Ministry of Agriculture
Republic of Peru

THE PREPARATORY STUDY
ON
PROJECT OF THE PROTECTION OF FLOOD PLAIN AND VULNERABLE RURAL POPULATION AGAINST FLOOD IN THE REPUBLIC OF PERU

FINAL REPORT
PRE-FEASIBILITY STUDY REPORT
II-1 PROGRAM REPORT
(TEMPORARY VERSION)

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JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

YACHIYO ENGINEERING CO., LTD.
NIPPON KOEI CO., LTD.
NIPPON KOEI LATIN AMERICA –
CARIBBEAN Co., LTD.

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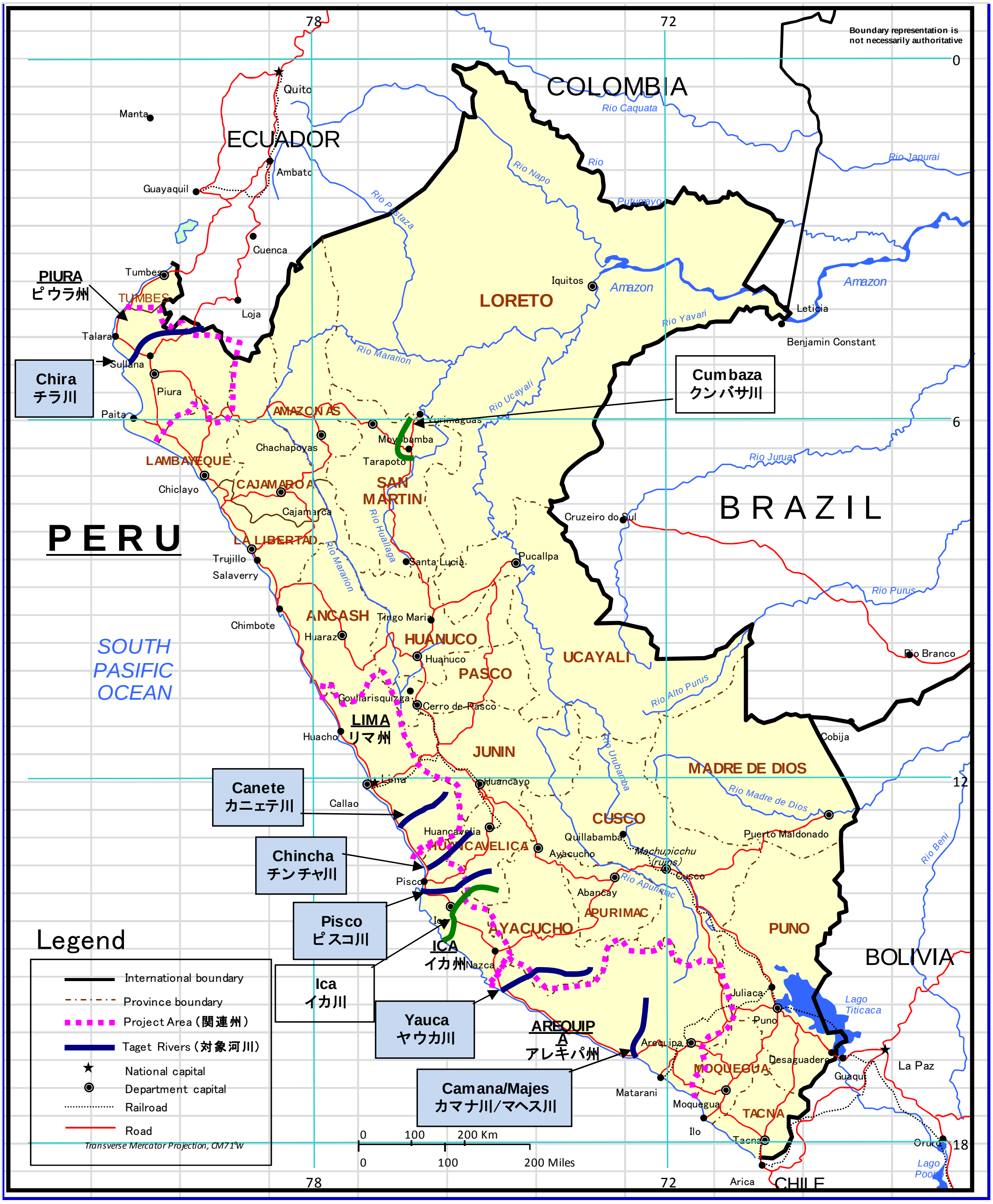
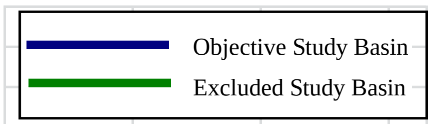


Location Map



Abbreviation

Abbreviation	Official Name or meaning
ANA	Water National Authority (Autoridad Nacional del Agua)
ALA	Water Local Authority (Autoridad Local del Agua)
C/B	Cost-Benefit relation (Cost-Benefit Ratio)
GDP	PBI (Producto Bruto Interno) (Gross Domestic Product)
GIS	Sistema de información geográfica (Geographic Information System)
DGAA	Dirección General de Asuntos Ambientales (Environmental Affairs General Direction)
DGFFS	Dirección General de Forestal y de Fauna Silvestre (Forestry and Fauna General Direction)
DGIH	Dirección General de Infraestructura Hidráulica (Hydraulic Infrastructure General Direction)
DGPM	Dirección General de Programación Multianual del Sector Público (Public Sector Multiannual Program General Direction)
DNEP	Dirección Nacional de Endeudamiento Público (Public Indebtedness National Direction)
DRA	Dirección Regional de Agricultura (Agriculture Regional Direction)
EIA	Estudio de impacto ambiental (Environmental Impact Assessment - EIA)
FAO	Organización de las Naciones Unidas para la Agricultura y la Alimentación (Food and Agriculture Organization of the United Nations)
F/S	Estudio de Factibilidad (Feasibility Study)
GORE	Gobiernos Regionales (Regional Governments)
HEC-HMS	Sistema de Modelado Hidrológico del Centro de Ingeniería Hidrológica (Hydrologic Model System from the Hydrology Engineer Center)
HEC-RAS	Sistema de Análisis de Ríos del Centro de Ingeniería Hidrológica (Hydrologic Engineering Centers River Analysis System)
IGN	Instituto Geográfico Nacional (National Geographic Institute)
IGV	Impuesto General a Ventas (TAX)
INDECI	Instituto Nacional de Defensa Civil (Civil defense National Institute)
INEI	Instituto Nacional de Estadística (Statistics National Institute)
INGEMMET	Instituto Nacional Geológico Minero Metalúrgico (Metallurgic Mining Geologic National Institute)
INRENA	Instituto Nacional de Recursos Naturales (Natural Resources National Institute)
IRR	Tasa Interna de Retorno (Internal Rate of Return - IRR)
JICA	Agencia de Cooperación Internacional del Japón (Japan International Cooperation Agency)
JNUDRP	Junta Nacional de Usuarios de los Distritos de Riego del Perú (Peruvian Irrigation Disctrict Users National Board)
L/A	Acuerdo de Préstamo (Loan Agreement)
MEF	Ministerio de Economía y Finanzas (Economy and Finance Ministry)
MINAG	Ministerio de Agricultura (Agriculture Ministry)
M/M	Minuta de Discusiones (Minutes of Meeting)

NPV	VAN (Valor Actual Neto)　(NET PRESENT VALUE)
O&M	Operación y mantenimiento　(Operation and maintenance)
OGA	Oficina General de Administración (Administration General Office)
ONERRN	Oficina Nacional de Evaluación de Recursos Naturales (Natural Resources Assessment National Office)
OPI	Oficina de Programación e Inversiones (Programming and Investment Office)
PE	Proyecto Especial Chira-Piura (Chira-Piura Special Project)
PES	PSA (Pago por Servicios ambientales) (Payment for Environmental Services)
PERFIL	Estudio del Perfil (Profile Study)
Pre F/S	Estudio de prefactibilidad (Pre-feasibility Study)
PERPEC	Programa de Encauzamiento de Ríos y protección de Estructura de Captación (River Channeling and Protection of Collection Structures Program)
PRONAMACHIS	Programa Nacional de Manejo de Cuencas Hidrográficas y Conservación de Suelos (Water Basins Management and Soil Conservation National Program)
PSI	Programa Sub Sectorial de irrigaciones (Sub-Sectorial Irrigation Program)
SCF	Factor de conversión estándar (Standard Conversion Factor)
SENAMHI	Servicio Nacional de Meteorología y Hidrología (Meteorology and Hydrology National Service)
SNIP	Sistema Nacional de Inversión Pública (Public Investment National System)
UF	Unidades Formuladoras (Formulator Units)
VALLE	Llanura aluvial, llanura de valle (Alluvial Plain, Valley Plain)
VAT	Impuesto al valor agregado (Value added tax)

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Table of Contents

1. EXECUTIVE SUMMARY

1.1 Project Name

"Protection program for valleys and rural communities vulnerable to floods"

1.2 Project's Objective

The ultimate impact that the project is design to achieve is to alleviate the vulnerability of valleys and the local community to flooding and boost local socioeconomic development.

1.3 Supply and Demand Balance

It has been calculated the theoretical water level in case of flow design flood based on the cross sectional survey data of the river with an interval of 500m, in each River's watershed, assuming a design flood flow equal to the flood flow with a return period of 50 years. Then, we determined the dike height as the sum of the design water level plus the dike's free board.

This is the required height of the dike to control the damages caused by design floods and is the indicator of the demand of the local community.

The height of the existing dike or current ground height is the height to control the current flood damages, and is the indicator of the current offer.

The difference between the dike design height (demand) and the height of the embankment or ground at present field (supply) is the gap between demand and supply.

Table 1.3-1 shows the average of flood water levels calculated with a return period of 50 years, of the required height of the dike (demand) to control the flow by adding the design water level plus the free board of the dike, of dike height or current ground height (supply), and the difference between these two (difference between demand and supply) of the river. Then, in Table 1.3-2 the values at each point, taking as example Cañete River are shown. The current height of the dike or the ground is greater than the required height of the dike, at certain points. In these, the difference between supply and demand is considered null. For the result details of each watershed's calculation, see each watershed project report or Annex 4 "Flood Control Plan"

Table 1.3-1 Demand and supply analysis

Unit: m

Basin	Present Height of Embankment or Ground(supply)		Flood Water Level of 1/50 Year Probability	Freeboard of Embankment	Required Height of Embankment (demand)	Supply and Demand Gap	
	Left Bank	Right Bank				Left Bank	Right Bank
	①	②	③	④	⑤=③+④	⑥=⑤-①	⑦=⑤-②
Chira River	31.85	29.27	31.38	1.20	32.58	2.71	3.53
Cañete River	188.40	184.10	184.77	1.20	185.97	1.18	2.03
Chincha river							
Chico River	144.81	145.29	144.00	0.80	144.80	0.40	0.45
Matagente River	133.72	133.12	132.21	0.80	133.01	0.29	0.36
Pisco River	219.72	217.26	214.82	1.00	215.82	0.63	0.76
Yauca River	187.54	183.01	179.03	0.80	179.83	0.21	0.40
Majes-Camana River	401.90	405.19	399.43	1.20	400.63	1.21	0.88

According to this Table, the biggest gap between the supply and demand is in Chira River and it's followed by Cañete and Majes-Camana Rivers. Instead, this gap is reduced in Chincha and Yauca Rivers.

Table 1.3-2 Supply and Demand Calculation (example Cañete River)

Watershed	Dike Height / current land (supply)		Theoretical water level with a return period of 50 years	Dike Freeboard	Required dike's heigth (demand)	Diff. demand/supply	
	Left margin	Right margin				Left margin	Right margin
	①	②	③	④	⑤=③+④	⑥=⑤-①	⑦=⑤-②
0.0	3.04	2.42	3.88	1.20	5.08	2.04	2.66
0.5	10.85	6.43	6.69	1.20	7.89	0.00	1.46
1.0	19.26	15.46	11.66	1.20	12.86	0.00	0.00
1.5	23.14	22.02	18.55	1.20	19.75	0.00	0.00
2.0	28.54	24.14	24.47	1.20	25.67	0.00	1.53
2.5	29.77	30.43	30.42	1.20	31.62	1.85	1.19
3.0	39.57	36.32	36.54	1.20	37.74	0.00	1.42
3.5	44.29	41.17	41.52	1.20	42.72	0.00	1.55
4.0	50.87	44.51	45.90	1.20	47.10	0.00	2.59
4.5	50.77	50.90	51.48	1.20	52.68	1.91	1.78
5.0	56.72	55.97	56.70	1.20	57.90	1.18	1.93
5.5	61.60	62.63	61.30	1.20	62.50	0.90	0.00
6.0	67.94	67.29	66.75	1.20	67.95	0.01	0.66
6.5	71.98	72.26	72.21	1.20	73.41	1.43	1.15
7.0	75.91	77.89	77.87	1.20	79.07	3.16	1.18
7.5	84.54	83.93	83.14	1.20	84.34	0.00	0.41
8.0	87.14	86.94	89.24	1.20	90.44	3.30	3.50
8.5	92.88	94.92	95.12	1.20	96.32	3.44	1.40
9.0	97.59	99.58	99.95	1.20	101.15	3.55	1.57
9.5	103.52	106.09	104.87	1.20	106.07	2.55	0.00
10.0	113.17	112.15	110.18	1.20	111.38	0.00	0.00
10.5	115.92	115.66	116.69	1.20	117.89	1.97	2.23
11.0	120.02	120.74	121.86	1.20	123.06	3.04	2.32
11.5	126.04	125.46	126.55	1.20	127.75	1.71	2.29
12.0	133.58	131.61	132.64	1.20	133.84	0.26	2.23
12.5	138.25	137.29	138.65	1.20	139.85	1.60	2.56
13.0	144.87	144.19	145.04	1.20	146.24	1.37	2.05
13.5	151.37	149.50	151.14	1.20	152.34	0.97	2.84
14.0	157.25	155.68	157.32	1.20	158.52	1.27	2.84
14.5	163.04	162.65	162.70	1.20	163.90	0.85	1.24
15.0	169.07	168.02	168.53	1.20	169.73	0.66	1.71
15.5	174.33	173.29	173.80	1.20	175.00	0.67	1.71
16.0	178.76	179.67	179.56	1.20	180.76	2.00	1.09
16.5	189.69	184.90	185.00	1.20	186.20	0.00	1.30
17.0	198.92	190.23	192.31	1.20	193.51	0.00	3.28
17.5	204.00	196.35	198.05	1.20	199.25	0.00	2.90
18.0	208.64	202.64	203.68	1.20	204.88	0.00	2.24

18.5	216.02	208.07	208.90	1.20	210.10	0.00	2.03
19.0	231.58	214.00	215.17	1.20	216.37	0.00	2.37
19.5	234.50	219.81	221.58	1.20	222.78	0.00	2.97
20.0	227.59	225.71	227.83	1.20	229.03	1.44	3.32
20.5	232.17	231.84	233.16	1.20	234.36	2.19	2.51
21.0	239.69	238.14	239.70	1.20	240.90	1.21	2.76
21.5	243.75	244.32	245.70	1.20	246.90	3.15	2.58
22.0	258.48	248.71	251.12	1.20	252.32	0.00	3.61
22.5	261.54	255.90	256.70	1.20	257.90	0.00	2.00
23.0	277.79	260.72	263.17	1.20	264.37	0.00	3.65
23.5	286.32	266.55	268.34	1.20	269.54	0.00	2.99
24.0	293.96	274.25	274.19	1.20	275.39	0.00	1.14
24.5	279.29	280.51	279.73	1.20	280.93	1.64	0.42
25.0	305.10	286.83	285.94	1.20	287.14	0.00	0.31
25.5	310.22	289.46	291.96	1.20	293.16	0.00	3.70
26.0	317.26	295.71	297.32	1.20	298.52	0.00	2.81
26.5	307.24	302.64	303.34	1.20	304.54	0.00	1.90
27.0	307.18	306.25	308.61	1.20	309.81	2.64	3.56
27.5	335.69	311.92	313.47	1.20	314.67	0.00	2.75
28.0	342.51	321.75	317.21	1.20	318.41	0.00	0.00
28.5	323.24	329.22	326.63	1.20	327.83	4.59	0.00
29.0	331.04	327.61	331.31	1.20	332.51	1.47	4.90
29.5	335.86	332.81	336.85	1.20	338.05	2.19	5.25
30.0	340.36	343.00	341.99	1.20	343.19	2.83	0.19
30.5	346.28	347.78	349.42	1.20	350.62	4.33	2.84
31.0	352.37	355.00	355.54	1.20	356.74	4.38	1.74
31.5	363.03	362.32	363.14	1.20	364.34	1.31	2.02
32.0	372.35	365.18	368.39	1.20	369.59	0.00	4.41
32.5	375.30	373.38	376.70	1.20	377.90	2.60	4.52
Average	188.40	184.10	184.77	1.20	185.97	1.18	2.03

1.4 Structural Measures

Structural measures are a subject that must be analyzed in the flood control plan covering the entire watershed. The analysis results are presented in section 4.13 “medium and long term plan.” This plan proposes the construction of dikes for flood control throughout the watershed. However, the plan requires a large project investing at a extremely high cost, far beyond the budget for this Project, which makes this proposal it impractical. Therefore, assuming that the dikes to control floods throughout the whole watershed will be progressively built over a medium and long term period, therefore this study focused on the most urgent works with high priority for flood protection.

(1) Design flood flow
The Methodological Guide for Protection Projects and/or Flood Control in Agricultural or Urban Areas（Guia Metodologica para Proyectos de Proteccion y/o Control de Inundaciones en Áreas Agricolas o Urbanas, 3.1.1 Horizonte de Proyectos）prepared by the Public Sector Multi Annual Programming General Direction (DGPM) of the Ministry of Economy and Finance (MEF) recommends a comparative analysis of different return periods: 25, 50 and 100 years for the urban area and 10, 25 and 50 years for rural and agricultural land.

Considering that the present Project is aimed at protecting the rural and agricultural land, the design flood flow is to be determined in a return period of 10 years to 50 years t in the mentioned Guide.

It was confirmed that the flood discharge with return period of 50 years in each basin is determined as design flood discharge and it is almost same as the past maximum observed discharge.

In Peru the flood protection works in the basins are developed almost nil, therefore it is not necessary to adopt the design discharge more than the past maximum discharge. However, the large disasters occurred in the past so that the design flood discharge with return period of 50 years, which is almost equal to the past maximum, is to be adopted considering to avoid the flood damage nearly equal to the damage occurred in the past .

The relation among flood discharge with different return period, damage caused by the floods and inundation areas is analyzed in each basin. The results are that the more the return periods of flood increase the more inundation area and damage amount increase in each basin except Chira basin, however the increase tendency of damage with project is more gentle compared with former two items, and the reduction of damage with project reaches to maximum in the case of the flood with return period of 50 years within the cases of flood with less return period of 50 years.
The projects in Chira river and Yauca river were excluded from this Project due to the low viability.

As described above, the adopted design flood discharge with return period of 50 years is almost same as the past maximum discharge and damage reduction amount in the adopted case becomes more than that of the flood discharges with less return period, and the result of social evaluation is also high.

(2) Selection of prioritized flood prevention works

We applied the following five criteria for the selection of priority flood control works.

- Demand from the local community (based on historical flood damage)
- Lack of discharge capacity of river channel (including the sections affected by the scouring)
- Conditions of the adjacent area (conditions in urban areas, farmland, etc.).
- Conditions and area of inundation (type and extent of inundation according to inundation analysis)
- Social and environmental conditions (important local infrastructures)

Based on the river survey, field investigation, discharge capacity analysis of river channel, inundation analysis, and interviews to the local community (irrigation committee needs, local governments, historical flood damage, etc...) a comprehensive evaluation was made applying the five evaluation criteria listed above. After that we selected a total of thirty two (32) critical points (with the highest score in the assessment) that require flood protection measures.

Concretely, since the river cross sectional survey was carried out every 500m interval and discharge capacity analysis and inundation analysis were performed based on the survey results, the integral assessment was also done for sections of 500 meters. This sections have been assessed in scales of 1 to 3 (0 point, 1 point and 2 points) and the sections of which score is more than 6 were selected as prioritized areas. The lowest limit (6 points) has been determined also taking into account the budget available for the Project in general

1.5 Non-structural measures

1.5.1 Reforestation and vegetation recovery

(1) Basic Policies

The reforestation plan and vegetation recovery that meets the objective of this project can be divided into: i) reforestation along river structures, and ii) reforestation in the upper watershed. The first has a direct effect on flood prevention expressing its impact in a short time, while the second one requires high cost and a long period for its implementation, as indicated later in the section 1.15 (2) “Reforestation Plan and vegetation recovery”, and also it is impractical to be implemented within the framework of this project. Therefore, this study focused on the first alternative.

(2) Reforestation along river structures

This alternative proposes planting trees along the river structures, including dikes and margin protection works.

- Objective: Reduce the impact of flooding of the river when an unexpected flood or by the presence of obstacles, using vegetation strips between the river and the objects to be protected.
- Methodology: Create vegetation stripes of a certain width land side of river structures.
- Execution of works: Plant vegetation with certain width in land side of the river structures (dikes, etc.).
- Maintenance after reforestation: Maintenance will be taken by irrigation committees under their own initiative.

