	1.25
I-81	Santa Isabel do Oeste	0	900	60.00	650	0.90	1400	3.00	450	2.10	1200	23.00	40	20.00	0	0.00	400	1.80
I-93	Santa Luiza	80	0	0.00	380	1.40	476	3.60	130	2.40	420	30.00	0	0.00	0	0.00	12	1.20
I-85	Santa Teresinha do Oeste	31	111	37.00	0	0.00	205	5.00	111	2.45	139	30.00	0	0.00	0	0.00	72	1.70
I-1	Santa Teresinha de Itaipu	7	95	45.00	0	0.00	73	6.00	185	2.20	179	20.00	0	0.00	0	0.00	28	1.60
I-75	Santo Antonio do Subceste	0	0	0.00	545	0.90	1580	2.50	165	2.20	720	13.50	0	0.00	0	0.00	125	1.45
I-58	São João	0	805	40.00	410	1.10	1080	4.00	494	2.48	710	20.00	0	0.00	0	0.00	440	1.48
I-24	São João do Trunfo	0	0	0.00	1293	0.90	2038	3.00	8	2.50	0	0.00	20	18.00	0	0.00	0	0.00
I-65	São Jorge do Oeste	0	1050	40.00	940	0.60	862	4.00	15	1.98	1100	15.00	0	0.00	0	0.00	48	1.49
I-4	São José dos Pinhais	0	0	0.00	1472	0.81	1546	2.40	0	0.00	0	0.00	37	9.85	0	0.00	0	0.00
I-26	São Mateus do Sul	0	0	0.00	2900	0.90	3200	2.50	75	2.40	250	28.50	30	20.00	0	0.00	30	2.00
I-89	São Miguel do Iguazu	27	777	40.00	0	0.00	548	5.50	868	2.40	274	28.00	0	0.00	0	0.00	229	2.22
I-6	Sevides do Iguazu	0	350	82.00	310	1.00	391	3.81	30	1.80	395	2.90	0	0.00	0	0.00	0	0.00
I-59	Sulina	0	660	50.00	560	0.75	900	3.20	180	2.10	880	31.00	0	0.00	0	0.00	280	1.48
I-13	Tupões do Sul	0	0	0.00	822	0.60	1276	2.03	0	0.00	0	0.00	10	18.60	0	0.00	0	0.00
I-87	Tres Barras do Paraná	130	220	45.00	610	1.20	1400	3.60	76	2.10	750	30.00	0	0.00	0	0.00	28	1.50
I-33	Urua de Vitória	0	0	0.00	610	0.60	630	2.23	4	2.10	580	12.00	0	0.00	0	0.00	0	0.00
I-57	Vere	0	0	0.00	1200	0.60	1200	3.00	320	2.70	1200	35.00	0	0.00	0	0.00	400	1.20
I-47	Virmound	0	0	0.00	400	0.70	660	1.80	0	0.00	0	0.00	0	0.00	0	0.00	5	1.10
I-53	Vitorino	0	0	0.00	150	1.48	475	4.00	300	2.40	0	0.00	0	0.00	0	0.00	110	1.40

No. of Farmers; Number of Farmers Involved, P.; Productivity with Regular Tillage  
Source: EMATER (1994)



Table-A3.8 Productivity of Dominant Crops and Number of Farmers Involved in Tibagi River Basin