The width, length and area of reforestation along river structures are 54.9km, and 167.8ha respectively.

1.5.2 Sediment control plan

The sediment control plan must be analyzed within the general plan of the watershed. The results of the analysis are presented in section 1.15 “Medium and long term plan (3) Sediment control”.

To sum up, the sediment control plan for the entire watershed requires a high investment cost, which goes far beyond the budget of this project, which makes it impractical to adopt. So, the sediments control plan in this project was focused on the alluvial fan.

Fluctuation analysis of the river bed has showed that in Chincha and Pisco rivers sediment accumulation has strong incidence. So, it is recommended to execute a sediment control plan in the alluvial fan for these rivers.

The set of priority works for flood control include a retarding basin at km 34.5 of Pisco River, which will have a retardation effect. Also, for Chincha River, a diversion weir of the rivers Chico and Matagente is planned to be built. This diversion work includes training dike and channel consolidation work. These flood protection works will also be used to control sediments.

1.5.3 Early Alert System for Chira River

As a model case, an early alert system is proposed to be installed in Chira River as described in n 4.3.2.3.
However, the following problems are revealed in installation the system.

a) The promising inundation area is almost composed of agricultural land and there is almost no urban area for which the early alert system is required.
b) Since the Poechos dam is located in the upstream of objective study area and the inflow discharge is observed, the forecasting of occurrence and increase of flood can be estimated to some extent of accuracy.
c) The system has a little meaning as an model case because there is the early alert system in the Piura river just adjacent to Chira river.
d) The flood prevention works in the Chira river are to be excluded from the Project. The cost for the system is so small that the system is not required to be adopted as Japanese Yen Loan project, the system can be implemented by the provincial government using its own budget in accordance with JICA plan.
e) The observation stations included in the system are under mobilization and rainfall and discharge data are being collected. However the present conditions data of installed equipment could not be collected so that the necessity of exchange of equipment cannot be judged. If the exchange of equipment is not necessary, 64% of the cost (2,640 nuevo soles) can be saved.

According to the above, the meeting among JICA Peru office, DGIH, OPI, DGPM and JICA Study Team held on December 5, 2011 concluded that the early alert system in Chira river will be excluded from the Project and if necessary, Piura provincial government will implement the system (Minutes of Meetings on Main Points of Interim Report, Lima, December 5, 2011).

1.6 Technical support

Based on the technical proposals of structural and nonstructural measures, it is also intends to incorporate in this project technical assistance to strengthen the measures.

The objective of the technical assistance is to "improve the capacity and technical level of the local community, to manage risk to reduce flood damage in selected valleys."

Technical assistance will cover the 6 watersheds of this Project: Chira, Cañete, Chincha, Pisco, Yauca and Majes-Camana.

Aiming to train characteristics of each watershed, courses for each one will be prepared. The beneficiaries are the representatives of the committees and irrigation groups from each watershed, governments employees (provincial and district), local community representatives, etc...

Qualified as participants in the training, people with ability to replicate and disseminate lessons learned in the courses to other community members, through meetings of the organizations to which they belong.

In order to carry out the technical assistance goal, the four activities propose the following: "Course on riverside defense activities", "Post-flood prevention and behavior course", "Watershed (slope) management against fluvial sedimentation" and "Course for risk management information network to floods" in this component.

1.7 Costs

In the Table 1.7-1 the costs of this Project according to watershed is shown. The cost of the 6 watersheds is around 323.4 million soles.

Table 1.7-1 Project Costs according to Watershed

1.8 Social Assessment results

The objective of the social assessment in this study is to evaluate the efficiency of investments in the structural measures from the point of view of national economy. To do this, we determined the economic evaluation indicators (B/C relation, Net Present Value-NPV, and Internal return rate - IRR).

The benefits of the evaluation period were estimated, from the first 15 years since the start of the project. Because, from these 15 years, two are from the work execution period, the evaluation was conducted for the 13 years following the completion of works.

Below the social assessment results for this Project based on the above economic evaluation indicators are shown.

Regarding social prices costs, the project may show a positive economic impact in Cañete, Chincha, Pisco and Majes-Camana Rivers, the relation B/C will be over 1.0. However, the contrary happens in Chira and Yauca Rivers. In Chira River specific case, the economic impact was reduced because the work was excluded for Poechos dam conservation of Chira-6.

In case of Yauca River, the result shown is such because the flood damage amount is reduced due to the small inundation area that exists for topographic reasons.

Next, the positive effects of the Project are shown, which are quite difficult to quantify in economic values:

① Contribution to local economic development to alleviate the fear to economic activities suspension and damages
② Contribution to increase local employment opportunities thanks to the local construction project
③ Strengthening the awareness of local people regarding damages from floods and other disasters
④ Contribution to increase from stable agricultural production income, relieving flood damage
⑤ Rise in farmland prices

From the results of the economic evaluation presented above, it is considered that this project will substantially contribute to the development of the local economy.

Table 1.8-1 Each Watershed's Social assessment

1.9 Sustainability Analysis

This project will be co-managed by the central government (through the DGIH), irrigation committees and regional governments, and the project cost will be covered with the respective contributions of the three parties. Usually the central government (in this case, the DGIH) assumes 80%, the irrigation commissions 10% and regional governments 10%. However, the percentages of the contributions of these last two are decided through discussions between both parties. On the other hand, the operation and maintenance (O & M) of completed works is taken by the irrigation committees. Therefore, the sustainability of the project is depends on the profitability of the project and the ability of O & M of irrigation committees.

In Table 1.9-1 the budget data from last year of the irrigation commissions is shown

Table 1.9-1 Irrigation Commission's Budget

Rivers	Annual Budget			(Unit/ S)	
	2006	2007	2008	2009	2010
Chira	30.369,84	78.201,40	1.705.302,40	8.037.887,44	
Cañete		2.355.539,91	2.389.561,65	2.331339,69	2.608.187,18
Chincha		1.562.928,56	1.763.741,29	1.483.108,19	
Pisco		1.648.019,62	1.669.237,35	1.725.290,00	1.425.961,39
Yauca	114.482,12	111.102,69	130.575,40		
Majes-Camana			1.867.880,10	1.959.302,60	1.864.113,30
Total		5.755.792,18	9.526.298,10	15.536.928,01	5.898.261,84

(1) Profitability

The Project is profitable in 4 watersheds, excluding Chira and Yauca Rivers. This shows the high sustainability of the project. On the two mentioned rivers, the very low profitability does not justify the Project's implementation.

(2) Operation and maintenance costs

In Table 1.9-2 the relation among 2008 irrigation commission's budgets according to watershed and the respective annual maintenance and operation cost is shown; supposing that the projects require an annual investment of % of the building cost for the maintenance of the works.

The annual cost of M&O in the Majes-Camana Watershed represents a percentage a little high from the Irrigations' Commission annual budget. However, in Yauca River's case, is extremely high which puts into question the sustainability of the Project.

Table 1.9-2 Irrigation commissions budget and the annual cost of maintenance and operation

Judging the capacity to cover O&M costs and the respective profitability of the irrigation commissions, the projects might be sustainable in the Cañete, Chincha, Pisco and Majes-Camana watersheds.

1.10 Project Selection

In Table 1.10-1 socioeconomic impact (social prices cost) and projects' costs of the 6 chosen watersheds are shown. The priority order according to calculated socioeconomic impact magnitude is also indicated. Chira and Yauca Rivers were excluded from the Table due to their reduced economic impact and only 4 watersheds were included where the project will show a positive economic impact. These are: Cañete, Chincha, Pisco and Majes-Camana, which project cost altogether will be: soles. This figure equals 114% of the initially estimated cost, of soles, being incremented in soles.

Table 1.10-1 Project Selection

1.11 Environmental Impact

（1）Procedure of Environmental Impact Assessment

Projects are categorized in three scales, based on the significance level of the negative and positive impacts, and each sector has an independent competence on this categorization. The Project holder should submit the Environmental Impact Statement (DIA, in Spanish) for all Projects under Category I. The project holder should prepare an EIA-sd or an EIA-d if the Project is categorized under Category II or III, respectively, to be granted the Environmental Certification from the relevant Ministry Directorate.

First, the Project holder applies for the Project classification, by submitting the Preliminary Environmental Assessment (PEA). The relevant sector assesses and categorizes the Project. The Project's PEA that is categorized under Category I becomes an EID, and those Projects categorized under Category II or III should prepare an EIA-sd or EIA-d, as applicable.

We reviewed and assessed the positive and negative environmental impact associated to the implementation of this project and the prevention and mitigation measures where set for these impacts. The preliminary environmental assessment (EAP) for 5 watersheds of Chira, Cañete, Chincha, Pisco and Yauca was carried out between December 2010 and January 2011and for Majes-Camana between September 2011 and October 2011 by a consulting firm registered in the Ministry of Agriculture (CIDES Ingenieros S.A.). EAP for the proceeding 5 watersheds was submitted to DGIH January 25, 2011 and for Majes-Camana December 20, 2011 by JICA Study Team and from DGIH to DGAA July 19,2011 and January 4,2012 respectively.
DGAA examined EAP for 5 watersheds and issued approval letter of Category I. Therefore, no further environmental impact assessment is required for three watersheds of Cañete, Chincha and Pisco. The projects in Chira and Yauca are excluded from the Project by DGIH. Although DGAA is still under assessment on Majes-Camana watershed,
DGAA will issue the approval of Category I, because the works of the project are similar to the previous three watersheds.

（2）Results of Environmental Impact Assessment
The procedures to review and evaluate the impact of the natural and social environment of the Project are the following. First, we reviewed the implementation schedule of the construction of river structures, and proceeded to develop the Leopold matrix.

The impact at environmental level (natural, biological and social environment) was evaluated and at Project level (construction and maintenance stage). The quantitative levels were determined by quantifying the environmental impact in terms of impact to nature, manifestation possibility, magnitude (intensity, reach, duration and reversibility).

The EAP showed that the environmental impact would be manifested by the implementation of this project in the construction and maintenance stages, mostly, it is not very noticeable, and if it were, it can be prevented or mitigated by appropriately implementing the management plan environmental impact.

On the other hand, the positive impact is very noticeable in the maintenance stage, which manifests at socioeconomic and environmental level, specifically, in greater security and reduced vulnerability, improved life quality and land use.

1.12 Execution plan

Table 1.12-1 presents the Project execution plan.

Table 1.12-1 Execution plan

	ITEMS	2010	2011	2012	2013	2014	2015	2016
		3 6 9 12	3 6 9 12	3 6 9 12	3 6 9 12	3 6 9 12	3 6 9 12	3 6 9 12
1	ESTUDIO PERFIL/EVALUACIÓN SNIP	ESTUDIO		EVALUACIÓN				
2	ESTUDIO FACTIBILIDAD/EVALUACIÓN SNIP		ESTUDIO	EVALUACIÓN				
3	NEGOCIACIÓN DE CREDITO EN YENES							
4	SELECCIÓN DE CONSULTOR							
5	SERVICIO DE CONSULTOR (DISEÑO DETALLADO, ELABORACIÓN DE DOCUMENTOS PARA LICITACIÓN)			DISEÑO/DOCUMENTO DE LICITACIÓN			SUPERVISIÓN DE OBRA	
6	SELECCIÓN DE CONSTRUCTOR							
7	EJECIÓN DE OBRAS							
1)	CONSTRUCCIÓN DE ESTRUCTURAS							
2)	REFORESTACIÓN							
3)	SISTEMA DE ALERTA TEMPRANA							
4)	CAPACITACIÓN PREVENTIVA DE DESASTRES							
8	CULMINACIÓN DE OBRAS/ENTREGA A JUNTAS DE USUARIOS							

1.13 Institutions and management

The institutions and its administration in the investment stage and in the operation and maintenance stage after the investment are as shown in the Figures 1.13-1 and 1.13-2.

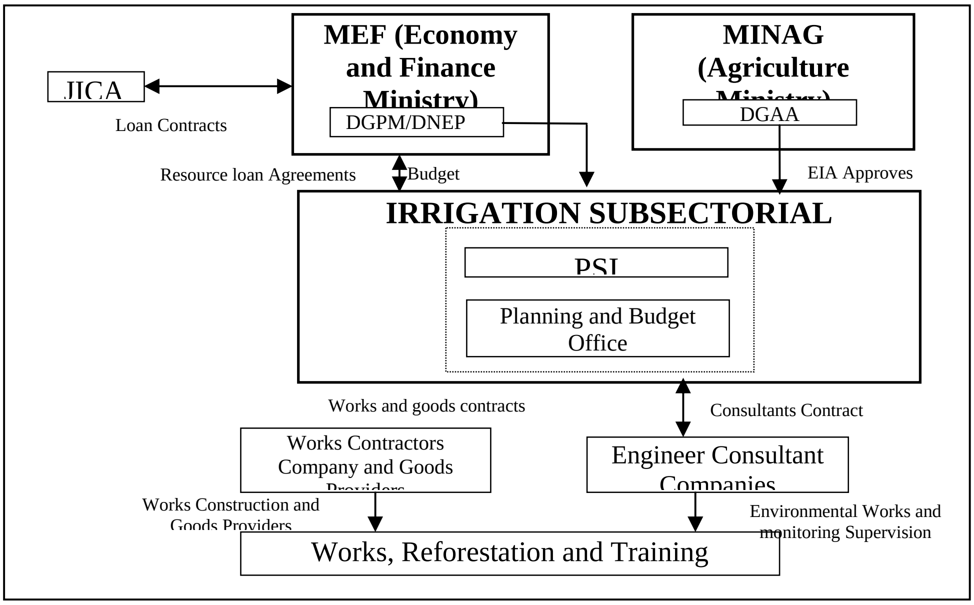

Figure 1.13-1 institutions related to the implementation of the project (investment stage)

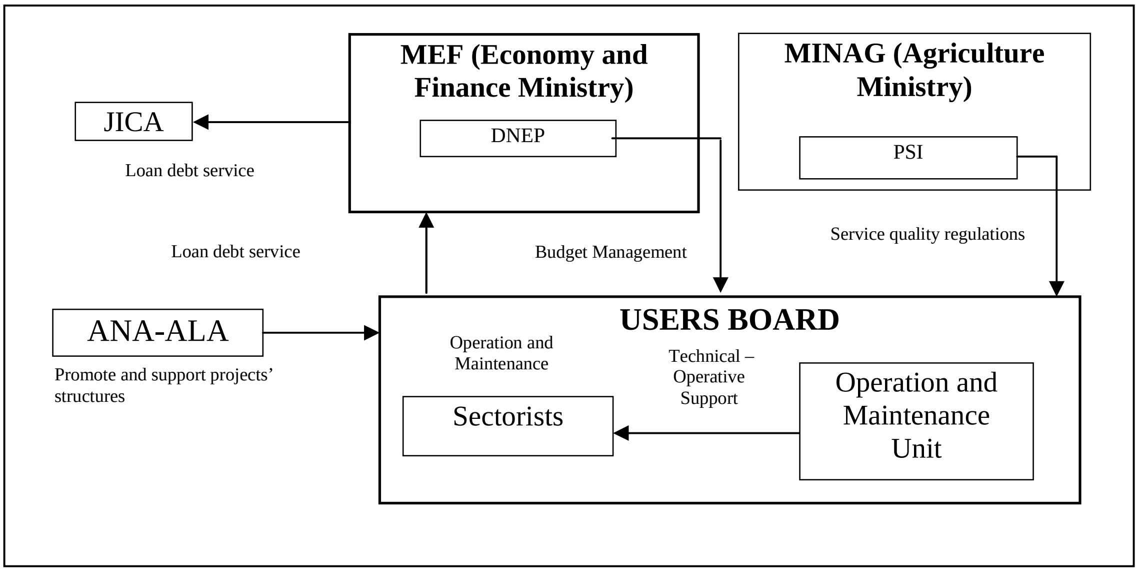

Figure 1.13-2 institutions related to the implementation of the project (operation and maintenance phase of post-investment)

1.14 Logical Framework

Table 1.14-1 presents the logical framework of the final selected alternative.

Table 1.14-1 Logical framework of the final selected alternative

Narrative Summary	Verifying Indicators	Verifying Indicators Media	Preliminary Conditions
Superior Goal			
Promote socioeconomic local development and contribute in communities' social welfare.	Improve local productivity, generate more jobs, increase population's income and reduce poverty index	Published statistic data	Socio-economic and policy stability
Objectives			
Relief the high vulnerability of valleys and local continuity to floods	Types, quantity and distribution of flood control works, population and beneficiaries areas	Monitoring annual calendar works and financial plan, budget execution control	Ensure the necessary budget, active intervention from central and regional governments, municipalities, irrigation communities, local population, etc.
Expected results			

Reduction of areas and flooded areas, functional improvement of intakes, road destruction prevention, irrigation channels protection, margin erosion control and Poechos dike safety	Number of areas and flooded areas, water intake flow variation, road destruction frequency, margin erosion progress and watershed's downstream erosion.	Site visits, review of the flood control plan and flood control works reports and periodic monitoring of local inhabitants	Maintenance monitoring by regional governments, municipalities and local community, provide timely information to the superior organisms
Activities			
Component A: Structural Measures	Dikes rehabilitation, intake and margin protection works, road damages prevention, construction of 28 works, including dike's safety	Detailed design review, works reports, executed expenses	Ensure the works budget, detailed design/works execution/good quality works supervision
Component B: Non-Structural Measures			
B-1 Reforestation and vegetation recovery	Reforested area, coastal forest area	Works advance reports, periodic monitor by local community	Consultants support, NGO's, local community, gathering and cooperation of lower watershed community
B-2 Early alert system	Installed equipments, operational state, emitted alerts state, emitted alerts frequency and information transmission state	Work advance reports, public entity and local community monitoring	Equipment adequate functioning, appropriate staff training, communication and promotion, equipment and programs O & M
Component C: Disaster prevention and capabilities development education	Number of seminars, trainings, workshops, etc	Progress reports, local governments and community monitoring	Predisposition of the parties to participate, consultants and NGO's assessments
Project's execution management			
Project's management	Detailed design, work start order, work operation and maintenance supervision	Design plans, work's execution plans, costs estimation, works specifications, works management reports and maintenance manuals	High level consultants and contractors selection, beneficiaries population participation in operation and maintenance

1.15 Middle and Long Term Plans

While it is true that due to the limited budget available for the Project, this study is focused mainly on the flood control measures analysis that must be implemented urgently. It is considered necessary to timely implement other necessary measures within a long term. In this section we will discuss the medium and long term plans.

(1) Flood Control General Plan

There are several ways to control floods in the entire watershed, for example, the building of dams, reservoirs, dikes or a combination of these. The options to build dams or reservoirs are not viable because in order to answer to a flood flow with a return period of 50 years, enormous works would be necessary to be built. So, the study was focused here on dikes' construction because it was the most viable option.

Flood water level was calculated in each watershed adopting a designed flood flow with a return period of 50 years. At this water level, freeboard was added in order to determine the required dikes height. After, sections of the rivers where the dikes or ground did not reach the required height were identified. These sections, altogether, add up to approx 396km. Also, from maintaining these works, annually a dragged of the rivers has to be done in the sections where, according to the bed fluctuation analysis the sediment gathering is elevating the bed's height. The volume of sediments that shall be eliminated annually was determined in approximately 91.000 m^3.

In Tables 1.15-1 and 1.15-2 the flood control general plan project cost is shown as well as the social assessment results in terms of private and social costs.

Table 1.15-1 Project Cost and Social Assessment of the general flood control plan (private prices costs)

Watershed	Damage Annual Medial Reduction	Damage Reduction in Assessment Period (in 15 years)	Project Cost	O&M Cost	Cost/Benefit Relation	Net Present Value (NPV)	Internal Return Rate (IRR)
Chira	1.678,976217	758.192,379	809.055,316	59.450,746	1.03	23.878,182	11%
Cañete	171.269,615	77.341,963	104.475,371	8.236,962	0.81	-17.765825	6%
Chincha	275.669,025	124.486,667	84.324,667	7.429,667	1.61	47.326,578	20%
Pisco	229.000,371	103.412028	110.779,465	9.420,215	1.02	2.217,423	10%
Yauca	4.592,758	2.073,999	9.920,549	894.671	0.23	-7,014,101	-
Majes-Camana	285.833,001	129.076,518	465.857,392	29.096,617	0.31	-291,140.63	-

Table 1.15-2 Project Cost and Social Assessment of the general flood control plan (social prices costs)

Watershed	Damage Annual Medial Reduction	Damage Reduction in Assessment Period (in 15 years)	Project Cost	O&M Cost	Cost/Benefit Relation	Net Present Value (NPV)	Internal Return Rate (IRR)
Chira	1.950.952,884	881.011,542	650.480,474	47.798,400	1.49	290.623,026	18%
Cañete	253.314,406	114.391,754	83.996,196	5.522,517	1.5	37.925,103	18%
Chincha	334.336,127	150.979,558	67.797,033	5.973,452	2.43	88.942,856	31%
Pisco	242.702,673	109.599.716	89.066,590	7.573,853	1.35	28.239,253	16%
Yauca	5.531,228	2497.793	7.976,121	719.315	0.34	-4,809,039	-
Majes-Camana	294.878,168	133.161.136	374.549,343	23.393,680	0.39	-204,593,450	-

In case of executing flood control works in all the watersheds, the Projects' cost would elevate to 1,584.4 million soles, which is a huge amount. Regarding social prices costs, the project's economic impact in Yauca and Majes-Camana Watershed does not justify this reimbursement.

(2) Reforestation Plan and Vegetation Recovery

The forestry option was analyzed, in a long term basis, to cover every area that requires being covered with vegetation in the upper watershed. The objective is improving this areas' water reload, reduce surface water and increase semi-underground and underground. So, the flood maximum flow will be achieved, also it could be possible to increase the water reserve in the mountain areas and prevent and soothe floods. The areas to be reforested will be the afforested areas or where the forest mass in the water reload areas has been lost.

In Table 1.15-3 the area to be afforested and the project's cost for each watershed is shown. These were calculated based on forestry plan of Chincha River. The total surface would be approximately 620.000hectares and in order to forest them the required time would be from 9 to 100 years and 1.670 million soles. To sum up, the Project has to cover an extensive area, with an investment of much time and at a high price.

Table 1.15-3 General Plan for forestry on upper stream watersheds

Watershed	Forestry Area (ha) A	Required Period for the project (years) B	Required Budget (soles) C
Cañete	110.114	35	297.212,406
Chincha	44.075	14	118.964,317
Pisco	53.938	17	145.585,872
Yauca	68.296	22	184.340,033
Chira	27.839	9	75.141,182
Camana-Majes	307.210	98	829.200,856
TOTAL	611.472	—	1.650.444,666
Chincha Project Cost per hectare: ＝ 2.699,13 (soles /ha) (Example: Cañete Watershed) 110.114 / 44.075 x 14 = 35 (years) 110.114 x 2.699,13 = 297.212.406 (ha)			

(3) Sediment Control Plan

As long term sediment control plan, it is recommended to perform necessary works on the upper watershed. These works will mainly consist of dams and margin protection. In Table 1.15-4 the estimate work cost is shown. There are two costs, one for executing works in the entire watershed and another one for executing works only in prioritized areas.

All the chosen watersheds for this Project are big. So, if margin protection works and sediment control dams want to be built, not only the works' cost would elevate but also a very long period of investment would have to be done in every watershed. This means that it's positive impact will be seen in a long time.

Table 1.15-4 Projects' General Costs of the Sediment Control Installations Upstream the Watersheds

Watersheds	Areas	Margin Protection		Bands		Dams		Works direct cost (total)	Project Cost (in millions de s/.)
		Qty. (km)	Works direct costs (million s/.)	Qty. (km)	Works direct costs (million s/.)	Qty. (km)	Works direct costs (million s/.)		
Chira	Totally	0	S/.0	0	S/.0	272	S/.423	S/.423	S/.796
	Prioritized areas	0	S/.0	0	S/.0	123	S/.192	S/.192	S/.361
Cañete	Totally	325	S/.347	32	S/.1	201	S/.281	S/.629	S/..1,184
	Prioritized areas	325	S/.347	32	S/.1	159	S/.228	S/.576	S/..1,084
Chincha	Totally	381	S/.407	38	S/.1	111	S/.116	S/.524	S/..986
	Prioritized areas	381	S/.407	38	S/.1	66	S/.66	S/.474	S/.892
Pisco	Totally	269	S/.287	27	S/.1	178	S/.209	S/.497	S/.935
	Prioritized areas	269	S/.287	27	S/.1	106	S/.126	S/.414	S/.779
Yauca	Totally	565	S/.604	57	S/.2	97	S/.144	S/.750	S/.1,412
	Prioritized areas	565	S/.604	57	S/.2	37	S/.54	S/.660	S/.1,242
Majes-Camana	Totally	264	S/.282	26	S/.1	123	S/.165	S/.448	S/.843
	Prioritized areas	264	S/.282	26	S/.1	81	S/.105	S/.388	S/.730
Total	Totally	1,803	S/.1,927	180	S/.5	982	S/.1,338	S/.3,271	S/.6,155
	Prioritized areas	1,803	S/.1,927	180	S/.5	572	S/.772	S/.2,705	S/.5,090

2. GENERAL ASPECTS

2.1 Name of the Project

"Protection program for valleys and rural communities vulnerable to floods"

2.2 Formulator and Executor Units

(1) Formulator Unit

Name: Hydraulic Infrastructure General Direction, Agriculture Ministry
Responsible: Orlando Chirinos Hernan Trujillo
General Director of the Water Infrastructure General Direction
Address: Av. Benavides N° 395 Miraflores, Lima 12 - Peru
Phone: (511) 4455457 / 6148154
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(2) Executor Unit
Name: Sub-sectorial Irrigation Program, Agriculture Ministry
Responsible: Jorge Zúñiga Morgan
Executive Director
Address: Jr. Emilio Fernandez N° 130 Santa Beatriz, Lima-Peru
Phone: (511) 4244488
Email: postmast@psi.gob.pe

2.3 Involved entities and Beneficiaries Participation

Here are the institutions and entities involved in this project, as well as beneficiaries.

(1) Agriculture Ministry (MINAG)
MINAG, as manager of natural resources of watersheds promotes agricultural development in each of them and is responsible of maintaining the economical, social and environmental to benefit agricultural development.
To accomplish effectively and efficiently this objective, the MINAG has been working since 1999 in the River Channeling and Collection Structures Protection Program (PERPEC). The river disaster prevention programs that are been carried out by regional governments are funded with PERPEC resources.

1) Administration Office (OA)
- Manages and executes the program's budget

- Establishes the preparation of management guides and financial affairs

2) Hydraulic Infrastructure general Direction (DGIH)
- Performs the study, control and implementation of the investment program
- Develops general guidelines of the program together with OPI

3) Planning and Investment Office (OPI)
- Conducts the preliminary assessment of the investment program
- Assumes the program's management and the execution of the program's budget
- Plans the preparation of management guides and financial affairs

4) Irrigation Sub-Sectorial Program (PSI)
- Carries-out the investment program approved by OPI and DGPM

(2) Economy and Finance Ministry (MEF)

Public Sector's Multiannual Programming General Direction (DGPM)

Is in charge of approving public investment works according to procedures under the Public Investment National System (SNIP) to assess the relevance and feasibility of processing the disbursement request of the national budget and the loan from JICA.

(3) Japan International Cooperation Agency (JICA)

It is a Japanese government institution with the objective of contributing in the socioeconomic development of developing countries through international cooperation. JICA has extended financial assistance to carry out pre-feasibility and feasibility studies of this Project.

(4) Regional Governments (GORE)

Regional governments assume the promotion of integrated and sustainable regional development following the national and regional plans and programs, trying to increase public and private investment, generating employment opportunities, protecting citizens rights and ensuring equal opportunities.

The regional governments' participation with their possible financial support is a very important factor to ensure the Project's sustainability.

The Special Project Chira-Piura, implemented by the Regional Government of Piura also includes the Chira River that is the Area of the current Study.

(5) Irrigation Commission

There are several irrigation commissions in the 6 watersheds of the 4 regions, who have a great expectation for the performance of dike repair works, margin protection, intakes, etc. that were damaged in floods. In Table 2.3-1 basic data of each watershed's commission is shown (to have more details refer to 3.1.3). Currently, the operation and maintenance of dikes, margin protection works, irrigation intakes and channels linked to agricultural land and irrigation systems in the Watershed, are mainly made by irrigation commissions and their members, with the assistance of local governments.

Table 2.3-1 General Data of Irrigation Commissions

Watershed	# of irrigation sectors	Commission numbers	Irrigated Area (ha)	Benefitiaries
Río Chira	6	6	48,676	18,796
Río Cañete	7	42	22,242	5,843
Río Chincha	3	14	25,629	7,676
Río Pisco	6	19	22,468	3,774
Río Yauca	3	3	1,614	557
Majes-Camana	34	83	14,301	5,907
Total	59	167	134,930	42,553

(6) Meteorology and Hydrology National Service (SENAMHI)

It is an agency from the Environment Ministry responsible for all activities related to meteorology, hydrology, environment and agricultural meteorology. Take part in global level monitoring, contributing to sustainable development, security and national welfare, and gathering information and data from meteorological stations and hydrological observation.

(7) Civil Defense National Institute (INDECI)

INDECI is the main agency and coordinator of the Civil Defense National System. It is responsible for organizing and coordinating the community, elaborating plans and developing disaster risk's management processes. Its objective is to prevent or alleviate human life loss due to natural and human disasters and prevent destruction of property and the environment.

(8) Water National Authority (ANA)

It is the highest technical regulating authority in charge of promoting, monitoring and controlling politics, plans, programs and regulations regarding sustainable use of water resources nationwide.

Its functions include sustainable management of these resources, as well as improving the technical and legal framework on monitoring and assessment of water supply operations in each region.

Along with maintaining and promoting a sustainable use of water resources, it is also responsible for conducting the necessary studies and developing main maintenance plans, national and international economic and technical cooperation programs.

(9) Agriculture Regional Directorates (DRA's)

Agricultural regional addresses fulfill the following functions under the respective regional government:

1) Develop, approve, assess, implement, control and manage national agriculture policies, sectorial plans as well as regional plans and policies proposed by municipalities
2) Control agriculture activities and services fitting them to related policies and regulations, as well as on the regional potential
3) Participate in the sustainable management of water resources agreeing with the watershed's general framework, as well as the policies of the Water National Authority (ANA)
4) Promote the restructure of areas, market development, export and agricultural and agro-industrial products consumption
5) Promote the management of: irrigation, construction and irrigation repair programs, as well as the proper management and water resources and soil conservation

2.4 Framework

2.4.1 Background

(1) Study Background

The Republic of Peru (hereinafter "Peru") is a country with high risk of natural disasters such as earthquakes, Tsunamis, etc. Among these natural disasters there are also floods. In particular, El Niño takes place with an interval of several years and has caused major flood of rivers and landslides in different parts of the country. The most serious disaster in recent years due to El Niño occurred in the rainy season of 1982-1983 and 1997-1998. In particular, the period of 1997-1998, the floods, landslides, among others left loss of 3,500 million of dollars nationwide. The latest floods in late January 2010, nearby Machupicchu World Heritage Site, due to heavy rains interrupted railway and roads traffic, leaving almost 2,000 people isolated.

In this context, the central government has implemented「El Niño phenomenon I and II contingency plans」in 1997-1998, throughout the Ministry of Agriculture (MINAG) in order to rebuild water infrastructures devastated by this phenomenon. Next, the Hydraulic Infrastructure General Direction (DGIH) of the Ministry of Agriculture (MINAG) began in 1999 the River Channeling and Intake Structures Protection Program (PERPEC) in order to protect villages, farmlands, agricultural infrastructure, etc located within flood risk areas. The program consisted of financial support for regional government to carry out works of bank protection. In the multiyear PERPEC plan between 2007-2009 it had been intended to execute a total of 206 bank protection works nationwide. These projects were designed to withstand floods with a return period of 50 years, but all the works have been small and limited, without giving a full and integral solution to control floods. So, every time floods occur in different places, damages are still happening.

MINAG planned a "Valley and Rural Populations Vulnerable to Floods Protection Project" for nine watersheds of the five regions. However, due to the limited availability of experiences, technical and financial resources to implement a pre-investment study for a flood control project of such magnitude, MINAG requested JICA's assistance to implementation this study. In response to this request, JICA and MINAG held discussions under the premise of implementing it in the preparatory study scheme to formulate a loan from JICA, about the content and scope of the study, the implementation's schedule, obligations and commitments of both parties, etc. expressing the conclusions in the Minutes of Meeting (hereinafter "M/M") that were signed on January 21 and April 16, 2010. This study has been implemented in accordance with this M/M.

(2) Progress of Study

The Profile Study Report for this Project at Program's level for nine watersheds of five provinces was elaborated by DGIH and sent to the Planning and Investment Office (OPI) on December 23, 2009, and approved on the 30th of the same month. Afterwards, DGIH presented the report to the Public Sector Multiannual Programming General Direction (DGPM) of the Economy and Finance Ministry (MEF) on January 18, 2010. On March 19th, DGPM informed DGIH about the results of the review and the correspondent comments.

The JICA Study Team began the study in Peru on September 5th, 2010. At the beginning, nine watersheds were included in the study. One, the Ica River was excluded of the Peruvian proposal leaving eight watersheds. The eight watersheds were divided into two groups: Group A with five watersheds and Group B with three watersheds. The study for the first group was assigned to JICA and the second to DGIH. Group A includes Chira, Cañete, Chincha, Pisco and Yauca Rivers' Watersheds and Group B includes the Cumbaza, Majes and Camana Rivers' Watersheds.

The JICA Study Team conducted the profile study of the five watersheds of Group A, with accuracy of pre-feasibility study level and handed DGIH the Program Report of group A and the Project Reports of the five watershed by the end of June 2011. Also, the feasibility study has already started, omitting the pre-feasibility study.

For the watersheds of Group B which study corresponded to DGIH, this profile study took place between mid-February and early March 2011 (and not with a pre-feasibility level, as established in the Meetings Minutes), where Cumbaza River Watershed was excluded because it was evident that it would not have an economic effect. The report on the Majes and Camana rivers watersheds were delivered to OPI, and OPI official comments were delivered to DGIH on April 26th, indicating that the performed study for these two watersheds did not meet the accuracy level required and it was necessary to study them again. Also, it was indicated to perform a single study for both rivers (Majes and Camana) because they belong to a single watershed.

On the other hand, due to the austerity policy announced on March 31st, prior to the new government assumption by new president on July 28th, it has been noted that it is extremely difficult to obtain new budget, DGIH has requested JICA on May 6th to perform the prefeasibility and feasibility studies of the Majes-Camana watershed.

JICA accepted this request and decided to perform the mentioned watershed study modifying the Minutes of Meeting for the second time (refer to Second Amendment of Minutes of Meetings on the Inception Report, Lima, July 22nd, 2011)

In accordance with the amendment, the JICA Study Team began in August the prefeasibility study for the watershed above mentioned, which was completed in the end of November.
This report corresponds with the program report with pre-feasibility study level of five watersheds of Group A and one watershed (Majes-Camana watershed) of Group B. The feasibility study of Majes-Camana watershed wants to be finished by mid-January 2012, and the feasibility study for all selected watersheds around the same dates.

DGIH processed the registration of four of the five watersheds (except Yauca) to the SNIP system on July 21st, based on projects reports at pre-feasibility level prepared by JICA Study Team. And DHIG decided to discard Yauca River due to its low impact in economy.

The Project Reports with pre-feasibility level for 4 watersheds (Chira, Cañete , Chincha, Pisco) were submitted to OPI from DGIH, and OPI issued their comments on the reports on September 22, 2011. The revision of the reports is under discussion among OPI, DGIH and JICA Study Team.

2.4.2 Laws, regulations, policies and guidelines related to the Program

This program has been elaborated following the mentioned laws and regulations, policies and guidelines:

(1) Water Resources Law N° 29338
Article 75 .- Protection of water
The National Authority, in view of the Watershed Council, must ensure for the protection of water, including conservation and protection of their sources, ecosystems and natural assets

related to it in the regulation framework and other laws applicable. For this purpose, coordination with relevant government institutions and different users must be done.
The National Authority, throughout the proper Watershed Council, executes supervision and control functions in order to prevent and fight the effects of pollution in the oceans, rivers and lakes. It can also coordinate for that purpose with public administration, regional governments and local governments sectors.
The State recognizes as environmentally vulnerable areas the headwater watersheds where the waters originate. The National Authority, with the opinion of the Environment Ministry, may declare protected areas the ones not granted by any right of use, disposition or water dumping.

Article 119 .- Programs flood control and flood disasters
The National Authority, together with respective Watershed Board, promotes integral programs for flood control, natural or manmade disasters and prevention of flood damages or other water impacts and its related assets. This promotes the coordination of structural, institutional and necessary operational measures.

Within the water planning, the development of infrastructure projects for multi-sectorial advantage is promoted. This is considered as flood control, flood protection and other preventive measures.

(2) Water Resources Law Regulation N° 29338
Article 118 .- From the maintenance programs of the marginal strip
The Water Administrative Authority, in coordination with the Agriculture Ministry , regional governments, local governments and water user organizations will promote the development of programs and projects of marginal strips forestry protection from water erosive action.

Article 259 º .- Obligation to defend margins
All users have as duty to defend river margins against natural phenomenon effects, throughout all areas that can be influenced by an intake, whether it is located on owned land or third parties' land. For this matter, the correspondent projects will be submitted to be reviewed and approved by the Water National Authority.

(3) Water Regulation
Article 49. Preventive measures investments for crop protection are less than the recovery and rehabilitation cost measures. It is important to give higher priority to these protective measures which are more economic and beneficial for the country, and also contribute to public expenses savings.

Article 50. In case the cost of dikes and irrigation channels protection measures is in charge of family production units or it exceeds the payment capacity of users, the Government may pay part of this cost.

(4) Multi-Annual Sectorial Strategic Plan of the Agriculture Ministry for the period 2007-2011 (RM N° 0821-2008-AG)

Promotes the construction and repair of irrigation infrastructure works with the premise of having enough water resources and their proper use.

(5) Organic Law of the Agriculture Ministry, N° 26821

In Article 3, it is stipulated that the agricultural sector is responsible for executing river works and agricultural water management. This means that river works and water management for agricultural purposes shall be paid by the sector.

(6) Guidelines for Peruvian Agricultural Policy - 2002, by the Policy Office of MINAG

Title 10 - Sectorial Policies

“Agriculture is a high risk productive activity due to its vulnerability to climate events, which can be anticipated and mitigated... The damage cost to infrastructure, crops and livestock can be an obstacle for the development of agriculture, and as consequence, in the deterioration of local, regional and national levels.”

(7) River Channeling and Collection Structures Protection Program, PERPEC

The MINAG’s DGIH started in 1999 the River Channeling and Collection Structures Protection Program (PERPEC) in order to protect communities, agricultural lands and facilities and other elements of the region from floods damages, extending financial support to margin protection works carried out by regional governments.

3. IDENTIFICATION

3.1 Diagnosis of the current situation

3.1.1 Nature

(1) Location

Figure 3.1.1-1 shows the location map of the 6 Watersheds in 4 provinces.