No	Municipality	Cotton No. of Farmers	Cotton P. (ton/ha)	Sugarcane No. of Farmers	Sugarcane P. (ton/ha)	Beans No. of Farmers	Beans P. (ton/ha)	Milze No. of Farmers	Milze P. (ton/ha)	Soybean No. of Farmers	Soybean P. (ton/ha)	Cassava No. of Farmers	Cassava P. (ton/ha)	Potato No. of Farmers	Potato P. (ton/ha)	Coffee No. of Farmers	Coffee P. (ton/ha)	Wheat No. of Farmers	Wheat P. (ton/ha)
T-22	Apucarana	5	1.62	0	0.00	116	0.60	197	4.14	66	2.40	0	0.00	0	0.00	121	0.60	33	1.00
T-23	Anapongas	8	1.40	5	74.00	92	0.60	236	4.20	168	2.60	0	0.00	0	0.00	136	1.50	84	1.37
T-31	Aessi	320	1.23	0	0.00	160	0.60	1120	3.60	690	2.20	0	0.00	0	0.00	38	1.07	790	0.60
T-21	California	28	1.40	0	0.00	215	0.85	297	3.00	0	0.00	0	0.00	0	0.00	39	0.42	0	0.00
T-38	Cambe	0	0.00	4	96.00	0	0.00	123	4.70	116	2.60	4	25.00	0	0.00	47	0.00	79	1.20
T-5	Castro	0	0.00	0	0.00	2078	0.97	2258	5.98	653	2.86	108	30.00	90	25.00	0	0.00	105	2.10
T-28	Congonhinhas	7	0.50	1	30.00	14	0.65	25	2.40	6	1.98	0	0.00	0	0.00	21	0.76	6	1.61
T-33	Corneio Protospio	17	0.50	2	115.70	0	0.00	139	2.23	158	2.23	0	0.00	0	0.00	42	1.60	70	1.20
T-16	Curitiba	0	0.00	0	0.00	249	0.85	311	2.20	0	0.00	44	16.00	0	0.00	0	0.00	0	0.00
T-36	Itabora	0	0.00	0	0.00	0	0.00	10	4.50	180	2.40	0	0.00	0	0.00	30	1.60	50	2.30
T-5	Imbituva	0	0.00	0	0.00	1738	1.00	2720	3.76	48	2.80	793	25.00	11	13.00	0	0.00	17	1.70
T-6	Itaiponga	0	0.00	0	0.00	1800	1.00	1990	4.40	60	2.80	1500	15.00	315	12.00	0	0.00	40	1.90
T-4	Itaiti	0	0.00	0	0.00	428	0.00	436	2.80	5	2.50	0	0.00	11	12.00	0	0.00	7	1.60
T-9	Ivaí	0	0.00	0	0.00	522	1.05	679	2.95	9	2.70	139	15.00	0	0.00	0	0.00	3	2.10
T-35	Jataizinho	58	0.65	0	0.00	0	0.00	120	3.40	130	2.36	0	0.00	0	0.00	0	0.00	125	0.60
T-41	Leópolis	17	1.58	0	0.00	320	0.80	2500	3.80	663	2.35	263	20.00	0	0.00	375	0.50	30	1.74
T-24	Londrina	30	0.00	0	0.00	84	0.60	257	6.10	64	2.50	0	0.00	0	0.00	10	0.40	14	1.80
T-2	Mariandia do Sul	0	0.00	0	0.00	0	0.00	9	7.20	8	2.70	0	0.00	0	0.00	0	0.00	3	1.95
T-19	Meua de Serra	70	0.90	1	76.00	30	0.42	60	2.48	66	1.98	0	0.00	0	0.00	12	0.14	65	1.49
T-32	Nova America da Colina	0	0.00	0	0.00	11	0.72	30	3.47	36	2.11	0	0.00	0	0.00	26	0.80	22	1.60
T-29	Nova Palmira	1	1.15	0	0.00	0	0.00	128	3.50	35	1.74	0	0.00	0	0.00	0	0.00	35	1.24
T-25	Nova Santa Barbara	140	0.99	0	0.00	0	0.00	1607	1.90	19	2.90	1285	20.00	3	10.00	0	0.00	8	1.80
T-15	Orizuela	0	0.00	0	0.00	1022	0.75	1636	3.90	393	2.70	0	0.00	33	15.00	0	0.00	65	1.90
T-2	Palmeira	0	0.00	0	0.00	522	1.25	671	4.40	148	2.60	143	20.00	9	25.00	0	0.00	9	2.40
T-12	Piraí do Sul	0	0.00	0	0.00	675	0.95	723	4.50	226	2.60	272	30.00	13	14.00	0	0.00	66	1.60
T-7	Porto Grossa	0	0.00	0	0.00	8	1.20	39	2.50	4	2.60	0	0.00	3	16.00	0	0.00	0	0.00
T-1	Ponto Azul	0	0.00	0	0.00	0	0.00	36	2.98	192	2.23	0	0.00	0	0.00	7	2.00	12	1.74
T-43	Primeiro de Maio	10	1.86	0	0.00	0	0.00	30	4.50	190	2.23	0	0.00	0	0.00	0	0.00	100	1.98
T-4	Rancho Alegre	5	2.36	0	0.00	0	0.00	628	1.80	4	2.30	163	30.00	3	20.00	0	0.00	5	2.00
T-37	Rolandia	0	1.55	16	84.00	765	0.80	185	3.72	54	2.60	4	25.00	0	0.00	16	0.98	36	2.23
T-26	Santa Cecilia do Pavão	0	0.00	0	0.00	52	0.85	120	3.72	37	2.23	0	0.00	0	0.00	0	0.00	35	0.90
T-27	Santo Antônio do Paraíso	19	1.05	0	0.00	0	0.00	710	2.98	110	1.86	0	0.00	0	0.00	0	0.00	55	1.36
T-18	São Jerônimo de Serra	470	0.74	0	0.00	450	0.37	80	3.70	191	2.23	0	0.00	0	0.00	250	1.20	90	1.98
T-3	São Sebastião de Amoreira	40	1.00	8	40.00	0	0.00	521	1.91	0	0.00	0	0.00	0	0.00	15	1.50	143	2.18
T-17	Sarapuí	0	0.00	0	0.00	268	0.85	27	4.49	116	2.25	0	0.00	0	0.00	27	0.63	0	0.00
T-42	Sertãozinho	0	0.00	0	0.00	0	0.00	124	4.10	906	2.36	0	0.00	0	0.00	0	0.00	25	1.33
T-39	Sertãozinho	0	0.00	0	0.00	2426	1.50	2623	3.70	437	2.50	0	0.00	80	13.20	48	0.60	133	1.49
T-3	Tietê Soares	0	0.00	0	0.00	75	0.90	310	2.30	5	2.20	200	21.00	15	12.00	0	0.00	0	0.00
T-14	Telemaco Borba	0	0.00	0	0.00	448	1.00	925	5.00	129	3.00	158	25.00	0	0.00	55	0.50	60	2.50
T-11	Tibagi	82	0.74	0	0.00	250	0.00	372	2.50	225	1.74	0	0.00	0	0.00	0	0.00	128	0.62
T-34	Uraí	0	0.00	0	0.00	120	0.62	138	2.50	12	2.50	0	0.00	0	0.00	0	0.00	0	0.00
T-13	Vertebral	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