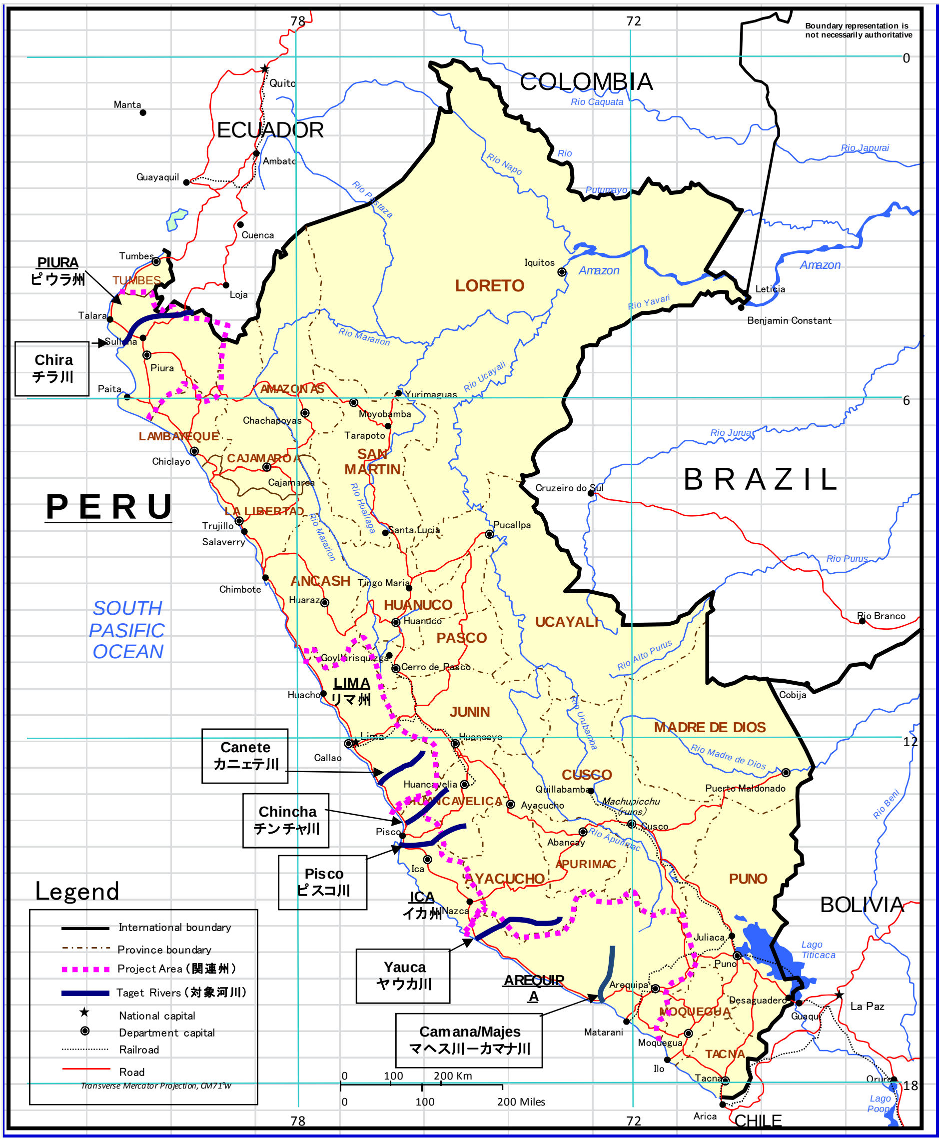


Figure 3.1.1-1 Selected Rivers for the Study

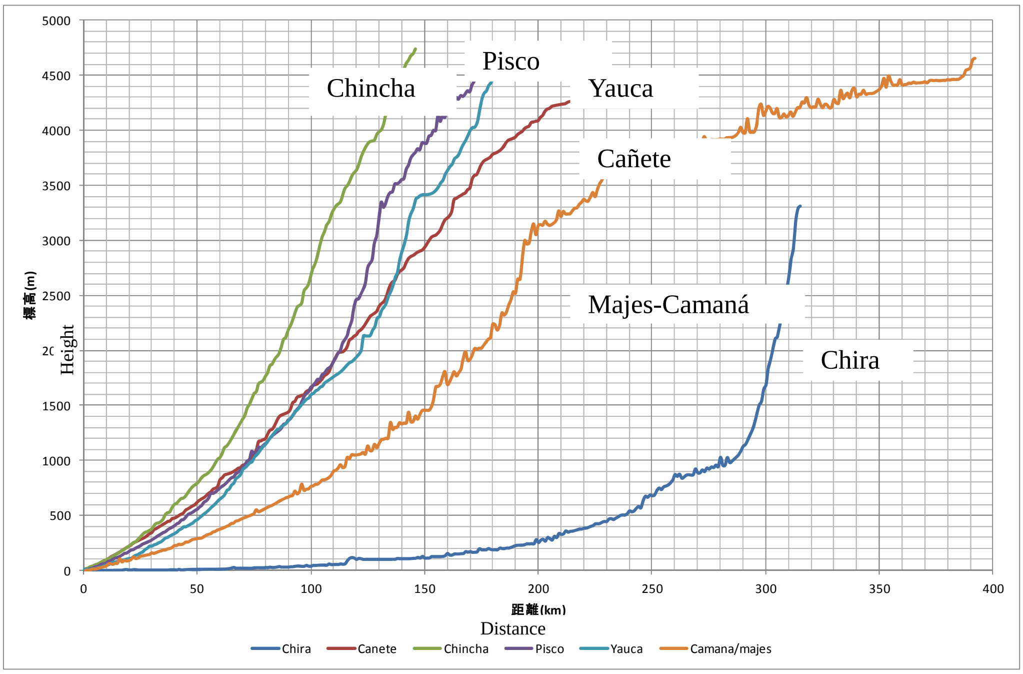
(2) General description of watersheds

The rivers of the objective watersheds for this study are born in the Andes and cruise through mountains covered with volcanic lava, run the valleys (composed of sand and gravel) between 100 and 500 meters wide, and lead to the Pacific Ocean after flowing down alluvial fans. The slopes are marked ranging from 1/30 and 1/100 in the valleys and between 1/100 and 1/300 in the alluvial fan. Such rivers are sabo river so-called in Japan which means they require some measures of sediment and erosion control. In the both side of river almost every area has agricultural activities. The flow carries large amounts of sediment from the Andes forming plural sandbars. The flow direction is changing and highly volatile. You cannot handle the Peruvian rivers with unique criteria, as these are characterized by climate variations, irregular flow, and steep slopes. In any case, we can say that these rivers are causing serious damage by seasonal extraordinary flood (December-March) and also periodically by the influence of El Niño phenomenon, etc.

In Table 3.1.1-1 and Figure 3.1.1-1 summarize watershed's general data. The main characteristics of each river are described in the next clause.

Table 3.1.1-1 General Data of the Rivers chosen for the Study

Region	River	Area (km2)	Length of river (km)	Middle Pending	Middle Flow (m3/s)	Specific flow (m3/s/km2)	Note
Piura	Chira	17,128	100	1/1,400	114.5	0.0119	
Lima	Cañete	6,066	33	1/90	63.0	0.0103	
Ica	Chincha	3,304	50	1/80	-	-	It is divided in two rivers
	Pisco	4,272	45	1/90	23.5	0.0055	
Arequipa	Yauca	4,323	45	1/100	7.6	0.0018	
	Majes-Camaná	17,049	115	1/125	-	-	
Total		52,142	388				



Source: Elaborated by JICA Study Team based on 30m mesh

Figure 3.1.1-1 Longitudinal profile of the 6 watersheds

1) Chira River

The Chira River runs approx. 850km to the north of the Capital of Lima and it is managed by Piura province. It is an International river, because part of its upper watershed belongs to Ecuador. The biggest Dam in Peru, Poechos, is located 100km upstream from the mouth of this River. This Dam has a capacity for 800 million cubic meters (multipurpose dam for irrigation, urban water, electric generation and other). The watershed area is approx. 13,000km^2 upstream Poechos dam (of which 6,500km^2 belong to Ecuador) and approx. 4,000km^2 downstream. In the 100 km section downstream of the dam that constitutes the Study Area, the river is characterized for a soft slope approximately of 1/1400 with a width between 500 and 1,500 meters.

Annual rainfalls are approximately 100 to 1000mm at altitudes less than 500m.a.s.l; and between 600 and 1600mm at altitudes greater than 3,000m.a.s.l. This tendency of increasing precipitations at higher altitudes is similar in other watersheds, but Chira River outstands due to its high average precipitations.

As to vegetation, 90% of the watershed is covered with shrub and dry forests, with the exception of a part of the upper watershed which is covered by tropical forest. On the other hand, the lower watershed (downstream Poechos dam), it is also covered with shrub and dry forests in 80% and of crops in 20%. Chira River belongs to a tropical weather with high precipitations and few arid areas. Agriculture lands are based on banana and sugar cane. The natural gas is under development in the lowest watershed.

2) Cañete River

The Cañete River runs 130km to the south of the Capital of Lima and it is the closest river to this city among the six rivers chosen. Its area covers 6,100 km^2. It's characterized by the small width of its lower watershed and for the great extension of the middle and upper watershed. Approximately, 50% of the watershed it is located above 4,000 m.a.s.l and only 10% below 1,000 m.a.s.l. The lower watershed, which is the study area, where the river has a slope approximately of 1/90 with a 200 meters of average width.

Annual rainfalls of Cañete River vary according the altitude. For example, in areas with more than 4,000 m.a.s.l , annually 1,000mm of rain happen and in areas with less than 500 m.a.s.l, only 20mm fall, suiting the desert. However, the water watershed area is wide and the flow is pretty abundant too.

As to vegetation, middle and upper watersheds are covered with scrublands. In the lower basin, most of it is desert, excepting crop land developed at the river sides. The main products are apple and grapes. Also, the river is used for prawn catch and for tourism (rafting, canoeing, etc.)

3) Chincha River

The Chincha River runs 170 km to the south of the Capital of Lima with an approximate surface of 3,300km2 which is smallest among other objective watersheds and is located adjacent to Cañete River and Pisco River.

It is featured by a wide area in middle watershed and narrow lower and upstream watersheds, its higher altitude is greater than 4,000 m.a.s.l and this area only represents 15% from the total amount. In the lower watershed (Study Area), the river is split into two by a diversion weir

located approx. 25 km upstream the mouth. The river north side is called , Chico and south side Matagente . The average slope is approx. 1/80 and its width varies between 100 and 200m.
Annual rain is similar to the one in Chincha River Watershed: with 1,000mm at altitudes over 3,000 m.a.s.l and only 20mm at altitudes smaller than 500 m.a.s.l .
Regarding vegetation, the upper watershed has puna grass and scrublands and the lower watershed in mainly constituted in 80% by desert and 20% of arable lands. This distribution of vegetal formation is like the Pisco River Watershed, which is next to it. The main product in these lands is cotton and grapes.

4) Pisco River

Pisco River runs approximately 200 km from the capital Lima, and borders the Chincha River watershed to the north. The watershed area is about 4,300 km2 which is average among the six selected watersheds in this study. It is an elongated watershed, and altitudes over 4,000 m occupy 20% of the total. The river flows in the lower watershed with an average gradient of 1/90 and its width varies between 200 and 600 meters.
The annual rainfall around 500 mm at altitudes greater than 4,000 m and 10 mm at altitudes less than 1,000 meters. Thus, the average flow rate is reduced compared with Chira and Cañete River.
Regarding the vegetation, the upper watershed is occupied in large part by grassland, and the lower and middle watersheds of deserts. In the lower watershed, also have farmlands on both river sides.

5) Yauca River

The Yauca River runs 460km to the south of the Capital of Lima and belongs to Arequipa province. Its area covers 4,300 km^2. It's characterized because its width increases as getting closer to the upper watershed. Altitudes above 4,000 m.a.s.l only represent a 10% of the total and 60% is constituted by 2,000 and 4,000 m.a.s.l . In its lower watershed, the river has a slope approximately of 1/100 with 200 meters width.

Annual rainfalls are approximately 500mm at altitudes between 2,000 and 3,000 m.a.s.l . But this data is not well confirmed because there is no complete monitoring of the details. The average flow is the most reduced among the 6 rivers, due to that precipitations themselves are pretty low.

As to vegetation, upper watersheds are covered with grassland, bushes in the middle watershed and deserts in the middle and lower watersheds. Agriculture lands are only 1% of the watershed. The main product is olive, which production occupies almost the entire agricultural lands in this area.

6) Majes-Camana River

The Majes – Camana River runs 700 km to the south of the Capital of Lima. It is the river running at the most southern part of all the rivers object of the present Study and belongs to the Arequipa Region. The watershed area is of 17,000 km^2 approximately and 60% of it is located above 4,000 m.a.s.l. The area objective of the Project is approximately 100km from the river mouth, which is below 2,000 m.a.s.l , representing 20% of the total surface of the watershed.

The limit between Majes and Camana is located approximately 40 km from the river mouth. From this point downstream the river is called “Camana” and “Majes” from this limit upstream. The slope of the riverbed is approximately 1/200 in Camana and 1/100 in Majes. Its width varies between 100 and 200 meters in Camana and between 200 and 500 meters in Majes. The river is wider in the upper part because, while in the lower part (Camana) the water course has been stabilized with dikes built by the irrigation commission, in the upper watershed (Majes) there are no sufficient dikes constructed.

Annual rainfalls show a clear tendency to increase in upper areas. This trend is such that they are of approximately 50 mm below 1,000 m.a.s.l and more than 500 mm above 4,000 m.a.s.l. The flow is abundant and the superficial water (fluvial) does not run out even in dried seasons.

As to vegetation, upper areas of more than 4,000 m.a.s.l represent 60% of the total area and are covered by wet grasslands, while the lower areas below 2,000 m.a.s.l are desert. Flat lands along the river are being used, mostly for agriculture, particularly for irrigated rice crops.

3.1.2 Socio-economic conditions of the Study Area

(1) Chira River Watershed

1) Administrative Division and Surface

The Chira River is located in the provinces of Sullana and Paita in the Piura Region.

Table 3.1.2-1 shows the main districts surrounding this river, with their corresponding surface.

Table 3.1.2-1 Districts surrounding the Chira River with areas

Region	Province	District	Area (㎢)
Piura	Sullana	Sullana	488.01
		Ignacio Escudero	306.53
		Marcavelica	1687.98
		Querocotillo	270.08
		Salitral	28.27
	Paita	Amotape	90.82
		Colán	124.93
		La Huaca	599.51
		Tamariodo	63.36

2)Population and number of households

The following Table, 3.1.2-2 shows how population varied within the period 1993-2007. From the total of 231,043 inhabitants in Sullana in 2007, 93% (215,069 inhabitants) lived in urban areas while 7% (15,974 inhabitants) lived in rural areas. Likewise, from the total of 29,906 inhabitants in Paita, 89% (26,494 inhabitants) lived in urban areas while 11% (3,412 inhabitants) lived in rural areas.

In both districts population is growing. In particular, Sullana outstood within the watershed for its quick population increase of approx. 35,000 inhabitants.

Regarding population variation between 1993 and 2007, rural and urban population of Sullana and urban area of Paita registered an increase between 1.0 and 1.6% meanwhile rural area of Paita had a reduction of 1.3%.

Table 3.1.2-2 Variation of the urban and rural population

Province	District	Total Population 2007					Total Population 1993					Variation (%)	
		Urban	%	Rural	%	Total	Urban	%	Rural	%	Total	Urban	Rural
Sullana	Sullana	145.882	93%	10.719	7%	156.601	115.484	95%	6.410	5%	121.894	1,7%	3,7%
	Ignacio Escudero	17.202	96%	660	4%	17.862	13.486	95%	689	5%	14.175	1,8%	-0,3%
	Marcavelica	24.462	94%	1.569	6%	26.031	19.406	92%	1.586	8%	20.992	1,7%	-0,1%
	Querocotillo	21.916	90%	2.536	10%	24.452	19.218	86%	3.219	14%	22.437	0,9%	-1,7%
	Salitral	5.607	92%	490	8%	6.097	4.075	81%	979	19%	5.054	2,3%	-4,8%
Total		**215,069**	**93%**	**15.974**	**7%**	**231.043**	**171.669**	**93%**	**12.883**	**7%**	**184.552**	**1,6%**	**1,5%**
Paita	Amotape	2.139	93%	166	7%	2.305	2.135	96%	87	4%	2.222	0,0%	4,7%
	Colan	11.343	92%	989	8%	12.332	10.753	92%	908	8%	11.661	0,4%	0,6%
	La Huaca	8.876	82%	1.991	18%	10.867	6.408	70%	2.756	30%	9.164	2,4%	-2,3%
	Tamarindo	4.136	94%	266	6%	4.402	3.643	91%	345	9%	3.988	0,9%	-1,8%
Total		**26.494**	**89%**	**3.412**	**11%**	**29.906**	**22.939**	**85%**	**4.096**	**15%**	**27.035**	**1,0%**	**-1,3%**

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 and 1993 Population and Housing Census.

Table 3.1.2-3 shows the number of households and members per home. The number of members per household has been 4.0 to 4.5. Each family has between 3.8 and 4.3 members.

Table 3.1.2-3 Number of households and families

Variables	District				
	Sullana	Ignacio escudero	Marcavelica	Querocotillo	Salitral
Population (inhabitants)	156,601	17,862	26,031	24,452	6,097
Number of households	34,218	4,024	6,309	5,730	1,468
Number of families	36,386	4,248	6,504	6,011	1,555
Members per household (person/home)	4.58	4.44	4.13	4.27	4.15
Members per family (person/family)	4.30	4.20	4.00	4.07	3.92

Variables	District			
	Amotape	Colan	La Huaca	Tamarindo
Population (inhabitants)	2,305	12,332	10,867	4,402
Number of households	544	2,725	2,422	1,075
Number of families	573	2,874	2,608	1,146
Members per household (person/home)	4.24	4.53	4.49	4.09
Members per family (person/family)	4.02	4.29	4.17	3.84

3)Occupation

Table 3.1.2-4, shows occupation lists of local inhabitants itemized by sector. In Sullana, the workers of the tertiary sector have increased in 71.8%, but in the other districts the primary sector is still absorbing a high labor percentage (between 40 and 80%)

Table 3.1.2-4 Occupation

	District									
	Sullana		Ignacio escudero		Marcavelica		Querocotillo		Salitral	
	People	%	People	%	People	%	People	%	People	%
EAP	52,662	100	5,042	100	7,897	100	3,920	100	2,211	100
Primary Sector	8,230	15.6	2,813	55.8	4,195	53.1	3,231	82.4	1,065	48.2
Secondary Sector	6,636	12.6	616	12.2	716	9.1	69	1.8	227	10.3
Tertiary Sector	37,796	71.8	1,613	32.0	2,986	37.8	620	15.8	919	41.6

* Primary Sector: agriculture, livestock, forestry and fishing; secondary: mining, construction, manufacture; tertiary: services and others

4)Poverty index

Table 3.1.2-5, shows the poverty index. 39.6% of the Sullana total population (231,043 inhabitants) belongs to the poor segment and 6.7% (15,536 inhabitants) to the extreme poverty segment. In Paita, 43.3% of the population (12,955 inhabitants) belongs to the poor segment and 4.8% (1,447 inhabitants) to the extreme poverty segment. In particular, poor and extreme poverty sectors of Colan district are 49.8% and 6.5/ respectively, representing almost half of the total population.

Table 3.1.2-5 Poverty index

	Sullana											
	Sullana		Ignacio Escudero		Marcavelica		Querecotillo		Salitral			
	People	%	People	%	People	%	People	%	People	%	Total	%
Regional Population	156,601	100	17,862	100	26,031	100	24,452	100	6,097	100	231,043	100
In poverty	65,747	42.0	6,197	34.7	9,566	36.7	8,013	32.8	2,008	32.9	91,531	39.6
In extreme poverty	13,269	8.5	538	3.0	983	3.8	622	2.5	124	2.0	15,536	6.7

	Paita									
	Amotape		Colan		La Huaca		Tamarindo			
	People	%	People	%	People	%	People	%	Total	%
Regional Population	2,305	100	12,332	100	10,867	100	4,402	100	29,906	100
In poverty	858	37.2	6,081	49.3	4,538	41.8	1,478	33.6	12,955	43.3
In extreme poverty	91	3.9	801	6.5	465	4.3	90	2.0	1,447	4.8

5)Type of housing

In Sullana, the walls of the houses are made 48% of bricks or cement, and 34% of adobe and mud. The floor is made 97% of earth or cement.
The public drinking water service exceeds 50%, except in Ignacio Escudero and Querecotillo, while the sewage service is more than 60% in Sullana and Salitral. Electrification reaches 82% in average.
In Paita, the walls of the houses are made 47% of bricks or cement, and 46% of adobe and mud. The floor is made 96% of earth or cement. The public drinking water service exceeds 60%, except in La Huaca, while the sewage service is less than 50%. Electrification reaches 70% in average.

Table 3.1.2-9 Type of housing (Sullana)

Variable/Indicator	Districts									
	Sullana		Ignacio escudero		Marcavelica		Querocotillo		Salitral	
	Houses	%	Houses	%	Houses	%	Houses	%	Houses	%
Name of housings										
Common residents housing	34.218	94,6	4.024	94,5	6.309	94,9	5.730	92,7	1.468	93
Walls materials										
Bricks or cement	18.384	53,7	1.108	27,5	1.769	28	1.308	22,8	391	26,6
Adobe and mud	7.930	23,2	2.200	54,7	1.353	21,4	1.611	28,1	96	6,5
Bamboo + mud or wood	6.662	19,5	664	16,5	3.041	48,2	2.777	48,5	974	66,3
Others	1.242	3,6	52	1,3	146	2,3	34	0,6	7	0,5
Floor Materials										
Soil	14.564	42,6	2.194	54,5	4.096	64,9	3.707	64,7	943	64,2
Cement	16.772	49	1.746	43,4	2.086	33,1	1.927	33,6	479	32,6
Ceramics, parquet, quality wood	2.706	7,9	50	1,2	107	1,7	83	1,4	41	2,8
Others	176	0,5	34	0,8	20	0,3	13	0,2	5	0,3
Running water system										
Public network within household	22.703	66,3	1.847	45,9	3.207	50,8	2.240	39,1	1.085	73,9
Public network within building	1.187	3,5	119	3	487	7,7	90	1,6	21	1,4
public use	960	2,8	642	16	31	0,5	449	7,8	8	0,5
Sewage										
Public sewage within household	21.836	63,8	643	16	1.351	21,4	1.860	32,5	645	43,9
Public sewage within building	842	2,5	99	2,5	138	2,2	78	1,4	22	1,5
Septic Tank	6.002	17,5	1.669	41,5	1.769	28	2.321	40,5	437	29,8
Electricity										
Public electric service	28.198	82,4	3.243	80,6	4.769	75,6	5.084	88,7	1.079	73,5
Member quantity										
Common residents housing	**36.386**	**100**	**4.248**	**100**	**6.504**	**100**	**6.011**	**100**	**1.555**	**100**
Appliances										
More than three	13.559	37,3	931	21,9	1.543	23,7	1.188	19,8	379	24,4
Communication Services										
Phones and mobiles	28.020	77,0	1.670	39,3	3.202	49,2	2.179	36,3	668	43,0

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 Population and Housing Census.

Table 3.1.2-7 Housing type (Paita)

	Districts							
Variable/Indicator	Amotape		Colan		La Huaca		Tamarindo	
	Hogares	%	Hogares	%	Hogares	%	Hogares	%
Name of housings								
Common residents housing	544	92,4	2.725	82,3	2.422	90,4	1.075	90,2
Walls materials								
Bricks or cement	188	34,6	958	35,2	683	28,2	202	18,8
Adobe and mud	14	2,6	428	15,7	383	15,8	115	10,7
Bamboo + mud or wood	337	61,9	1.304	47,9	1.323	54,6	745	69,3
Others	5	0,9	35	1,3	33	1,4	13	1,2
Floor Materials								
Soil	291	53,5	1.891	69,4	1.499	61,9	680	63,3
Cement	242	44,5	779	28,6	885	36,5	388	36,1
Ceramics, parquet, quality wood	10	1,8	52	1,9	29	1,2	6	0,6
Others	1	0,2	3	0,1	9	0,4	1	0,1
Running water system								
Public network within household	386	71	1.660	60,9	1.126	46,5	656	61

Public network within building	7	1,3	69	2,5	44	1,8	8	0,7
public use	11	2	21	0,8	12	0,5	3	0,3
Sewage								
Public sewage within household	4	0,7	977	35,9	332	13,7	500	46,5
Public sewage within building			68	2,5	45	1,9	25	2,3
Septic Tank	149	27,4	843	30,9	839	34,6	116	10,8
Electricity								
Public electric service	363	66,7	1.841	67,6	1.743	72	711	66,1
Member quantity								
Common residents housing	**573**	**100**	**2.874**	**100**	**2.608**	**100**	**1.146**	**100**
Appliances								
More than three	134	23,4	463	16,1	544	20,9	242	21,1
Communication Services								
Phones and mobiles	154	26,9	1.028	35,8	1.049	40,2	346	30,2

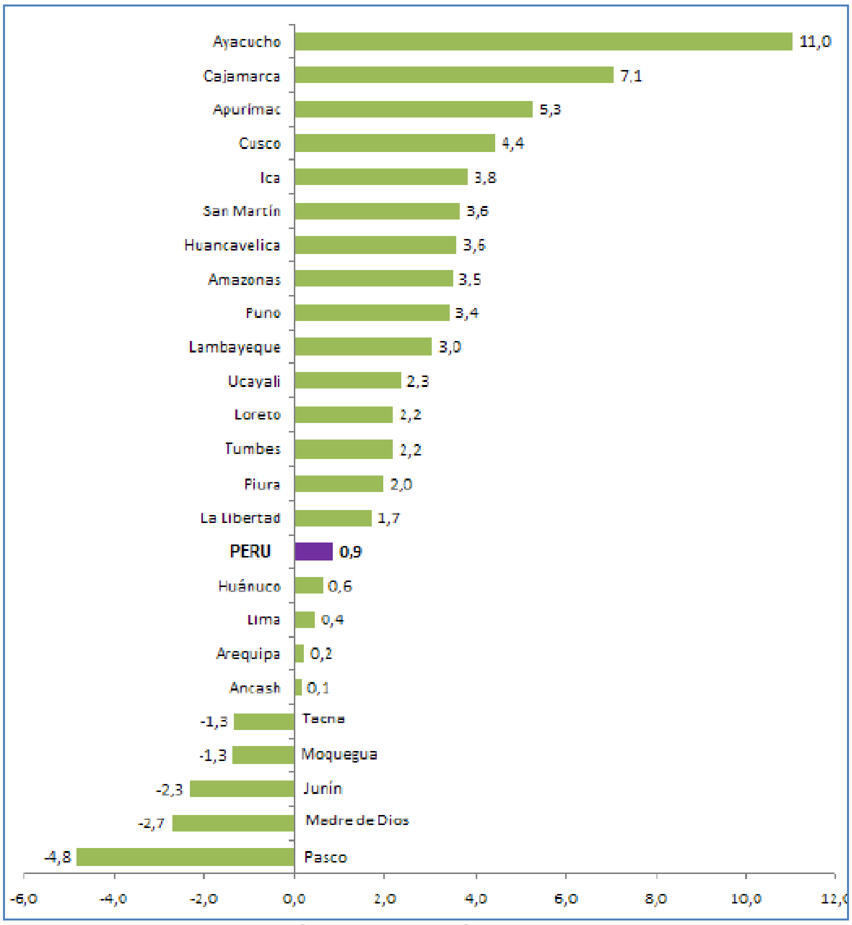
Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 Population and Housing Census

6)GDP

Peru's GDP in 2009 was S./392,565,000,000.

The growth rate in the same year was of + 0.9 % compared with the previous year with the poorest level within 11 years.

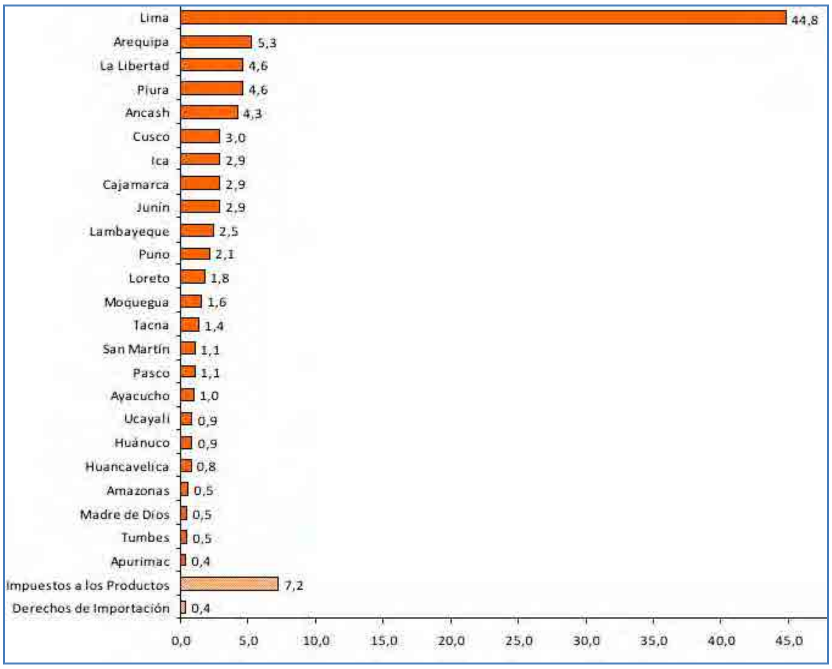
Itemized by regions, Ica registered a growth of 3.8 %, Piura 2.0 %, Lima 0.4 % and Arequipa 0.2 %. Particularly Ica and Piura regions registered Figures that were beyond the national average.



INEI Source – National Accounts National Direction

Figure 3.1.2-1 Growth rate of GDP per region (2009/2008)

The Table below shows the contribution of each region to the GDP. Lima Region represents almost half of the total, that is to say 44.8%. Arequipa contributed with 5.3 %, Piura 4.6 % and Ica 2.9 %. Taxes and duties contributed with 7.2 % and 0.4 %, respectively.

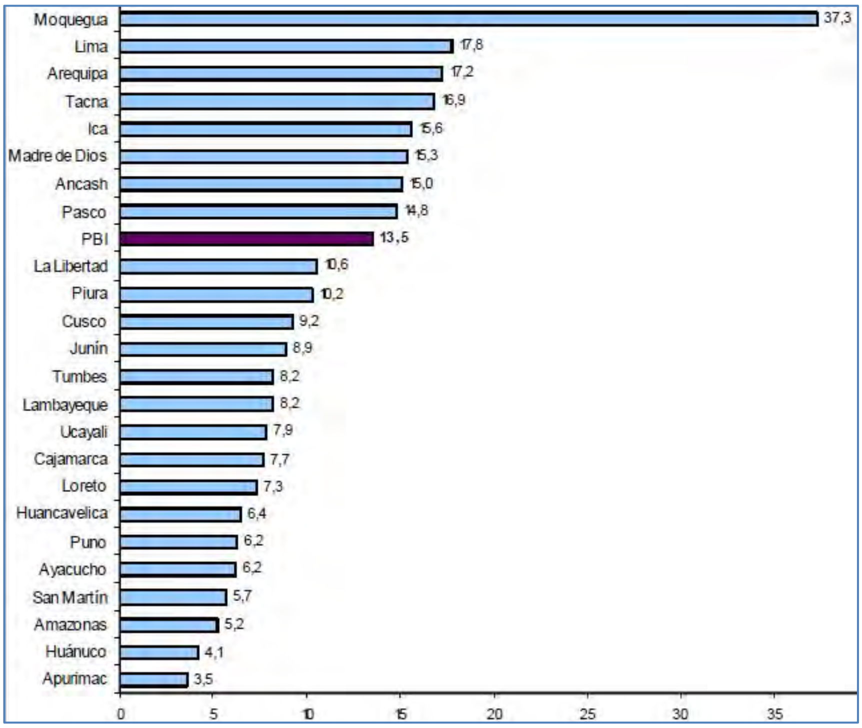


INEI Source – National Accounts National Direction

Figure 3.1.2-2 Region contribution to GDP

The GDP per capita in 2009 was of S/.13,475.

The Table below shows data per region: Lima S/.17,800, Arequipa S/.17,200, Ica S/.15,600 and Piura S/.10,200. The first three regions exceeded the national average, with exception of Piura.



INEI Source – National Accounts National Direction

Figure 3.1.2-3 GDP per capita (2009)

Table 3.1.2-8 shows the variation along the years of the GDP per capita per region, during the last 9 years (2001-2009).

The GDP national average increased in 44% within nine years from 2001 until 2009. The Figures per region are: +83.9 % for Ica, +54.2 % for Arequipa, +48.3 % for Piura +429 % for Lima.

Figures in Table 3.1.2-8 were established taking 1994 as base year.

Table 3.1.2-8 Variation of the GDP per capita (2001-2009)

(1994 Base year, S/.)

Departamentos	2001	2002	2003	2004	2005	2006	2007P/	2008P/	2009E/	Crecimiento Acumulado 2001-2009 (%)
Cusco	2 194	2 086	2 195	2 565	2 768	3 071	3 340	3 554	3 685	67,9
Ica	4 055	4 259	4 343	4 663	5 214	5 582	6 025	7 265	7 457	83,9
La Libertad	3 162	3 316	3 483	3 410	3 697	4 216	4 586	4 874	4 895	54,8
Ucayali	3 063	3 149	3 203	3 411	3 584	3 754	3 846	4 007	4 039	31,9
Moquegua	10 405	11 967	12 670	13 455	13 882	13 794	13 606	14 201	13 865	33,3
Arequipa	5 387	5 766	5 895	6 143	6 488	6 807	7 786	8 379	8 308	54,2
Apurimac	1 216	1 278	1 334	1 400	1 494	1 619	1 653	1 691	1 770	45,5
Piura	2 733	2 780	2 847	3 049	3 192	3 472	3 780	4 007	4 052	48,3
San Martin	2 026	2 059	2 094	2 232	2 393	2 476	2 655	2 870	2 928	44,5
Ayacucho	1 788	1 870	1 942	1 900	2 045	2 207	2 448	2 640	2 896	61,9
Amazonas	1 835	1 910	1 996	2 081	2 212	2 349	2 510	2 684	2 761	50,5
Madre de Dios	4 441	4 708	4 550	4 846	5 171	5 215	5 617	5 878	5 564	25,3
Cajamarca	2 493	2 731	2 947	2 968	3 165	3 113	2 864	3 094	3 295	32,2
Ancash	4 037	4 703	4 772	4 876	4 999	5 089	5 408	5 852	5 827	44,3
Tumbes	2 744	2 802	2 873	3 018	3 385	3 212	3 427	3 594	3 611	31,6
Lima	6 451	6 579	6 700	6 925	7 284	7 817	8 520	9 314	9 220	42,9
Puno	2 105	2 236	2 234	2 270	2 365	2 460	2 617	2 731	2 800	33,0
Lambayeque	2 941	3 046	3 132	2 959	3 164	3 300	3 615	3 882	3 963	34,8
Junín	3 245	3 311	3 350	3 527	3 505	3 856	4 072	4 379	4 248	30,9
Loreto	2 827	2 917	2 936	2 995	3 079	3 192	3 287	3 402	3 429	21,3
Huánuco	1 678	1 694	1 833	1 866	1 890	1 915	1 942	2 050	2 044	21,8
Pasco	5 137	5 552	5 481	5 634	5 644	6 062	6 711	6 729	6 349	23,6
Tacna	6 004	6 124	6 382	6 643	6 782	6 941	7 256	7 458	7 253	20,8
Huancavelica	2 700	2 632	2 683	2 697	2 864	3 014	2 903	2 959	3 039	12,5
PBI	4 601	4 765	4 890	5 067	5 345	5 689	6 121	6 643	6 625	44,0

INEI Source – National Accounts National Direction

(2) Cañete River Watershed

1) Administrative Division and Surface

The Cañete River is located in the provinces of Cañete in the Lima Region.

Table 3.1.2-9 shows the main districts surrounding this river, with their corresponding surface.

Table 3.1.2-9 Districts surrounding the Cañete River with areas

Region	Province	District	Area(㎢)
Lima	Cañete	San Vicente de Cañete	513.15
		Cerro Azul	105.17
		Nuevo Imperial	329.3
		San Luis	38.53
		Lunahuaná	500.33

2)Population and number of households

The following Table 3.1.2-10 shows how population varied within the period 1993-2007. In 2007, from 120,663 inhabitants, 85% (102,642 inhabitants) lived in urban areas while 15% (18,021 inhabitants) lived in rural areas.

Population is increasing in all districts. However, while the urban area registers an annual medium increase of 2.7%, exceeding the national average, the rural area experiments a decrease of 0.1%.

Table 3.1.2-10 Variation of the urban and rural population

District	Total Population 2007					Total Population 1993					Variation (%)	
	Urban	%	Rural	%	Total	Urban	%	Rural	%	Total	Urban	Rural
San Vicente de Cañete	37.512	81 %	8.952	19 %	46.464	22.244	68 %	10.304	32 %	32.548	3,8 %	-1,0 %
Cerro Azul	5.524	80 %	1.369	20 %	6.893	3.271	64 %	1.853	36 %	5.124	3,8 %	-2,1 %
Imperial	33.728	93 %	2.612	7 %	36.340	28.195	92 %	2.459	8 %	30.654	1,3 %	0,4 %
Nuevo Imperial	15.144	80 %	3.882	20 %	19.026	9.403	72 %	3.733	28 %	13.136	3,5 %	0,3 %
San Luis	10.734	90 %	1.206	10 %	11.940	7.725	76 %	2.434	24 %	10.159	2,4 %	-4,9 %
Total	**102.642**	**85 %**	**18.021**	**15 %**	**120.663**	**70.838**	**77 %**	**20.783**	**23 %**	**91.621**	**2,7 %**	**-1,0 %**

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 and 1993 Population and Housing Census.

Table 3.1.2-11 shows the number of households and members per home in 2007. The number of members per household has been 4.4 in average, except for Nuevo Imperial that had a minor number of 3.91.

The number of members per family is around 4.1 persons, with exception of Nuevo Imperial, with a lower Figure of 3.77.

Table 3.1.2-11 Number of households and families

Variables	District				
	San Vicente de Cañete	Cerro Azul	Imperial	Nuevo Imperial	San Luis
Population (inhabitants)	46,464	6,893	36,340	19,026	11,940
Number of households	10,468	1,549	8,170	4,867	2,750
Number of families	11,267	1,662	8,922	5,052	2,940
Members per household (person/home)	4.44	4.45	4.45	3.91	4.34
Members per family (person/family)	4.12	4.15	4.07	3.77	4.06

3)Occupation

Table 3.1.2-12, shows occupation lists of local inhabitants itemized by sector.

It highlights the primary sector in all districts representing between 27.9 and 56.5% of the economically active population (EAP).

Table 3.1.2-12 Occupation

	District									
	San Vicente de Cañete		Cerro Azul		Imperial		Nuevo Imperial		San Luis	
	People	%	People	%	People	%	People	%	People	%
EAP	19,292	100	2,562	100	15,114	100	7,770	100	4,723	100
Primary Sector	5,910	30.6	742	29.0	4,213	27.9	4,393	56.5	2,349	49.7
Secondary Secto	2,310	12.0	550	21.5	1,590	10.5	621	8.0	504	10.7
Tertiary Sector	11,072	57.4	1,270	49.6	9,311	61.6	2,756	35.5	1,870	39.6

* Sector primario: agricultura, ganadería, forestal y pesca; secundario: minería, construcción, manufactura; terciario servicios y otros

4)Poverty index

Table 3.1.2-13, shows the poverty index. 34.7% of the districts' population (41,840 inhabitants) belongs to the poor segment, and 3.1% (3,793 inhabitants) belong to extreme poverty. Particularly, the Nuevo Imperial district stands out for its high poverty percentage with 42.8%, and 4.6% of extreme poverty.

Table 3.1.2-13 Poverty index

	Distrito											
	San Vicente		Cerro Azul		Imperial		Nuevo Imperial		San Luis			
	People	%	People	%	People	%	People	%	People	%	Total	%
Regional Population	46,464	100	6,893	100	36,340	100	19,026	100	11,940	100	120,663	100
In poverty	14,068	30.3	2,097	30.4	12,947	35.6	8,152	42.8	4,576	38.3	41,840	34.7
In extreme poverty	1,382	3.0	129	1.9	1,029	2.8	878	4.6	375	3.1	3,793	3.1

5)Type of housing

The walls of the houses are made 39% of bricks or cement, and 42% of adobe and mud. The floor is made 94% of earth or cement. Except Nuevo Imperial, the public drinking water service covers approximately 58%, while the sewage service is 52%. In the specific case of Nuevo Imperial there is a low coverage of both services, with 25.1% and 11.3% respectively.

Table 3.1.2-14 Type of housing

Variable/Indicator	Distrit									
	San Vicente de Cañete		Cerro Azul		Imperial		Nuevo Imperial		San Luis	
	Hogares	%	Hogares	%	Hogares	%	Hogares	%	Hogares	%
Variable/Indicator										
	10.468	78,8	1.549	45,1	8.170	88,9	4.867	77,1	2.750	84,5
Name of housings	4.685	44,8	853	55,1	2.661	32,6	1.220	25,1	848	30,8
Common residents housing	3.518	33,6	210	13,6	4.075	49,9	2.105	43,3	1.145	41,6
Walls materials	783	7,5	288	18,6	161	2,0	650	13,4	183	6,7
Bricks or cement	1.482	14,2	198	12,8	1.273	15,6	892	18,3	574	20,9
Adobe and mud										
Bamboo + mud or wood	4.196	40,1	661	42,7	4.279	52,4	2.842	58,4	1.501	54,6
Others	4.862	46,4	781	50,4	3.432	42	1.925	39,6	1.109	40,3
Floor Materials	1.342	12,8	100	6,5	421	5,2	67	1,4	102	3,7
Soil	68	0,6	7	0,5	38	0,5	33	0,7	38	1,4
Cement										
Ceramics, parquet, quality wood	5.729	54,7	886	57,2	5.642	69,1	1.220	25,1	1.457	53,0
Others	584	5,6	66	4,3	373	4,6	334	6,9	166	6,0
Running water system	666	6,4	52	3,4	234	2,9	80	1,6	346	12,6
Public network within household										
Public network within building	4.987	47,6	824	53,2	5.115	62,6	549	11,3	1.167	42,4
public use	482	4,6	32	2,1	364	4,5	70	1,4	118	4,3
Sewage	2.002	19,1	317	20,5	1.206	14,8	3.564	73,2	203	7,4
Public sewage within household										
Public sewage within building	8.373	80	1.217	78,6	6.733	82,4	3.520	72,3	2.110	76,7
Septic Tank										
Electricity	**11.267**	**100**	**1.662**	**100**	**8.922**	**100**	**5.052**	**100**	**2.940**	**100**
Public electric service										
Member quantity	4.844	43,0	648	39	2.822	31,6	1.237	24,5	1.045	35,5
Common residents housing										
Appliances	9.391	83,3	1.373	82,6	5.759	64,5	2.708	53,6	1.728	58,8

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 Population and Housing Census.

(3) Chincha River Water shed

1)Administrative Division and Surface

The Chincha River is located in the provinces of Chincha in the Ica Region.

Table 3.1.2-15 shows the main districts surrounding this river, with their corresponding surface.

Table 3.1.2-15 Districts surrounding the Chincha River with areas

Región	Provincia	Distrito	Área (㎢)
Ica	Chincha	Chincha Alta	238.34
		Alto Laren	298.83
		Chincha Baja	72.52
		El Carmen	790.82
		Tambo de Mora	22.00

2)Population and number of households

The following Table 3.1.2-16 shows how population varied within the period 1993-2007. From the total 94.439 inhabitants (2007), 82% (77.695 inhabitants) lives in urban areas while 18% (16.744 inhabitants) lived in rural areas. However, in Chincha Baja and El Carmen Districts 58% and 57% respectively, live in rural areas, with more rural areas than other areas.

Population is increasing in all districts.

Table 3.1.2-16 Variation of the urban and rural population

District	Total Population 2007					Total Population 1993					Variation (%)	
	Urban	%	Rural	%	Total	Urban	%	Rural	%	Total	Urban	Rural
Chincha Alta	59.574	100 %	0	0 %	59.574	49.748	100 %	0	0 %	49.748	1,3 %	0,0 %
Alto Laran	3.686	59 %	2.534	41 %	6.220	1.755	41 %	2.530	59 %	4.285	5,4 %	0,01 %
Chincha Baja	5.113	42 %	7.082	58 %	12.195	3.402	30 %	7.919	70 %	11.321	3,0 %	-0,8 %
El Carmen	5.092	43 %	6.633	57 %	11.725	3.766	43 %	5.031	57 %	8.797	2,2 %	2,0 %
Tambo de Mora	4.230	90 %	495	10 %	4.725	3.176	79 %	868	21 %	4.044	2,1 %	-3,9 %
Total	**77.695**	**82 %**	**16.744**	**18 %**	**94.439**	**61.847**	**79 %**	**16.348**	**21 %**	**78.195**	**1,6 %**	**0,2 %**

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 and 1993 Population and Housing Census.