No. of Farmers Number of Farmers Involved, P.: Productivity with Regular Tillage  
Source: EMATER (1994)

Table-A3.9 Application of Non Tillage in Iguacu River Basin (1/2)

No.	Municipality	Cotton		Beans		Maize		Soybean		Wheat	
		Total Area (ha)	N.T. Area (ha)	Total Area (ha)	N.T. Area (ha)	Total Area (ha)	N.T. Area (ha)	Total Area (ha)	N.T. Area (ha)	Total Area (ha)	N.T. Area (ha)
1-17	Agudeo do Sul	0	0	2200	0	10800	0	0	0	0	0
1-7	Almirante Tamandare	0	0	1200	0	2200	0	0	0	0	0
1-78	Ampere	0	0	1100	0	7300	0	3300	0	1500	0
1-25	Antonio Olinto	0	0	7400	0	7400	0	0	0	0	0
1-10	Aruacaria	0	0	4100	0	15600	310	200	134	220	0
1-14	Balsa Nova	0	0	2300	0	3300	0	100	0	1000	0
1-73	Sarnaço	0	0	1600	0	12200	0	0	0	0	0
1-36	Blumenau	0	0	5900	0	18800	0	0	0	0	0
1-67	Bom Esperança do Iguacu	0	0	2700	0	8100	0	2200	0	1000	0
1-91	Bom Vista da Aparecida	1000	0	2300	0	5000	0	1300	0	200	0
1-56	Bom Sucesso do Sul	0	0	1500	0	3300	0	2100	1575	1500	0
1-1	Campina Grande do Sul	0	0	300	0	700	0	0	0	0	0
1-20	Campo do Tenente	0	0	3000	0	8600	0	900	220	0	0
1-9	Campo Largo	0	0	3300	0	9200	0	0	0	0	0
1-46	Carndói	0	0	3100	0	24200	4840	11200	3360	3540	100
1-46	Carregallo	0	0	2700	0	24900	246	2400	144	420	0
1-86	Capitania	0	0	4300	0	7500	0	9200	0	3000	0
1-92	Capitão Leonidas Marques	1100	0	1700	0	6300	0	5600	0	700	0
1-80	Casarel	0	0	600	0	18600	6510	37400	13660	6666	3334
1-85	Catanduvus	1000	0	500	0	17000	1602	4600	1170	350	0
1-96	Cru Azul	200	0	0	0	1700	68	2100	126	2768	0
1-49	Chopacinho	0	0	3800	0	24600	2214	12900	8543	5000	60
1-42	Clovelândia	0	0	2900	0	12100	0	16000	0	1200	83
1-5	Colombo	0	0	700	0	900	0	0	0	0	0
1-15	Cordeiros	0	0	3200	0	6000	0	0	0	0	0
1-50	Coronel Vitor	0	0	1200	0	19000	0	8100	3240	0	0
1-37	Cruz Machado	0	0	28500	0	28500	0	1400	0	2000	0
1-66	Cruzeiro do Iguacu	0	0	600	0	4000	0	0	0	0	0
1-6	Curitiba	0	0	0	0	13900	0	3600	0	2060	0
1-68	Dois Vizinhos	0	0	1800	0	3100	0	700	0	360	0
1-69	Ereos Marques	0	0	4200	0	5100	0	0	0	0	0
1-11	Fazenda Rio Grande	0	0	1400	0	3100	0	0	0	0	0
1-72	Fior da Serra do Sul	0	0	300	0	2700	54	100	0	150	0
1-101	Foz do Iguacu	0	0	0	0	1900	0	6300	252	525	0
1-70	Francisco Beltrão	0	0	5400	0	26300	263	3200	608	1500	15
1-35	General Carneiro	0	0	2700	0	21600	0	0	0	0	0
1-63	Guaranicui	200	0	900	0	9800	0	1500	750	1270	0
1-38	Guarapuava	0	0	10900	0	78900	54372	64900	61655	4276	3935
1-43	Honório Serpa	0	0	2800	0	18900	1692	13600	4692	1600	624
1-89	Ibama	0	0	100	0	3100	713	800	502	0	0
1-38	Inacio Martins	0	0	7400	0	14300	0	0	0	0	0
1-28	Irap	0	0	10100	0	11200	0	700	56	46	0
1-56	Itapejara D'Oeste	0	0	1000	0	6100	244	5900	236	800	0
1-21	Lapa	0	0	36800	0	36000	720	14100	1269	1200	252
1-48	Laranjeiras do Sul	0	0	9000	0	26300	5786	4700	4700	1941	100
1-94	Limboeira	2900	0	500	0	11300	500	0	0	230	0
1-30	Mallet	0	0	13100	393	13300	1330	1400	1400	0	0
1-12	Manduzuba	0	0	5300	0	12700	0	0	0	160	0
1-44	Manquebituba	0	0	3400	0	13900	2502	14900	2692	1200	0
1-52	Maripolis	0	0	1200	0	3900	2067	6100	5551	500	30
1-71	Marmeleiro	0	0	4700	0	12900	1032	2100	7050	100	0
1-87	Matelandia	100	0	0	0	2500	0	3000	0	1967	0
1-98	Medianeira	200	0	0	0	4900	0	11000	0	4653	0
1-79	Nova Esperança do Sudoeste	0	0	2100	0	6900	0	100	0	150	0