Table 3.1.2-17 shows the number of households and members per home. Every home has between 4,0 and 4,4 members and every family among 3,9 and 4,1 members.

Table 3.1.2-17 Number of households and families

Variables	Distrito				
	Chincha Alta	Alto Laran	Chincha Baja	El Carmen	Tambo de Mora
Población (habitantes)	59,574	6,220	12,195	11,725	4,725
Número de hogares	13,569	1,522	2,804	2,696	1,124
Número de familias	14,841	1,559	2,997	2,893	1,200
Miembros por hogar (personas/hogar)	4.39	4.09	4.35	4.35	4.20
Miembros por familia (personas/famili	4.01	3.99	4.07	4.05	3.94

3)Occupation

Table 3.1.2-18, shows occupation lists of local inhabitants itemized by sector. In Chincha Alta and Tambo de Mora where the population is predominantly urban, there is a low percentage of primary sector, meanwhile in the other districts the primary sector is predominant.

Table 3.1.2-18 Occupation

	Distrito									
	Chincha Alta		Alto Laran		Chincha Baja		El Carmen		Tambo de Mora	
	Personas	%	Personas	%	Personas	%	Personas	%	Personas	%
Pob. Económicame	23,596	100	2,415	100	4,143	100	3,966	100	1,640	100
Serctor primario	1,889	8.0	1,262	52.3	1,908	46.1	2,511	63.3	334	20.4
Sector secundario	6,514	27.6	443	18.3	931	22.5	399	10.1	573	34.9
Sector terciario	15,190	64.4	710	29.4	1,304	31.5	1,056	26.6	733	44.7

* Sector primario: agricultura, ganadería, forestal y pesca; secundario: minería, construcción, manufactura; terciario servicios y otros

4)Poverty index

Table 3.1.2-19 shows the poverty index. From the total population, 15,6% (14.721 inhabitants) belong to the poor segment, and 0.3% (312 inhabitants) belong to extreme poverty. Chincha Baja has reached a lower poverty index than the rest, with 10.6% (poor) and 0.2% (extreme poverty).

Table 3.1.2-19 Poverty index

	Distrito											
	Chincha Alta		Alto Laran		Chincha Baja		El Carmen		Tambo de Mora			
	Personas	%	Personas	%	Personas	%	Personas	%	Personas	%	Total	%
Población regional	59,574	100	6,220	100	12,195	100	11,725	100	4,725	100	94,439	100
En pobre	9,316	15.6	1,309	21.0	1,296	10.6	1,950	16.6	850	18.0	14,721	15.6
En extrema pobreza	214	0.4	30	0.5	22	0.2	35	0.3	11	0.2	312	0.3

5)Type of housing

The walls of the houses are made 21% of bricks or cement, and 44% of adobe and mud. The floor is made 94% of earth or cement. The public drinking water service is low, with an average of 45%, except for El Carmen and Tambo de Mora, while the sewage service is scarcely 29%. The average electrification rate is 74%.

Table 3.1.2-20 Type of housing

Variable/Indicator	Districts									
	Chincha Alta		**Alto Laran**		**Chincha Baja**		**El Carmen**		**Tambo de Mora**	
	Housing	%	Housing	%	Housing	%	Housing	%	Housing	%
Name of housings										
Common residents housing	13.569	85,7	1.522	76,1	2.804	93,3	2.696	87,6	1.124	85,3
Walls materials										
Bricks or cement	5.220	38,5	170	11,2	590	21	176	6,5	309	27,5
Adobe and mud	4.817	35,5	891	58,5	1.146	40,9	1.589	58,9	289	25,7
Bamboo + mud or wood	281	2,1	121	8,0	125	4,5	160	5,9	45	4,0
Others	3.251	24,0	340	22,3	943	33,6	771	28,6	481	42,8
Floor Materials										
Soil	5.036	37,1	812	53,4	1.521	54,2	1.547	57,4	604	53,7
Cement	6.454	47,6	680	44,7	1.136	40,5	1.081	40,1	450	40
Ceramics, parquet, quality wood	1.979	14,6	25	1,6	134	4,8	42	1,6	58	5,2
Others	100	0,7	5	0,3	13	0,5	26	1,0	12	1,1
Running water system										
Public network within household	10.321	76,1	705	46,3	1.055	37,6	861	31,9	379	33,7
Public network within building	1.030	7,6	87	5,7	239	8,5	242	9	62	5,5
public use	311	2,3	214	14,1	192	6,8	202	7,5	38	3,4
Sewage										
Public sewage within household	9.244	68,1	167	11	709	25,3	320	11,9	336	29,9
Public sewage within building	748	5,5	60	3,9	77	2,7	31	1,1	61	5,4
Septic Tank	1.441	10,6	621	40,8	1.167	41,6	1.348	50	259	23
Electricity										
Public electric service	10.989	81	811	53,3	2.251	80,3	2.146	79,6	837	74,5
Member quantity										
Common residents housing	**14.841**	**100**	**1.559**	**100**	**2.997**	**100**	**2.893**	**100**	**1.200**	**100**
Appliances										
More than three	7.024	47,3	466	29,9	1.159	38,7	908	31,4	473	39,4
Communication Services										
Phones and mobiles	12.640	85,2	920	59,0	2.182	72,8	1.919	66,3	872	72,7

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 Population and Housing Census.

(4) Pisco River Watershed

1) Administrative Division and Surface

The Pisco River is located in the Pisco province, Ica Region.

Table 3.1.2-21 shows the main districts surrounding this river, with their corresponding surface.

Table 3.1.2-21 Districts surrounding Pisco River with areas

Region	Province	District	Area (㎢)
Ica	Pisco	Pisco	24.92
		San Clemente	127.22
		Tupac Amaru	55.48
		San Andres	39.45
		Humay	1,112.96
		Independencia	273.34

2)Population and number of households

The following Table 3.1.2-22 shows how population varied within the period 1993-2007. In 2007, from 119,975 inhabitants, 89% (106,394 inhabitants) lived in urban areas while 11% (13,581 inhabitants) lived in rural areas.

Population is increasing in all districts. However, the population tends to decrease, except in Humay and Independencia.

Table 3.1.2-22 Variation of the urban and rural population

District	Total Population 2007					Total Population 1993					Variation (%)	
	Urban	%	Rural		Urban	%	Rural		Urban	%	Rural	
Pisco	54.677	99 %	320	1 %	54.997	51.639	99 %	380	1 %	52.019	0,4 %	-1,2 %
San Clemente	18.849	98 %	475	2 %	19.324	13.200	93 %	1.002	7 %	14.202	2,6 %	-5,2 %
Túpac Amaru Inca	14.529	99 %	147	1 %	14.676	9.314	98 %	228	2 %	9.542	3,2 %	-3,1 %
San Andrés	11.495	87 %	1.656	13 %	13.151	10.742	86 %	1.789	14 %	12.531	0,5 %	-0,6 %
Humay	3.099	57 %	2.338	43 %	5.437	2.016	46 %	2.331	54 %	4.347	3,1 %	0,0 %
Independencia	3.745	30 %	8.645	70 %	12.390	1.630	19 %	7.004	81 %	8.634	6,1 %	1,5 %
Total	**106.394**	**89 %**	**13.581**	**11 %**	**119.975**	**88.541**	**87 %**	**12.734**	**13 %**	**101.275**	**1,3 %**	**0,5 %**

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 and 1993 Population and Housing Census.

Table 3.1.2-3-23 shows the number of households and members per home in 2007. Each house has between 3.8 and 4.4 people, according to the district. Each family has an average between 3.7 and 4.1 people.

Table 3.1.2-23 Number of households and families

Variables	District					
	Pisco	San Clemente	Túpac Amaru Inca	San Andrés	Humay	Independencia
Population (inhabitants)	54,997	19,324	14,676	13,151	5,437	12,390
Number of households	12,483	4,837	3,609	3,087	1,409	3,062
Number of families	13,356	5,163	3,828	3,206	1,455	3,204
Members per household (person/home)	4.41	4.00	4.07	4.26	3.86	4.05
Members per family (person/family)	4.12	3.74	3.83	4.10	3.74	3.87

3)Occupation

Table 3.1.2-24, shows occupation lists of local inhabitants itemized by sector. In Humay and Independencia, there is a predominance of primary sector accounts for more than 70% of the occupation. In the remaining districts, the largest percentage is concentrated in the tertiary sector.

Table 3.1.2-24 Occupation

	District											
	Pisco		San Clemente		Túpac Amaru Inca		San Andrés		Humay		Independencia	
	People	%	People	%	People	%	People	%	People	%	People	%
EAP	19,837	100	7,027	100	5,057	100	4,406	100	2,011	100	4,451	100
Primary Sector	1,657	8.4	2,381	33.9	1,065	21.1	1,429	32.4	1,512	75.2	3,234	72.7
Secondary Sector	4,866	24.5	1328	18.9	1,366	27.0	767	17.4	93	4.6	259	5.8
Tertiary Sector	13,313	67.1	3,318	47.2	2,626	51.9	2,207	50.1	406	20.2	958	21.5

* Primary Sector: agriculture, livestock, forestry and fishing; secondary: mining, construction, manufacture; tertiary: services and others

4)Poverty index

Table 3.1.2-25 shows poverty rate. 18.7% of the population (22,406 inhabitants) belongs to the poor segment, and 0.4% (493 people) to the extreme poverty segment. Pisco is noted for its low poverty rate and extreme poverty from 15.8% and 0.3% respectively, compared to other districts.

Table 3.1.2-25 Poverty index

	District													
	Pisco		San Clemente		Túpac Amaru Inca		San Andrés		Humay		Independencia			
	People	%	People	%	People	%	People	%	People	%	People	%	Total	%
Regional Population	54,997	100	19,324	100	14,676	100	13,151	100	5,437	100	12,390	100	119,975	100
In poverty	8,716	15.8	4,455	23.1	3,042	20.7	2,613	19.9	1,024	18.8	2,556	20.6	22,406	18.7
In extreme poverty	172	0.3	126	0.7	69	0.5	39	0.3	22	0.4	65	0.5	493	0.4

5)Type of housing

The walls of the houses are built 45% of bricks or cement, and 19% of adobe and mud. The floor is made 87% of earth or cement.

The public drinking water service in Humay and Independence is low, with 25%. Except these two districts, the coverage of this service is 45% on average. Meanwhile, sewage service is 48% on average, but again and Independence Humay shows a low coverage of 11% and 13% respectively.

The electrification reaches 65% on average.

Table 3.1.2-26 Type of housing

Variable/Indicator	Districts											
	Pisco		San Clemente		Túpac Amaru Inca		San Andrés		Humay		Independencia	
	Hogares	%	Hogares	%	Hogares	%	Hogares	%	Hogares	%	Hogares	%
Name of housings												
Common residents housing	12.483	83,7	4.837	84,1	3.609	90	3.087	88,2	1.409	79,9	3.062	87,8
Walls materials												
Bricks or cement	7.600	60,9	1.339	27,7	1.198	33,2	2.088	67,6	65	4,6	401	13,1
Adobe and mud	1.008	8,1	1.780	36,8	284	7,9	159	5,2	644	45,7	1.621	52,9
Bamboo + mud or wood	623	5,0	80	1,7	99	2,7	113	3,7	76	5,4	298	9,7
Others	3.252	26,1	1,638	33,9	2.028	56,2	727	23,6	624	44,3	742	24,2
Floor Materials												
Soil	4.199	33,6	2,552	52,8	2.244	62,2	894	29	899	63,8	1.896	61,9
Cement	5.752	46,1	2,109	43,6	1.179	32,7	1.749	56,7	438	31,1	997	32,6
Ceramics, parquet, quality wood	2.320	18,6	136	2,8	131	3,6	361	11,7	40	2,8	147	4,8
Others	212	1,7	40	0,8	55	1,5	83	2,7	32	2,3	22	0,7
Running water system												
Public network within household	8.351	66,9	2,359	48,8	2.226	61,7	1.928	62,5	266	18,9	706	23,1
Public network within building	726	5,8	302	6,2	255	7,1	352	11,4	355	25,2	67	2,2
public use	645	5,2	109	2,3	163	4,5	30	1	3	0,2	139	4,5
Sewage												
Public sewage within household	7.771	62,3	1,729	35,7	1.712	47,4	1.941	62,9	157	11,1	410	13,4
Public sewage within building	526	4,2	113	2,3	79	2,2	201	6,5	178	12,6	26	0,8
Septic Tank	977	7,8	1,532	31,7	587	16,3	302	9,8	250	17,7	1.623	53
Electricity												
Public electric service	8.933	71,6	2,975	61,5	2.043	56,6	2.342	75,9	949	67,4	1.283	41,9
Member quantity												
Common residents housing	**13.356**	**100**	**5,163**	**100**	**3.828**	**100**	**3.206**	**100**	**1.455**	**100**	**3.204**	**100**
Appliances												
More than three	5.976	44,7	1,426	27,6	1.086	28,4	1.417	44,2	402	27,6	553	17,3
Communication Services												
Phones and mobiles	11.385	85,2	3,401	65,9	2.795	73,0	2.579	80,4	630	43,3	1.719	53,7

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 Population and Housing Census.

(5) Yauca River Watershed

1) Administrative Division and Surface

The Yauca River is located in the provinces of Caraveli in the Arequipa Region.

Table 3.1.2-27 shows the main districts surrounding this river, with their corresponding surface.

Table 3.1.2-27 Districts surrounding the Yauca River with areas

Region	Province	District	Area (㎢)
Arquipa	Caravelí	Yauca	556.30
		Jaquí	424.73

2)Population and number of households

The following Table 3.1.2-28 shows how population varied within the period 1993-2007. From 1,708 inhabitants in 2007, 84% (2,844 inhabitants) lived in urban areas while 16% (549 inhabitants) lived in rural areas.

Yauca population has not varied. However, a reduction of rural population is observed. In Jaqui district, both populations, rural and urban, have decreased.

Table 3.1.2-28 Variation of the urban and rural population

District	Total Population 2007					Total Population 1993					Variation (%)	
	Urban	%	Rural	%	Total	Urban	%	Rural	%	Total	Urban	Rural
Yauca	1.442	84 %	266	16 %	1.708	1.370	81 %	321	19 %	1.691	0,4 %	-1,3 %
Jaqui	1.402	83 %	283	17 %	1.685	2.016	81 %	482	19 %	2.498	-2,6 %	-3,7 %
Total	**2.844**	**84 %**	**549**	**16 %**	**3.393**	**3.386**	**81 %**	**803**	**19 %**	**4.189**	**-1,2 %**	**-2,7 %**

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 and 1993 Population and Housing Census.

Table 3.1.2-29 shows the number of households and members per home. The number of members per household has been 3.5 in average in Yauca and 3.7 in Jaqui. The number of members per family in Yauca is 3.4 and in Jaqui is 3.5.

Table 3.1.2-29 Number of households and families

Variables	Distrito	
	Yauca	Jaqui
Population (inhabitants)	1,708	1,685
Number of households	492	461
Number of families	499	483
Members per household (person/home	3.47	3.66
Members per family (person/family)	3.42	3.49

3)Occupation

Table 3.1.2-30, shows occupation lists of local inhabitants itemized by sector. In Yauca, primary sector is 39% of labor; meanwhile tertiary sector is 51%, being the second one predominant. In Jaqui, primary sector is 55% of labor and the tertiary sector is 35%, being the first one predominant

Table 3.1.2-30 Occupation

	Distrito			
	Yauca		Jaqui	
	人	%	人	%
EAP	688	100	604	100
Primary Sector	269	39.1	334	55.3
Secondary Sector	68	9.9	56	9.3
Tertiary Sector	351	51.0	214	35.4

* Sector primario: agricultura, ganadería, forestal y pesca; secundario: minería, construcción, manufactura; terciario servicios y otros

4)Poverty index

Table 3.1.2-31, shows the poverty index. 28.2% of the districts' population (956 inhabitants) belongs to the poor segment, and 4.4% (150 inhabitants) belong to extreme poverty.

Table 3.1.2-31 Poverty index

	Distrito					
	Chincha Alta		Tambo de Mora			
	Personas	%	Personas	%	Total	%
Regional Populatior	1,708	100	1,685	100	3,393	100
In poverty	449	26.3	507	30.1	956	28.2
In extreme poverty	71	4.2	79	4.7	150	4.4

5)Type of housing

The walls of the houses are made 55% of bricks or cement, and 24% of adobe and mud. The floor is made 95% of earth or cement.
The public drinking water service covers approximately 66% in Yauca and 68% in Jaqui, while the sewage service is 63% in Yauca and 22% in Jaqui (Jaqui is a little far behind in this topic). Electrification reaches 78% in average.

Table 3.1.2-32 Type of housing

Variable/Indicator	Districts			
	Yauca		Jaqui	
	Hogares	%	Hogares	%
Name of housings				
Common residents housing	492	59,3	461	79,2
Walls materials				
Bricks or cement	262	53,3	265	57,5
Adobe and mud	133	27	100	21,7
Bamboo + mud or wood	44	8,9	68	14,8
Others	53	10,8	28	6,1
Floor Materials				
Soil	136	27,6	160	34,7
Cement	315	64	290	62,9
Ceramics, parquet, quality wood	38	7,7	10	2,2
Others	3	0.6	1	0.2
Running water system				
Public network within household	325	66.1	313	67.9
Public network within building	27	5,5	49	10.6
public use	4	0.8		
Sewage				
Public sewage within household	308	62,6	99	21,5
Public sewage within building	19	3,9	27	5,9
Septic Tank	23	4,7	147	31,9
Electricity				
Public electric service	422	85,8	321	69,6
Member quantity				
Common residents housing	**499**	**100**	**483**	**100**
Appliances				
More than three	198	39,7	136	28,2
Communication Services				
Phones and mobiles	241	48,3	7	1,4

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 Population and Housing Census

(6) Majes-Camana River Watershed

1) Administrative Division and Surface

The Majes – Camana River is located in the provinces of Castilla and Camana in the Arequipa Region. Table 3.1.2-33 shows the main districts surrounding this river, with their corresponding surface.

Table 3.1.2-33 Districts surrounding the Majes – Camana River with areas

Region	Province	District	Area (Km^2)
Arequipa	Castilla	Uraca	713.83
		Aplao	640.04
		Huancarqui	803.65
	Camana	Camana	11.67
		Nicolas de Pierola	391.84
		Mariscal Caceres	579.31
		Samuel Pastor	113.4
		Jose Maria Quimper	16.72

2)Population and number of households

The following Table 3.1.2-34 shows how population varied within the period 1993-2007. In 2007, from 44,175 inhabitants, 91% (40,322 inhabitants) lived in urban areas while 9% (3,853 inhabitants) lived in rural areas.

Population is increasing in all districts. However, while the urban area registers an annual medium increase of 2.8% to 3.4%, exceeding the national average, the rural area experiments a decrease of -1.3% to -6.6%.

Table 3.1.2-34 Variation of the urban and rural population

Province	District	2007 Total Population					1993 Total Population					Variation (%)	
		Urban	%	Rural	%	Total	Urban	%	Rural	%	Total	Urban	Rural
Castilla	Uraca	2,664	37%	4,518	63%	7,182	1,953	29%	4,698	71%	6,651	2.20%	-0.30%
	Aplao	4,847	45%	4,004	55%	8,851	2,928	35%	5,334	65%	8,262	3.70%	-2.00%
	Huancarqui	1,191	18%	254	82%	1,445	1,047	65%	555	35%	1,602	0.90%	-5.40%
Total		**8,702**	**49.80%**	**8,776**	**50.20%**	**17,478**	**5,928**	**36%**	**10,587**	**64%**	**16,515**	**2.80%**	**-1.30%**
Camana	Camana	14,642	1%	116	99%	14,758	13,284	94%	809	6%	14,093	0.70%	-13.00%
	Nicolas de Pierola	5,362	88%	703	12%	6,065	4,688	88%	613	12%	5,301	1.00%	1.00%
	Mariscal Caceres	4,705	86%	758	14%	5,463	2,562	67%	1,253	33%	3,815	4.40%	-3.50%
	Samuel Pastor	12,004	91%	1,138	9%	13,142	2,285	26%	6,501	74%	8,786	12.60%	-11.70%
	Jose Maria Quimper	3,609	76%	1,138	24%	4,747	2,426	74%	870	26%	3,296	2.90%	1.90%
Total		**40,322**	**91.30%**	**3,853**	**8.70%**	**44,175**	**25,245**	**72%**	**10,046**	**28%**	**35,291**	**3.40%**	**-6.60%**

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 and 1993 Population and Housing Census.

Table 3.1.2-35-36 shows the number of households and members per home in 2007. Apparently Huancarqui has fewer members per household (3.36 persons) while Jose Maria

Quimper has a greater number with 4.4; remaining districts vary between 3.6 and 4.1 persons.