Table-A3.9 Application of Non Tillage in Iguaqu River Basin (2/2)

No.	Municipality	Cotton Total Area (ha)	Cotton N.T. Area (ha)	Cotton Imple (%)	Beans Total Area (ha)	Beans N.T. Area (ha)	Beans Imple (%)	Maize Total Area (ha)	Maize N.T. Area (ha)	Maize Imple (%)	Soybean Total Area (ha)	Soybean N.T. Area (ha)	Soybean Imple (%)	Wheat Total Area (ha)	Wheat N.T. Area (ha)	Wheat Imple (%)
I-62	Nova Laranjeiras	0	0	0	1100	0	0	6800	136	2	200	126	63	100	68	50
I-62	Nova Prata do Iguacu	0	0	0	5000	250	5	7400	515	7	5000	280	5	1000	0	0
I-41	Palmas	0	0	0	2700	0	0	24900	1494	6	24400	12932	53	555	555	100
I-23	Palmeira	0	0	0	500	0	0	4200	2100	50	5300	2968	56	456	146	32
I-51	Pato Branco	0	0	0	2500	0	0	9000	0	0	13300	0	0	700	0	0
I-32	Paula Freitas	0	0	0	3900	0	0	6900	0	0	5000	0	0	0	0	0
I-31	Paulo Frontin	0	0	0	7200	0	0	9900	0	0	3900	0	0	0	0	0
I-63	Perola do Oeste	0	0	0	2100	0	0	7600	0	0	4000	0	0	4570	0	0
I-18	Planaltina	0	0	0	2300	0	0	10200	0	0	0	0	0	230	0	0
I-6	Pinhal	0	0	0	0	0	0	2500	0	0	0	0	0	0	0	0
I-77	Pinhal de Sao Bento	0	0	0	300	0	0	1200	0	0	100	0	0	450	0	0
I-40	Pinhao	0	0	0	6000	0	0	49400	29640	60	49400	45400	100	3300	1485	45
I-3	Piraquara	0	0	0	0	0	0	4700	0	0	0	0	0	0	0	0
I-64	Planalto	0	0	0	2000	0	0	5800	0	0	10000	0	0	3000	0	0
I-22	Ponte Amazonas	0	0	0	700	0	0	2900	0	0	1100	880	80	0	0	0
I-34	Ponto Victoria	0	0	0	1200	0	0	3800	0	0	0	0	0	0	0	0
I-76	Prairie	0	0	0	2200	0	0	5000	0	0	6600	0	0	5000	0	0
I-2	Quatro Barras	0	0	0	1200	0	0	1400	0	0	0	0	0	0	0	0
I-64	Quedas do Iguacu	0	0	0	2700	513	19	17900	5549	31	3900	3081	79	500	120	24
I-16	Quindizinha	0	0	0	6700	0	0	11700	0	0	0	0	0	210	0	0
I-85	Restezza	0	0	0	1700	0	0	8900	89	1	9300	0	0	4658	0	0
I-27	Rebouças	0	0	0	10500	0	0	14800	296	2	2600	206	10	188	0	0
I-64	Renasçanca	0	0	0	1100	0	0	7000	280	4	10000	0	0	2000	1000	50
I-29	Rio Azul	0	0	0	13900	0	0	16200	0	0	900	216	24	100	0	0
I-61	Rio Bonito do Iguacu	0	0	0	700	0	0	4400	924	21	800	400	50	500	300	60
I-19	Rio Negro	0	0	0	5100	0	0	8600	0	0	300	300	100	0	0	0
I-74	Salgado Filho	0	0	0	1300	0	0	6700	0	0	0	0	0	350	0	0
I-80	Santa Izabel do Oeste	700	0	0	4400	88	2	9500	190	2	1500	0	0	1500	105	7
I-93	Santa Lucia	400	0	0	1100	0	0	6600	130	2	7200	72	1	4000	0	0
I-95	Santa Tereza do Oeste	400	0	0	1200	0	0	3900	0	0	2900	0	0	130	0	0
I-00	Santa Teresinha de Itaipu	100	0	0	0	0	0	5100	765	16	7500	4600	60	1669	1001	60
I-75	Santo Antonio do Sulcoeste	0	0	0	4800	0	0	1700	0	0	2400	0	0	839	0	0
I-58	Sao Jose	0	0	0	900	0	0	8400	476	6	9400	1974	21	3300	300	10
I-24	Sao Jose do Triunfo	0	0	0	3600	0	0	11900	476	4	600	402	67	0	0	0
I-65	Sao Jorge do Oeste	0	0	0	1900	0	0	14300	429	3	500	235	47	484	121	25
I-26	Sao Mateus do Sul	0	0	0	6500	0	0	21700	0	0	0	0	0	0	0	0
I-69	Sao Miguel do Iguacu	400	0	0	17100	0	0	18900	185	5	6600	0	0	400	0	0
I-60	Saude do Iguacu	0	0	0	1000	0	0	6000	900	15	400	0	0	548	0	0
I-59	Sulina	0	0	0	400	0	0	6100	0	0	1600	0	0	750	0	0
I-13	Tijucas do Sul	0	0	0	700	0	0	7100	0	0	0	0	0	0	0	0
I-37	Tres Barras do Patena	700	0	0	3600	0	0	16900	0	0	1900	0	0	400	0	0
I-33	Uniao da Vitoria	0	0	0	4100	0	0	9600	0	0	500	0	0	5000	0	0
I-87	Veve	0	0	0	1800	0	0	11100	0	0	4300	0	0	100	0	0
I-47	Vimond	0	0	0	1500	0	0	7300	73	1	0	0	0	0	0	0
I-63	Vitorino	0	0	0	700	0	0	6000	0	0	7800	0	0	700	0	0
Total		9400	0	0	349400	1244	0.4	1116300	131719	11.8	907000	191901	37.9	105168	23229	22.1
Average																