The number of members per family is around 4,1 persons, with exception of Nuevo Imperial, with a lower Figure of 3.77.

Table 3.1.2-35 Number of households and families in Castilla

Variables	District		
	Uraca	Aplao	Huancarqui
Population (inhabitants)	7,182	8,851	1,445
Number of households	1,760	2,333	430
Number of families	1,887	2,416	434
Members per household (persons/household)	4.08	3.79	3.36
Members per family (persons/family)	3.81	3.66	3.33

Table 3.1.2-36 Number of households and families in Camana

Variables	District				
	Camana	Nicolas de Pierola	Mariscal Caceres	Samuel Pastor	Jose Maria Quimper
Population (inhabitants)	14,758	6,065	5,463	13,142	4,747
Number of households	3,845	1,680	1,394	3,426	1,078
Number of families	4,066	1,738	1,448	3,554	1,108
Members per household (persons/househol	3.84	3.61	3.92	3.84	4.4
Members per family (persons/family)	3.63	3.49	3.77	3.7	4.28

3)Occupation

Table 3.1.2-37, shows occupation lists of local inhabitants itemized by sector.

It highlights the primary sector in all districts representing between 23 and 65% of the economically active population (EAP).

Table 3.1.2-37 Occupation in Castilla

EAP	Uraca		Aplao		Huancarqui	
	persons	%	Persons	%	Persons	%
Economically Active Pop. 1/	3,343	100	3,618	100	649	100
a) Primary sector	2,174	65.03	1,966	54.34	413	63.64
b) Secondary sector	160	4.79	251	6.94	40	6.16
c) Tertiary sector	1,009	30.18	1,401	38.72	196	30.2

Source: National Institute of Statistics - INEI, 2007 Population and Housing Census.

1/ Primary sector: agriculture, livestock, forest and fishery; secondary: mining, construction, manufacturing; tertiary: services and others

Table 3.1.2-38 Occupation in Camana

PEA	District									
	Samuel Pastor		Camana		Jose Maria Quimper		Mariscal Cáceres		Nicolas de Pierola	
	persons	%	persons	%	persons	%	persons	%	persons	%
Economically Active Pop. 1/	5,237	100	6,292	100	1,463	100	1,888	100	2,348	100
a) Primary sector	1,749	33	1,469	23	548	37	1,181	63	1,125	48
b) Secondary sector	624	12	473	8	127	9	88	5	167	7
c) Tertiary sector	2,864	55	4,350	69	788	54	619	33	1,056	45

Source: National Institute of Statistics –INEI, 2007 Population and Housing.

1/ Primary sector: agriculture, livestock, forest and fishery; secondary: mining, construction, manufacturing; tertiary: services and others

4)Poverty index

Table 3.1.2-39, -40 shows the poverty index. 25 % to 27 % of the districts' population belongs to the poor segment, and 3.8% to 4.4% belong to extreme poverty. Particularly, the Huancarqui district stands out for its high poverty percentage with 33.1%, and 6.9% of extreme poverty.

Table 3.1.2-39 Poverty index in Castilla

Variable /Indicator	District (Castilla)							
	Aplao		Huancarqui		Uraca		Total	
	Persons	%	Persons	%	Persons	%	Persons	%
Total Population (inhab.)	8,851		1,445		7,182		17,478.00	100
Poor	2,153	24.3	480	33.1	1,731	24.1	4,364	25
Extreme Poverty	358	4.1	98	6.9	305	4.3	761	4.4

Table 3.1.2-40 Poverty index in Camana

Variable /Indicator	District (Canana)											
	Mariscal Caceres		Samuel pastor		Nicolas de Pierola		Jose Maria Quimper		Camana		Total	
	Persons	%	Persons	%	Persons	%	Persons	%	Persons	%	Persons	%
Total Population (inhab)	5,463		13,142		6,065.00		4,747.00		14,758.00		44,175.00	100
Poor	1,927	35.2	4,410.00	33.5	1,494.00	24.6	979	24.9	3,013.00	20.4	11,823	26.8
Extreme Poverty	391	7.4	629	4.9	221	3.8	140	3.7	303	2.1	1,684	3.8

5)Type of housing

Tables 3-1.2-41 and 3-1.2-42 show data on Castilla and Camana housing. The walls of the houses in Castilla are made 46% of bricks or cement, and 43% of adobe and mud. The floor is made 96% of earth or cement. The public drinking water service covers 50%, while the sewage service is scarcely 45,5% in Huancarqui. The average electrification rate is 86%.

In Camana, walls are made 65% bricks or cement, and 4% with adobe and mud. The floor is made of 98% earth or cement. The public drinking water service covers more than 50% while the sewage service is less than 50%, with exception of Camana. The average electrification rate is 84%.

Table 3.1.2-41 Type of housing in Castilla

Variable/Indicator	Districts					
	Uraca		Aplao		Huancarqui	
	Households	%	Households	%	Households	%
Number of Households						
Common houses with residents	1,760	86	2,333	75.3	430	63
Wall material						
Brick or cement	999	56.8	820	35.1	106	24.7
Adobe and mud	195	11.1	1,067	45.7	237	55.1
With walls of quincha and wood	521	29.6	332	14.2	78	18.1
Other	45	2.6	114	4.9	9	2.1
Floor material						
Earth	687	39	831	35.6	195	45.3
Cement	996	56.6	1,381	59.2	226	52.6
Tile, terrazzo tile, parquet or polished wood, wood, boards	71	4	106	4.5	7	1.6
Other	6	0.3	15	0.6	2	0.5
Drinking water system						
Public service in the house	1,216	69.1	1,483	63.6	255	59.3
Public service out of the house but within the building	86	4.9	228	9.8	20	4.7
Public sink	115	6.5	34	1.5		
Sewage and latrine service						
Public sewage service in the house	472	26.8	705	30.2	193	44.9
Public sewage service within the building	26	1.5	58	2.5	4	0.9
Cesspit/ latrine	753	42.8	875	37.5	153	35.6
Houses with lighting system						
Public network	1,505	85.5	1,790	76.7	340	79.1
HOUSEHOLD						
Households in special houses with present occupants	**1,887**	**100**	**2,416**	**100**	**434**	**100**
Head of household						
Man	1,477	78.3	1,839	76.1	335	77.2
Woman	410	21.7	577	23.9	99	22.8
Home appliances						
Has three or more home appliances or equipment	541	28.7	683	28.3	113	26
Information and communication service						
Has landline telephone or mobile	1,353	71.7	1,301	53.8	242	55.8

Source: Prepared by JICA Study Team, Statistics National Institute- INEI, 2007 Population and Housing Census

Table 3.1.2-42 Type of housing in Camana

Variable/Indicador	Samuel Pastor		Camana		Jose Maria Quimper		Mariscal Caceres		Nicolas d
	Households	%	Households	%	Households	%	Households	%	Households
Number of Households									
Common houses with residents	3,426	69.7	3,845	90.7	1,078	74.7	1,394	70	1,680
Wall material									
Brick or cement	1,956	57.1	2,942	76.5	674	62.5	664	47.6	986
Adobe and mud	66	1.9	175	4.6	20	1.9	28	2	78
With walls of quincha and wood	716	20.9	427	11.1	226	21	172	12.3	419
Other	688	20.1	301	7.8	158	14.7	530	38	197
Floor material									
Earth	1,780	52	961	25	487	45.2	841	60.3	792
Cement	1,432	41.8	2,335	60.7	547	50.7	530	38	806
Tile, terrazzo tile, parquet or polished wood, wood, boards	154	4.5	514	13.4	38	3.5	16	1.1	70
Other	60	1.8	35	0.9	6	0.6	7	0.5	12
Drinking water system									
Public service in the house	1,987	58	3,028	78.8	732	67.9	774	55.5	957
Public service out of the house but within the building	231	6.7	236	6.1	108	10	160	11.5	323
Public sink	851	24.8	164	4.3	13	1.2	9	0.6	57
Sewage and latrine service									
Public sewage service in the house	1,466	42.8	2,816	73.2	181	16.8	243	17.4	778
Public sewage service within the building	104	3	246	6.4	24	2.2	5	0.4	208
Cesspit/latrine	1,144	33.4	360	9.4	526	48.8	763	54.7	463
Houses with lighting system									
Public network	2,734	79.8	3,556	92.5	935	86.7	1,017	73	1,284
HOUSEHOLD									
Households in special houses with present occupants	**3,554**	**100**	**4,066**	**100**	**1,108**	**100**	**1,448**	**100**	**1,738**
Home appliances									
Has three or more home appliances or equipment	997	28.1	1,902	46.8	360	32.5	304	21	524
Information and communication service									
Has landline telephone or mobile	2,297	64.6	3,586	88.2	790	71.3	654	45.2	1,073

Source: Prepared by JICA Study Team, Statistics National Institute–INEI, 2007 Population and Housing Census.

3.1.3 Agriculture

Next is a summarized report on the current situation of agriculture in the Watershed of the Chincha River, including irrigation commissions, crops, planted area, performance, sales, etc.

(1) Chira River

1)Irrigation Sectors

Table 3.1.3-1 shows basic data on the irrigation commissions. In the Chira River Watershed there are 6 irrigation sectors, 6 irrigation commissions with 18,796 beneficiaries. The surface managed by these sectors reaches a total of 48,676 hectares.

Table 3.1.3-1 Basic data of the irrigation commissions

Irrigation Sectors	Irrigation Commissions	Areas under irrigation		Nº of Beneficiaries (People)	River
		ha	%		
Miguel Checa	Miguel Checa	12.701	26 %	8.499	Chira
El Arenal	El Arenal	3.608	7 %	2.045	
Poechos - Pelados	Poechos - Pelados	4.433	9 %	1.719	
Cieneguillo	Cieneguillo	6.859	14 %	1.451	
Margen Derecha	Margen Derecha	12.415	26 %	3.755	
Margen Izquierda	Margen Izquierda	8.660	18 %	1.327	
Total		**48.676**	**100 %**	**18.796**	

Source: Prepared by JICA Study Team, Users Board of Yauca, October 2010

2)Main crops

Table 3.1.3-2 shows the variation between 2005 and 2010 of the planted surface and the performance of main crops.

In the Chira River Watershed, the main products would have been bananas and lime. However, in 2009 sugar cane production began in order to produce ethanol, which sales exceeded lime sales in 2009-2010.

The sowing area and sales vary depending on the year.

Table 3.1.3-3 Sowing and sales of main crops

	Variables	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	Total
Rice	Planted Area (ha)	16,769	21,943	23,921	22,226	19,973	**104,832**
	Unit Performance (kg/Ha)	9,882	9,764	9,785	9,588	9,753	
	Harvest (Kg)	165,711,258	214,251,452	234,066,985	213,102,888	194,796,669	**1,021,929,252**
	Unit Price (S/./kg)	0.81	0.93	1.12	0.76	0.81	
	Sales (S/.)	134,226,119	199,253,850	262,155,023	161,958,195	157,785,302	**915,378,489**
Banana	Planted Area (ha)	4,595	5,280	5,096	5,096	5,096	**25,163**
	Unit Performance (kg/Ha)	44,406	41,787	41,608	42,453	43,984	
	Harvest (Kg)	204,045,570	220,635,360	212,034,368	216,340,488	224,142,464	**1,077,198,250**
	Unit Price (S/./kg)	0.40	0.55	0.63	0.67	0.63	
	Sales (S/.)	81,618,228	121,349,448	133,581,652	144,948,127	141,209,752	**622,707,207**
Sugar Cane	Planted Area (ha)				565	5,482	**6,047**
	Unit Performance (kg/Ha)				138,969	139,859	
	Harvest (Kg)				78,517,485	766,707,038	**845,224,523**
	Unit Price (S/./kg)				0.07	0.07	
	Sales (S/.)				5,496,224	53,669,493	**59,165,717**
Lime	Planted Area (ha)	3,146	1,932	1,932	1,932	1,932	**10,874**
	Unit Performance (kg/Ha)	31,856	42,425	38,238	31,034	31,500	
	Harvest (Kg)	100,218,976	81,965,100	73,875,816	59,957,688	60,858,000	**376,875,580**
	Unit Price (S/./kg)	0.36	0.43	0.64	0.46	0.58	
	Sales (S/.)	36,078,831	35,244,993	47,280,522	27,580,536	35,297,640	**181,482,523**
Corn	Planted Area (ha)	1,156	1,472	1,677	1,255	1,069	**6,629**
	Unit Performance (kg/Ha)	5,216	5,177	5,266	5,320	5,141	
	Harvest (Kg)	6,029,696	7,620,544	8,831,082	6,676,600	5,495,729	**34,653,651**
	Unit Price (S/./kg)	0.55	0.77	0.76	0.78	0.85	
	Sales (S/.)	3,316,333	5,867,819	6,711,622	5,207,748	4,671,370	**25,774,892**
Mango	Planted Area (ha)	537	646	646	646	610	**3,085**
	Unit Performance (kg/Ha)	25,000	28,855	26,550	26,570	28,292	
	Harvest (Kg)	13,425,000	18,640,330	17,151,300	17,164,220	17,258,120	**83,638,970**
	Unit Price (S/./kg)	0.42	0.29	0.71	0.65	0.44	
	Sales (S/.)	5,638,500	5,405,696	12,177,423	11,156,743	7,593,573	**41,971,935**
Legumes	Planted Area (ha)	366	674	279	303	272	**1,894**
	Unit Performance (kg/Ha)	1,399	1,480	1,743	1,780	1,589	
	Harvest (Kg)	512,034	997,520	486,297	539,340	432,208	**2,967,399**
	Unit Price (S/./kg)	1.77	1.87	1.98	2.04	2.00	
	Sales (S/.)	906,300	1,865,362	962,868	1,100,254	864,416	**5,699,200**
Pastures	Planted Area (ha)	67	372	254	309	191	**1,193**
	Unit Performance (kg/Ha)	7,313	7,363	6,996	7,010	7,543	
	Harvest (Kg)	489,971	2,739,036	1,776,984	2,166,090	1,440,713	**8,612,794**
	Unit Price (S/./kg)	0.64	0.68	0.80	0.84	0.82	
	Sales (S/.)	313,581	1,862,544	1,421,587	1,819,516	1,181,385	**6,598,613**
Pastos	Planted Area (ha)	319	183	181	181	166	**1,030**
	Unit Performance (kg/Ha)	45,824	57,169	46,442	77,790	75,268	
	Harvest (Kg)	14,617,856	10,461,927	8,406,002	14,079,990	12,494,488	**60,060,263**
	Unit Price (S/./kg)	0.15	0.19	0.15	0.20	0.20	
	Sales (S/.)	2,192,678	1,987,766	1,260,900	2,815,998	2,498,898	**10,756,240**
Prunes	Planted Area (ha)	160	160	160	160	160	**800**
	Unit Performance (kg/Ha)	3,519	3,056	3,131	2,867	3,667	
	Harvest (Kg)	563,040	488,960	500,960	458,720	586,720	**2,598,400**
	Unit Price (S/./kg)	0.40	0.35	0.33	0.49	0.44	
	Sales (S/.)	225,216	171,136	165,317	224,773	258,157	**1,044,598**
Others	Planted Area (ha)	4,013	3,004	3,129	2,851	2,886	15,883
Total	Planted Area (ha)	31,128	35,666	37,275	35,524	37,837	177,430
	Harvest (Kg)	505,613,401	557,800,229	557,129,794	609,003,509	1,284,212,149	3,513,759,082
	Sales (S/.)	264,515,787	373,008,615	465,716,915	362,308,113	405,029,984	1,870,579,415

	Variables	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	Total
Arroz	Sup. sembrada (ha)	16,769	21,943	23,921	22,226	19,973	**104,832**
	Rendimiento unitario (kg/Ha)	9,882	9,764	9,785	9,588	9,753	
	Cosecha (Kg)	165,711,258	214,251,452	234,066,985	213,102,888	194,796,669	**1,021,929,252**
	Precio unitario (S/./kg)	0.81	0.93	1.12	0.76	0.81	
	Ventas (S/.)	134,226,119	199,253,850	262,155,023	161,958,195	157,785,302	**915,378,489**
Banano	Sup. sembrada (ha)	4,595	5,280	5,096	5,096	5,096	**25,163**
	Rendimiento unitario (kg/Ha)	44,406	41,787	41,608	42,453	43,984	
	Cosecha (Kg)	204,045,570	220,635,360	212,034,368	216,340,488	224,142,464	**1,077,198,250**
	Precio unitario (S/./kg)	0.40	0.55	0.63	0.67	0.63	
	Ventas (S/.)	81,618,228	121,349,448	133,581,652	144,948,127	141,209,752	**622,707,207**
Caña de azúcar	Sup. sembrada (ha)				565	5,482	**6,047**
	Rendimiento unitario (kg/Ha)				138,969	139,859	
	Cosecha (Kg)				78,517,485	766,707,038	**845,224,523**
	Precio unitario (S/./kg)				0.07	0.07	
	Ventas (S/.)				5,496,224	53,669,493	**59,165,717**
Limón	Sup. sembrada (ha)	3,146	1,932	1,932	1,932	1,932	**10,874**
	Rendimiento unitario (kg/Ha)	31,856	42,425	38,238	31,034	31,500	
	Cosecha (Kg)	100,218,976	81,965,100	73,875,816	59,957,688	60,858,000	**376,875,580**
	Precio unitario (S/./kg)	0.36	0.43	0.64	0.46	0.58	
	Ventas (S/.)	36,078,831	35,244,993	47,280,522	27,580,536	35,297,640	**181,482,523**
Maíz	Sup. sembrada (ha)	1,156	1,472	1,677	1,255	1,069	**6,629**
	Rendimiento unitario (kg/Ha)	5,216	5,177	5,266	5,320	5,141	
	Cosecha (Kg)	6,029,696	7,620,544	8,831,082	6,676,600	5,495,729	**34,653,651**
	Precio unitario (S/./kg)	0.55	0.77	0.76	0.78	0.85	
	Ventas (S/.)	3,316,333	5,867,819	6,711,622	5,207,748	4,671,370	**25,774,892**
Mango	Sup. sembrada (ha)	537	646	646	646	610	**3,085**
	Rendimiento unitario (kg/Ha)	25,000	28,855	26,550	26,570	28,292	
	Cosecha (Kg)	13,425,000	18,640,330	17,151,300	17,164,220	17,258,120	**83,638,970**
	Precio unitario (S/./kg)	0.42	0.29	0.71	0.65	0.44	
	Ventas (S/.)	5,638,500	5,405,696	12,177,423	11,156,743	7,593,573	**41,971,935**
Legumbre	Sup. sembrada (ha)	366	674	279	303	272	**1,894**
	Rendimiento unitario (kg/Ha)	1,399	1,480	1,743	1,780	1,589	
	Cosecha (Kg)	512,034	997,520	486,297	539,340	432,208	**2,967,399**
	Precio unitario (S/./kg)	1.77	1.87	1.98	2.04	2.00	
	Ventas (S/.)	906,300	1,865,362	962,868	1,100,254	864,416	**5,699,200**
Maíz	Sup. sembrada (ha)	67	372	254	309	191	**1,193**
	Rendimiento unitario (kg/Ha)	7,313	7,363	6,996	7,010	7,543	
	Cosecha (Kg)	489,971	2,739,036	1,776,984	2,166,090	1,440,713	**8,612,794**
	Precio unitario (S/./kg)	0.64	0.68	0.80	0.84	0.82	
	Ventas (S/.)	313,581	1,862,544	1,421,587	1,819,516	1,181,385	**6,598,613**
Pastos	Sup. sembrada (ha)	319	183	181	181	166	**1,030**
	Rendimiento unitario (kg/Ha)	45,824	57,169	46,442	77,790	75,268	
	Cosecha (Kg)	14,617,856	10,461,927	8,406,002	14,079,990	12,494,488	**60,060,263**
	Precio unitario (S/./kg)	0.15	0.19	0.15	0.20	0.20	
	Ventas (S/.)	2,192,678	1,987,766	1,260,900	2,815,998	2,498,898	**10,756,240**
Ciruelas	Sup. sembrada (ha)	160	160	160	160	160	**800**
	Rendimiento unitario (kg/Ha)	3,519	3,056	3,131	2,867	3,667	
	Cosecha (Kg)	563,040	488,960	500,960	458,720	586,720	**2,598,400**
	Precio unitario (S/./kg)	0.40	0.35	0.33	0.49	0.44	
	Ventas (S/.)	225,216	171,136	165,317	224,773	258,157	**1,044,598**
Otros	Sup. sembrada (ha)	4,013	3,004	3,129	2,851	2,886	15,883
Total	Sup. sembrada (ha)	31,128	35,666	37,275	35,524	37,837	177,430
	Cosecha (Kg)	505,613,401	557,800,229	557,129,794	609,003,509	1,284,212,149	3,513,759,082
	Ventas (S/.)	264,515,787	373,008,615	465,716,915	362,308,113	405,029,984	1,870,579,415