Total area of each crop is adjusted to the result of SANEPAE GIS computation. Application % of non tillage based on EMATER data (1994) was used to obtain the area of non tillage.

NT: Non tillage, Imple. %: implementation % of non tillage

Source: EMATER (1994) for non tillage implementation %

Table-A3.10 Application of Non Tillage in Tibagi River Basin

No.	Municipality	Cotton		Beans		Maize		Soybean		Wheat		Wheat Total Area (ha)	Wheat N.T. Area (ha)	Wheat N.T. (%)
		Total Area (ha)	Impl. (%)	Total Area (ha)	Impl. (%)	Total Area (ha)	Impl. (%)	Total Area (ha)	Impl. (%)	Total Area (ha)	Impl. (%)			
T-22	Apucarana	100	0	200	0	3900	20	2200	308	14	637	283	40	
T-23	Avanhandava	100	40	100	0	2500	7	500	770	14	2187	481	22	
T-31	Assai	2200	0	400	0	9000	0	24300	0	0	12000	0	0	
T-21	California	100	0	400	0	1900	0	0	0	0	0	0	0	
T-36	Cambe	0	0	0	0	2000	29	6400	1344	21	5093	2394	47	
T-8	Casero	0	0	4400	616	28100	70	41400	36848	89	11798	11798	100	
T-29	Congonhinhas	300	0	200	0	2400	0	3200	0	0	196	0	0	
T-33	Coronel Procopio	300	0	1600	0	11300	6	11300	0	0	2683	0	0	
T-16	Cunuru	0	0	3600	0	7100	0	0	0	0	2000	0	0	
T-38	Ibipora	0	0	0	0	300	0	16600	0	0	680	408	60	
T-5	Imbituva	0	0	5700	114	11400	21	6200	4340	70	680	680	100	
T-6	Ipiranga	0	0	2200	0	22100	32	6500	4875	75	1999	1999	100	
T-4	Iraí	0	0	3500	0	3900	0	200	16	8	16	0	0	
T-9	Ivaí	0	0	3100	0	4100	11	400	332	83	87	0	0	
T-35	Jesuino	500	0	0	0	4400	8	5900	295	5	1960	0	0	
T-41	Leopoldo	800	0	2000	0	2000	0	3400	204	6	999	0	0	
T-24	Londrina	0	0	1500	0	27800	13	40200	6432	16	12000	3240	27	
T-20	Marilandia do Sul	0	0	300	0	3900	61	2400	2400	100	593	593	100	
T-19	Matua de Sertão	0	0	0	0	600	0	500	0	0	215	0	0	
T-32	Nova America da Colina	400	0	300	0	1100	0	3000	0	0	1800	0	0	
T-20	Nova Fátima	200	0	100	0	1200	28	2800	364	13	792	158	20	
T-25	Nova Santa Barbara	4000	0	1600	0	1600	19	4500	675	15	1500	285	19	
T-15	Oriquetira	0	0	14400	0	46800	932	2	2800	390	15	771	0	
T-2	Palmeira	0	0	2600	0	23100	50	28600	16128	56	2045	654	32	
T-12	Piraí do Sul	0	0	2600	0	12000	30	6900	5576	82	600	426	71	
T-7	Porto Grossa	0	0	5800	348	36300	37	40500	27540	68	6584	3056	60	
T-1	Porto Amazonas	0	0	300	0	1100	0	500	400	80	0	0	0	
T-43	Primeiro de Maio	100	0	0	0	900	0	8500	0	0	461	0	0	
T-40	Rancho Alegre	200	0	0	0	2500	0	12400	0	0	6000	0	0	
T-10	Reserva	0	0	9100	0	15000	0	500	0	0	377	0	0	
T-37	Rolândia	0	0	0	0	700	30	2000	760	38	1211	363	30	
T-28	Santa Cecilia do Pavão	0	0	200	0	2100	0	4600	276	6	1200	136	13	
T-27	Santo Antonio do Paraíso	300	0	2300	0	8300	0	8300	498	6	4000	0	0	
T-18	Sao Jeronimo da Serra	9000	0	2400	0	23500	0	7800	0	0	1209	0	0	
T-30	Sao Sebastiao da Amoreira	500	0	4800	0	1500	12	6900	621	9	3566	285	8	
T-17	Sapopema	0	0	0	0	16500	0	0	0	0	0	0	0	
T-42	Sertãozinho	0	0	0	0	3200	0	12100	1694	14	2199	178	8	
T-39	Sertãozinho	0	0	0	0	2100	0	26600	0	0	2914	0	0	
T-3	Taipira Soares	0	0	9900	4116	16300	47	13900	11120	80	1164	1164	100	
T-14	Talassoma Borba	0	0	1200	0	7700	0	400	0	0	0	0	0	
T-11	Tibagi	0	0	2600	858	26500	56	52700	51244	92	13545	11983	86	
T-34	Uraí	1400	0	600	0	5000	0	11000	0	0	3100	0	0	
T-13	Ventania	0	0	600	0	5200	8	8600	7482	87	1845	1162	63	
Average		20700	40	82800	6052	392800	23.1	445400	102900	41.1	112358	41954	37.3	

Total area of each crop is adjusted to the result of SANEPAR GIS computation. Application % of non tillage based on EMATER data (1994) was used to obtain the area of non tillage.

NT: non tillage, implie. %: implementation % of non tillage

Source: EMATER (1994) for non tillage implementation %

Table-A3.11 Productivity of Non Tillage and Regular Tillage in Iguaçu River Basin (1/2)

BACIA	Municipality	Beans R.P. (ton/ha)	Beans N.P. (ton/ha)	Maize R.P. (ton/ha)	Maize N.P. (ton/ha)	Soybean R.P. (ton/ha)	Soybean N.P. (ton/ha)	Wheat R.P. (ton/ha)	Wheat N.P. (ton/ha)
I-17	Agudos do Sul	0.90		3.10					
I-7	Almirante Tamandare	0.50		1.33					
I-78	Ampere	0.70		2.20		2.20		1.70	
I-25	Antonio Olinto	1.10		2.10					
I-1	Araucaria	1.20		2.70	4.50	2.20	2.35	1.85	
I-14	Balsa Nova	0.99		3.67					
I-73	Barracao	0.70		2.20		1.80		0.85	
I-36	Bituruna	1.00		2.30					
I-67	Boa Esperanca do Iguacu	1.58		3.20		1.80		1.24	
I-91	Boa Vista da Aparecida	0.60		2.50		2.10		1.50	
I-55	Bom Sucesso do Sul	2.10		4.50		2.20	2.25	1.50	
I-1	Campina Grande do Sul	0.42		1.50					
I-2	Campo do Tenente	1.00		2.40		2.40	3.00		
I-9	Campo Largo	0.90		2.00					
I-45	Candol	0.84		4.05	4.05	2.40	2.40	2.42	2.42
I-46	Canitagoala	0.86		2.30	4.00	2.30	2.60	1.20	
I-86	Capenema	1.20		3.20		2.00		1.60	
I-92	Capitao Leonidas Marques	1.60		3.70		2.60		1.10	
I-9	Cascavel	1.10		5.00	6.00	2.35	2.70	0.90	0.90
I-88	Calandujvas	0.90		4.88	4.90	2.70	2.20	0.90	
I-96	Ceu Azul			5.00	5.00	2.80	2.80	1.20	
I-49	Chopininho	1.20		3.70	6.50	2.40	2.60	1.80	1.92
I-42	Clevelandia	0.90		0.30		2.30		1.40	1.50
I-5	Colombo	0.60		2.25					
I-15	Confenda	1.24		3.72					
I-5	Coronel Vivida	0.40		2.80		2.49	2.49		
I-37	Cruz Machado	0.90		1.60				1.20	
I-66	Cruzeiro do Iguacu	1.00		2.80		2.00		1.50	
I-8	Curitiba			2.00					
I-68	Dois Vizinhos	1.32		3.26		2.10		1.80	
I-69	Eneas Marques	0.80		2.40				1.10	
I-11	Fazenda Rio Grande	1.00		3.20		1.80			
I-72	Flor da Serra do Sul	0.90		2.60	4.00	2.50		1.50	
I-11	Foz do Iguacu			4.80		2.30	2.40	1.35	
I-7	Francisco Beltrao	1.00		2.80	3.30	2.40	2.10	1.10	1.30
I-35	General Carneiro	0.80		1.50					
I-63	Guaraniaçu	0.80		2.50		2.50	3.20	0.60	
I-39	Guarapuava	0.70		4.50	6.40	2.65	2.80	2.24	2.30
I-43	Honorio-Serpa	1.10		2.45	4.00	2.40	2.50	1.78	1.70
I-89	Itaema	1.30		4.50	5.45	2.45	2.55		
I-35	Inacio Martins	0.65		1.60					
I-28	Irati	0.90		2.80		2.50	2.80	1.60	
I-56	Itapejara D'Oeste	1.20		2.80	4.00	1.80	2.10	1.50	
I-21	Lapa	1.20		3.60	6.50	2.25	2.60	1.50	1.30
I-48	Laranjeiras do Sul	0.90		2.75	5.40	2.35	2.35	1.39	1.39
I-94	Lindoeste	0.60		2.15		2.00		1.45	
I-3	Mallet	1.05	1.05	2.90	2.90	2.50	2.50		
I-12	Mandrituba	1.10		3.00				1.00	
I-44	Mangueirinha	1.10		3.40	6.50	2.10	3.00	1.70	
I-52	Maripolis	1.50		3.00	3.50	2.35	2.50	2.24	
I-71	Marmeleiro	0.90		2.75	2.75	2.30	2.30	1.50	
I-97	Matelandia			5.50		2.70		0.70	
I-98	Medianeira			5.20		2.23		1.00	
I-79	Nova Esperanca do Sudoeste	1.00		2.80		2.40		1.20	
I-62	Nova Laranjeiras	0.70		2.00	6.00	2.20	2.70	1.50	1.80
I-82	Nova Prata do Iguacu	1.20	1.20	3.50	3.50	2.40	2.40	1.60	
I-41	Palmas	0.90		3.50	6.00	2.25	2.25	1.60	1.60
I-23	Palmaira	0.75		3.60	6.00	2.70	3.20	1.60	2.00
I-51	Pato Branco	1.24		3.77		2.50		1.56	
I-32	Paula Freitas	1.20		2.20		1.90			
I-31	Paulo Frontin	0.89		2.50		1.98			
I-83	Perola do Oeste	0.75		3.60		2.00		1.70	
I-18	Pien	0.85		2.82				1.05	
I-6	Pinhais			1.60					
I-77	Pinhal de Sao Bento	0.75		2.50		1.50		1.20	
I-4	Pinhao	0.55		4.25	5.85	2.70	2.70	2.23	2.23
I-3	Piraquara			1.60					
I-84	Planalto	1.00		3.00		1.80		1.50	
I-22	Porto Amazonas	1.20		2.50		2.50	2.70		
I-34	Porto Vitoria	1.50		2.00					
I-76	Pranchita	1.20		3.00		2.50		2.20	
I-2	Quatro Barras	0.72		1.80					
I-64	Quedas do Iguacu	0.90	1.20	2.70	4.50	2.48	2.72	1.10	1.30

Table-A3.11 Productivity of Non Tillage and Regular Tillage in Iguacu River Basin (2/2)

BACIA	Municipality	Beans R.P. (ton/ha)	Beans N.P. (ton/ha)	Maize R.P. (ton/ha)	Maize N.P. (ton/ha)	Soybean R.P. (ton/ha)	Soybean N.P. (ton/ha)	Wheat R.P. (ton/ha)	Wheat N.P. (ton/ha)
I-16	Quitandinha	0.92		2.60				0.90	
I-85	Realeza	1.00		3.80	6.20	2.30		2.10	
I-27	Rebouças	1.20		3.00	4.80	2.40	2.50	1.65	
I-54	Renascença	1.00		4.50	5.00	2.40		1.50	1.60
I-29	Rio Azul	0.99		2.50		2.30	2.50	1.60	
I-61	Rio Bonito do Iguacu	0.90		3.30	6.20	2.35	2.70	1.20	2.20
I-19	Rio Negro	1.20		2.80		2.40	2.40		
I-74	Salgado Filho	1.00		2.60				1.20	
I-8	Salto do Lontra	1.30	3.50	3.00	4.00	2.50		1.25	1.50
I-81	Santa Izabel do Oeste	0.90		3.00	3.00	2.10	2.00	1.80	
I-93	Santa Lucia	1.40		3.60		2.40		1.20	
I-95	Santa Tereza do Oeste			5.00	5.70	2.48	3.00	1.70	2.00
I-1	Santa Terezinha de Itaipu			6.00		2.20		1.60	
I-75	Santo Antonio do Sudoeste	0.90		2.50		2.20		1.45	
I-58	Sao Joao	1.10		4.00	6.19	2.48	2.73	1.46	1.98
I-24	Sao Joao do Triunfo	0.80		3.00	4.44	2.50	2.40		
I-65	Sao Jorge do Oeste	0.60		4.00	5.00	1.98	2.50	1.49	2.00
I-4	Sao Jose dos Pinhais	0.81		2.40					
I-26	Sao Mateus do Sul	0.90		2.50		2.40		2.00	
I-99	Sao Miguel do Iguacu			5.50	0.60	2.40	2.98	2.22	
I-6	Saudade do Iguacu	1.00		3.81	5.20	1.80			
I-59	Sulina	0.75		3.20		2.10		1.48	
I-13	Tijucas do Sul	0.60		2.03					
I-87	Tres Barras do Parana	1.20		3.60		2.10		1.50	
I-33	Uniao da Vitoria	0.90		2.23		2.10			
I-57	Vere	0.60		3.00		2.70		1.20	
I-47	Virmound	0.70		1.60	2.80			1.10	
I-53	Vitorino	1.48		4.00		2.40	0.00	1.40	

R.P.: Productivity of Regular Tillage, N.P. Productivity of Non Tillage

Source: EMATER (1994)

Table A3.12 Productivity of Non Tillage and Regular Tillage in Tibagi River Basin

BACIA	Municipality	Beans R.P. (ton/ha)	Beans N.P. (ton/ha)	Maize R.P. (ton/ha)	Maize N.P. (ton/ha)	Soybean R.P. (ton/ha)	Soybean N.P. (ton/ha)	Wheat R.P. (ton/ha)	Wheat N.P. (ton/ha)
T-22	Apucarana	0.60		4.14	6.45	2.40	2.73	1.00	1.00
T-23	Arapongas	0.60		4.20	4.20	2.60	2.60	1.37	1.37
T-31	Assal	0.60		3.60		2.20		0.60	
T-21	California	0.85		3.00					
T-38	Cambe			4.70	5.00	2.60	2.80	1.20	1.20
T-8	Castro	0.97	2.20	5.58	7.00	2.88	3.00	2.10	2.10
T-28	Congoninhas	0.55		2.40		1.98		1.61	
T-33	Cornelio Procopio			3.60	6.00	2.23		1.20	
T-16	Curitiba	0.85		2.20					
T-36	Ibitipora			4.50		2.40		2.30	
T-5	Imbituva	1.00	1.65	3.76	5.80	2.00	2.50	1.70	1.85
T-6	Ipiranga	1.00		4.40	6.00	2.80	2.80	1.90	1.90
T-4	Irati	0.90		2.80		2.50	2.80	1.60	
T-9	Ivaí	1.05		2.95	5.50	2.70	2.70	2.10	
T-35	Jataizinho			3.40	4.46	2.36	2.60	0.60	
T-41	Leópolis			4.40		2.20	2.36	1.74	
T-24	Londrina	0.60		3.80	3.80	2.35	2.35	1.70	1.80
T-2	Marilândia do Sul	0.80		5.10	6.20	2.50	2.50	1.80	1.80
T-19	Mau da Serra			7.20		2.70		1.95	
T-32	Nova America da Colina	0.42		2.48		1.98		1.49	
T-29	Nova Fátima	0.72		3.47	6.50	2.11	3.00	1.60	1.74
T-25	Nova Santa Barbara			3.50	4.95	1.74	2.48	1.24	1.73
T-15	Ortigueira	0.80		1.60	3.20	2.00	2.40	1.80	
T-2	Palmeira	0.75		3.60	6.00	2.70	3.20	1.60	2.00
T-12	Piraí do Sul	1.25		4.40	5.40	2.60	2.60	2.40	2.40
T-7	Ponta Grossa	0.95	1.90	4.50	6.10	2.50	2.70	1.60	2.10
T-1	Porto Amazonas	1.20		2.50		2.50	2.70		
T-43	Primeiro de Maio			2.98		2.23		1.74	
T-4	Rancho Alegre			4.50		2.23		1.98	
T-1	Reserva	0.80		1.80		2.20		2.00	
T-37	Rolândia			5.00	6.00	2.60	0.30	2.23	2.50
T-26	Santa Cecília do Pavao	0.85		3.72		2.23	2.48	0.99	1.00
T-27	Santo Antonio do Paraíso			3.72		1.88	2.98	1.36	
T-18	São Jerônimo da Serra	0.37		2.98		2.23		1.98	
T-3	São Sebastião da Amoreira			3.70	5.00	2.23	2.20	2.18	2.50
T-17	Sapopema	0.85		1.91					
T-42	Sertaneja			4.49		2.25	2.25	1.33	1.73
T-39	Sertãozinho			4.10		2.36		1.49	
T-3	Teixeira Soares	1.50	1.98	3.70	6.20	2.50	2.48	1.60	1.60
T-14	Telemaco Borba	0.90		2.30		2.20			
T-11	Tibagi	1.00	1.80	5.00	6.50	3.00	3.20	2.50	2.80
T-34	Uraí			3.72		1.74		0.62	
T-13	Ventania	0.62		2.50	5.00	2.50	2.50	2.30	2.30

R.P.: Productivity of Regular Tillage, N.P.: Productivity of Non Tillage  
Source: EMATER (1994)