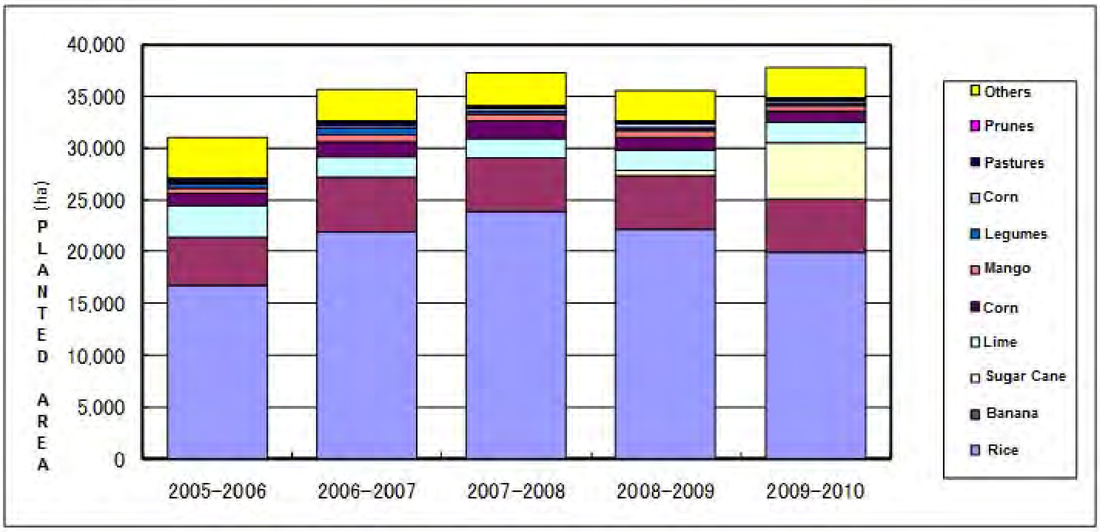


Figure 3.1.3-1 Planted Surface

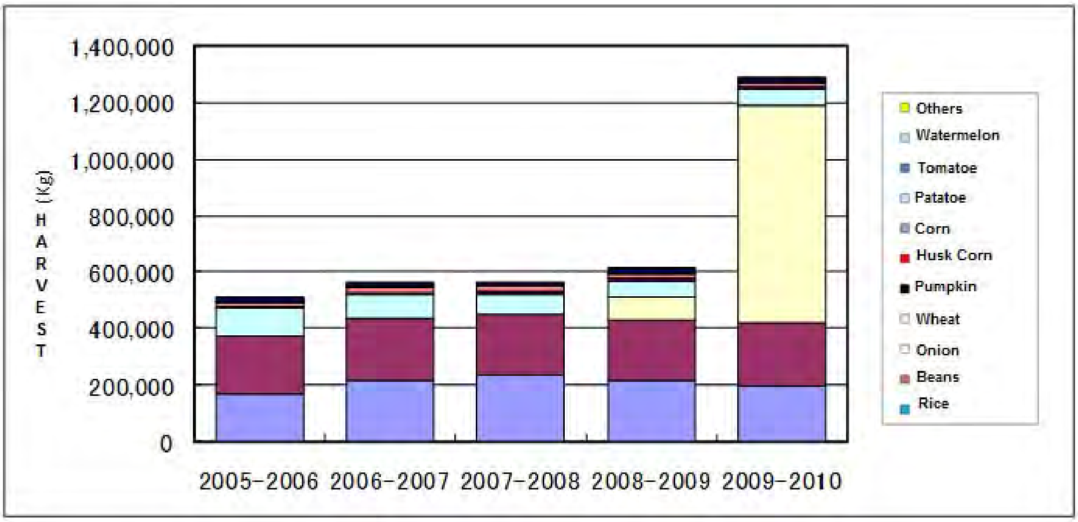


Figure 3.1.3-2 Harvest

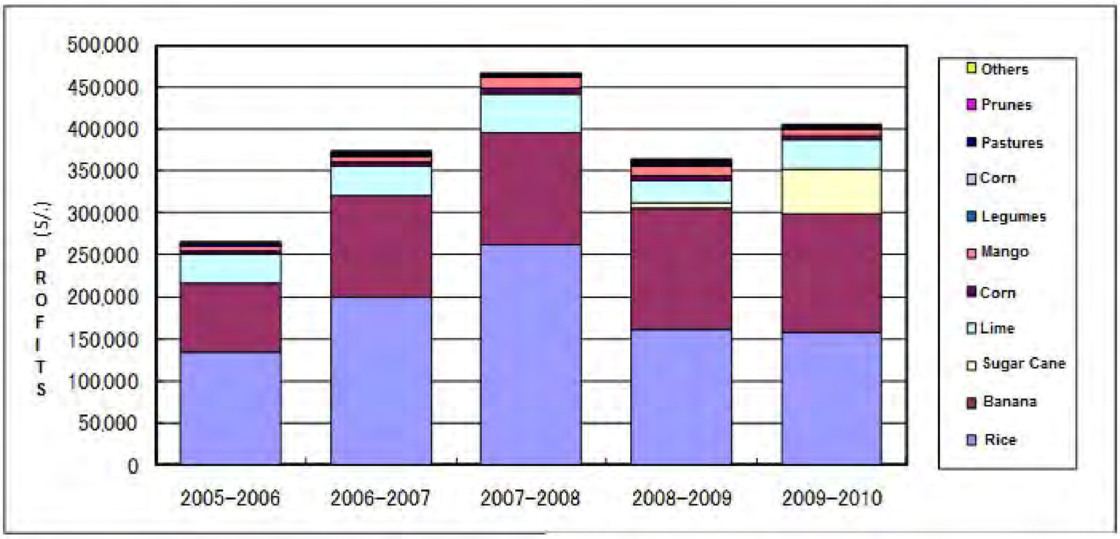


Figure 3.1.3-3 Sales

(2) Cañete River

1)Irrigation Sectors

Table 3.1.3-4 shows basic data on the irrigation commissions. In the Cañete River Watershed there are 42 irrigation sectors, 7 irrigation commissions with 22,242 beneficiaries. The surface managed by these sectors reach a total of 5,843 hectares.

Table 3.1.3-4 Basic data of the irrigation commissions

Irrigation Sectors	Irrigation Commissions	Areas under irrigation		Nº of Beneficiaries (People)	River
		ha	%		
Roma Rinconada. La Huerta	Canal Nuevo Imperial	7.883	35	2.202	Cañete
Lateral A					
Cantera Almenares					
Lateral B					
Lateral T					
Túnel Grande					
Quebrada Ihuanca					
Cantagallo-U Campesina					
Caltopa Caltopilla					
Casa Pintada Sn Isidro	Canal Viejo Imperial	3.715	17	1.080	
Cerro Alegre Huaca Chivato					
Conde Chico Ungara					
Josefina Sta. Gliceria					
Tres Cerros	Canal María Angola	1.785	8	470	
Montejato					
La Quebrada					
Hualcara					
Cerro de Oro					
Chilcal					
Montalván-Arona-La Qda.-Tupac	Canal San Miguel	3.627	16	860	
Lúcumo - Cuiva - Don Germán					
Lateral 74-La Melliza-Sta Bárbara					
Casa Blanca - Los Lobos					
Lúcumo - Cuiva - Don Germán	Canal Huanca	2.301	10	421	
Huanca Media					
Huanca Baja					
Huanca Alta					
Gr.9.2 lateral 4	Canal Pachacamilla	928	4	234	
Gr.9.1 lateral 3					
Gr.8.2 lateral 2					
Gr.8.1 lateral 1					
Gr.7 compuerta 10 Y 11					
Gr.6 compuerta 9					
Gr.5 compuerta 6,7 Y 8					
Gr.4 compuerta 5					
Gr.3 compuerta 4 Y 12					
Gr.2 compuerta 2 Y 3					
Gr.11 Basombrio					
Gr.10 Pachacamilla Vieja					
Gr.1 compuerta 1					
Palo	Canal Palo Herbay	2.003	9	576	
Herbay Alto					
Total		**22.242**	**100**	**5.843**	

Source: Prepared by JICA Study Team, Users Board of Camana-Majes, September 2011

2)Main crops

Table 3.1.3-5 shows the variation between 2004 and 2009 of the planted surface and the performance of main crops.

In the Cañete River Watershed, in 2005 and 2007 the planted area, performance and sales decreased, but later increased so that during the period of 2009 levels of 2004-2005 were recovered. The profits of 2008-2009 were of S/.219,095,280. Main crops in this watershed were represented by: corn, cotton, beets, grapes and fresh corn.

Table 3.1.3-5 Sowing and sales of main crops

	Variables	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Corn (yellow)	Planted Area (ha)	10,700	9,203	7,802	11,285	12,188
	Unit performance (kg/Ha)	8,225	8,278	8,591	8,711	8,411
	Harvest (Kg)	88,010,215	76,182,249	67,023,861	98,302,605	102,512,719
	Unit Price (S/./kg)	0.53	0.57	0.69	0.80	0.69
	Sales (S/.)	46,645,414	43,423,882	46,246,464	78,642,084	70,733,776
Cotton	Planted Area (ha)	6,750	6,241	4,146	4,887	1,697
	Unit performance (kg/Ha)	3,015	3,290	3,295	3,502	3,448
	Harvest (Kg)	20,350,647	20,533,219	13,662,388	17,112,523	5,850,911
	Unit Price (S/./kg)	2.14	2.13	2.77	2.67	1.85
	Sales (S/.)	43,550,385	43,735,756	37,844,815	45,690,436	10,824,186
Beets	Planted Area (ha)	2,794	1,804	2,823	1,475	3,855
	Unit performance (kg/Ha)	24,367	24,434	18,953	21,768	20,088
	Harvest (Kg)	68,088,708	44,081,379	53,500,528	32,112,154	77,429,196
	Unit Price (S/./kg)	0.24	0.33	0.45	0.58	0.37
	Sales (S/.)	16,341,290	14,546,855	24,075,238	18,625,049	28,648,803
Grapes	Planted Area (ha)	1,725	1,898	1,780	2,100	2,247
	Unit performance (kg/Ha)	14,891	15,735	17,928	19,088	18,702
	Harvest (Kg)	25,685,486	29,857,163	31,911,840	40,077,165	42,023,394
	Unit Price (S/./kg)	0.62	0.84	1.12	1.11	0.99
	Sales (S/.)	15,925,001	25,080,017	35,741,261	44,485,653	41,603,160
Corn	Planted Area (ha)	2,617	2,602	2,453	2,796	2,563
	Unit performance (kg/Ha)	47,095	47,125	48,377	54,848	52,276
	Harvest (Kg)	123,224,068	122,623,963	118,683,294	153,333,069	133,957,250
	Unit Price (S/./kg)	0.07	0.07	0.08	0.10	0.10
	Sales (S/.)	8,625,685	8,583,677	9,494,664	15,333,307	13,395,725
Tangerine	Planted Area (ha)	932	941	814	1,077	1,087
	Unit performance (kg/Ha)	38,670	41,261	42,913	43,596	SD
	Harvest (Kg)	36,032,706	38,818,349	34,944,056	46,957,252	
	Unit Price (S/./kg)	0.74	0.64	0.79	0.67	1.19
	Sales (S/.)	26,664,202	24,843,743	27,605,804	31,461,359	
Apples	Planted Area (ha)	769	802	752	865	833
	Unit performance (kg/Ha)	20,459	21,884	21,717	22,175	25,526
	Harvest (Kg)	15,726,833	17,540,026	16,329,012	19,185,810	21,270,816
	Unit Price (S/./kg)	0.52	0.63	0.63	0.75	0.75
	Sales (S/.)	8,177,953	11,050,216	10,287,278	14,389,358	15,953,112
Potatoes	Planted Area (ha)	1,161	739	772	878	1,053
	Unit performance (kg/Ha)	24,700	25,216	23,717	26,687	24,386
	Harvest (Kg)	28,681,640	18,637,146	18,302,409	23,420,511	25,676,019
	Unit Price (S/./kg)	0.37	0.44	0.35	0.74	0.43
	Sales (S/.)	10,612,207	8,200,344	6,405,843	17,331,178	11,040,688
Yucca	Planted Area (ha)	686	1,030	671	717	981
	Unit performance (kg/Ha)	33,162	33,594	32,856	36,007	37,963
	Harvest (Kg)	22,732,551	34,605,179	22,056,233	25,817,019	37,241,703
	Unit Price (S/./kg)	0.36	0.36	0.42	0.67	0.42
	Sales (S/.)	8,183,718	12,457,865	9,263,618	17,297,403	15,641,515
Avocado	Planted Area (ha)	306	411	403	662	765
	Unit performance (kg/Ha)	5,844	6,064	8,162	5,424	6,129
	Harvest (Kg)	1,790,602	2,494,123	3,285,205	3,589,603	4,689,298
	Unit Price (S/./kg)	2.69	3.02	2.54	2.66	2.40
	Sales (S/.)	4,816,718	7,532,252	8,344,421	9,548,345	11,254,315
Others	Planted Area (ha)	3,947	4,839	4,223	5,281	5,296

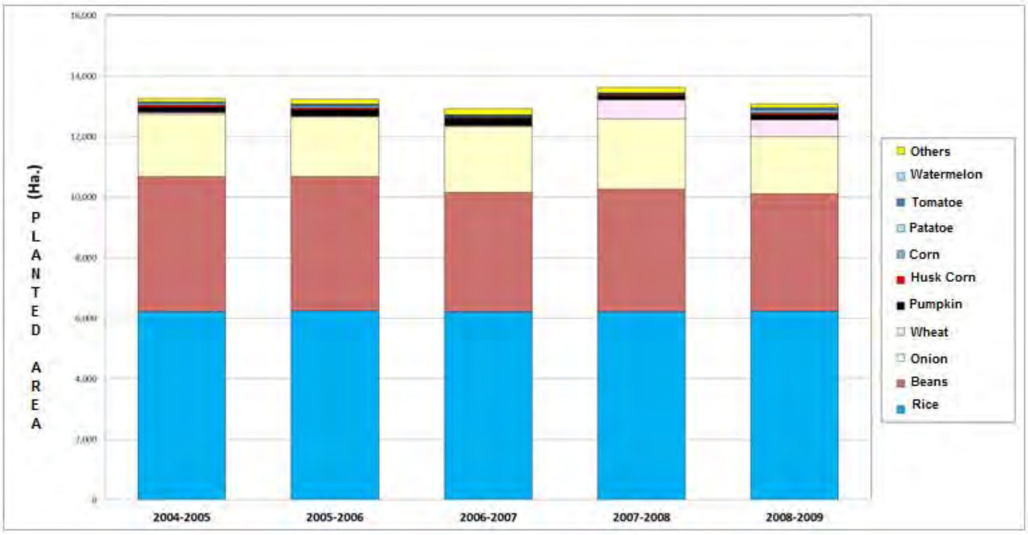


Figure 3.1.3-4 Planted Surface

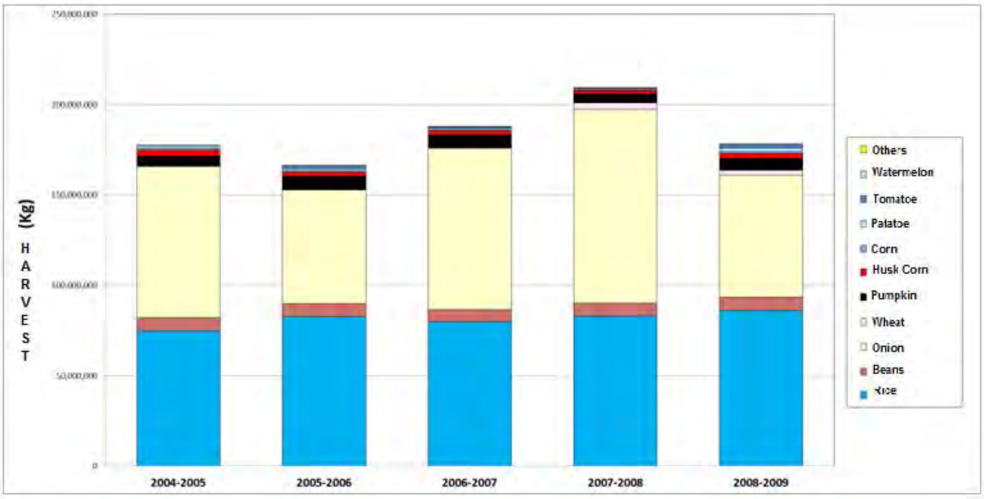


Figure 3.1.3-5 Harvest

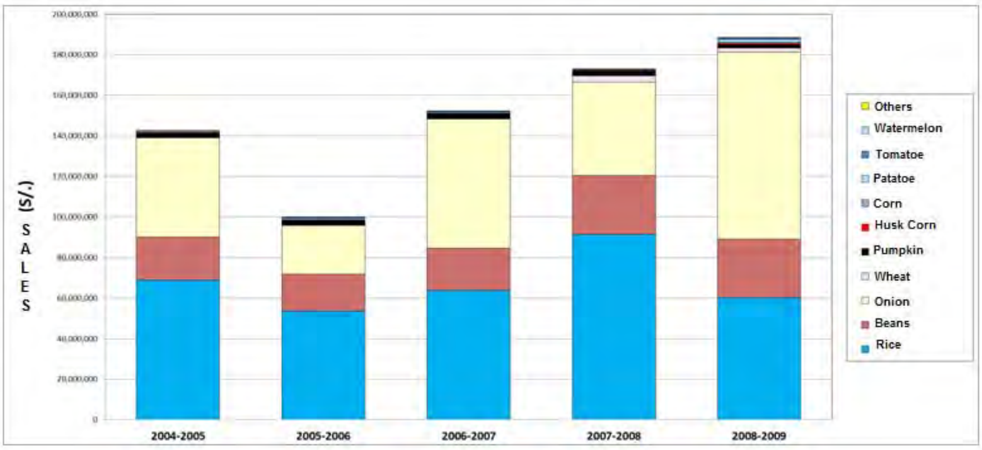


Figure 3.1.3-6 Sales

(3) Chincha River

1) Irrigation Sectors

Table 3.1.3-6 shows basic data on the irrigation commissions. In the Watersheds of Matagente and Chico Rivers there are 3 irrigation sectors, 14 irrigation commissions with 7,676 beneficiaries. The surface managed by these sectors reaches a total of 25,629 hectares.

Table 3.1.3-6 Basic data of the irrigation commissions

Irrigation Sectors	Irrigation Commissions	Areas under irrigation		Nº of Beneficiaries (Person)	River
		ha	%		
La Pampa	Chochocota	1.624	6 %	277	Matagente
	Belen	1.352	5 %	230	Matagente
	San Regis	1.557	6 %	283	Matagente
	Pampa Baja	4.124	16 %	596	Matagente
Chincha Baja	Matagente	2.609	10 %	421	Matagente
	Chillon	2.258	9 %	423	Matagente
	Rio Viejo	2.054	8 %	367	Matagente
	Chincha Baja	1.793	7 %	351	Matagente
Chincha Alta	Rio Chico	475	2 %	106	Chico
	Cauce Principal	1.644	6 %	456	Chico
	Pilpa	218	1 %	573	Chico
	Ñoco	1.227	5 %	1.428	Chico
	Aceqia Grande	1.077	4 %	1.520	Chico
	Irrigación Pampa de Ñoco	3.616	14 %	645	Chico
Total		**25.629**	100 %	**7.676**	

Source: Prepared by JICA Study Team, Users Board of Camana-Majes, September 2011

2)Main crops

Table 3.1.3-7 shows the variation between 2004 and 2009 of the planted surface and the performance of main crops.

In the Chincha River Watershed, is increasing as planted area, performance and sales decreased. In the period 2008-2009 profits were of S/.242,249,071. Main crops in this watershed were represented by: cotton, corn, grapes, artichokes and asparagus.

Table 3.1.3-7 Sowing and sales of main crops

	Variables	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Cotton	Planted Area (ha)	10,217	11,493	10,834	11,042	8,398
	Unit performance (kg/Ha)	2,829	2,634	2,664	2,515	2,386
	Harvest (Kg)	28,903,893	30,272,562	28,861,776	27,770,630	20,037,628
	Unit Price (S/./kg)	2.19	2.21	2.82	2.65	1.95
	Sales (S/.)	63,299,526	66,902,362	81,390,208	73,592,170	39,073,375
Corn (yellow)	Planted Area (ha)	3,410	3,631	3,918	4,190	5,148
	Unit performance (kg/Ha)	7,585	7,460	7,640	7,860	8,286
	Harvest (Kg)	25,864,850	27,087,260	29,933,520	32,933,400	42,656,328
	Unit Price (S/./kg)	0.62	0.64	0.80	0.94	0.76
	Sales (S/.)	16,036,207	17,335,846	23,946,816	30,957,396	32,418,809
Grapes	Planted Area (ha)	1,589	1,271	1,344	1,411	1,325
	Unit performance (kg/Ha)	14,420	16,658	13,137	17,029	17,720
	Harvest (Kg)	22,913,380	21,172,318	17,656,128	24,027,919	23,479,000
	Unit Price (S/./kg)	0.92	1.06	1.40	1.54	1.66
	Sales (S/.)	21,080,310	22,442,657	24,718,579	37,002,995	38,975,140
Artichoke	Planted Area (ha)	587	896	993	777	1,426
	Unit performance (kg/Ha)	16,595	18,445	19,525	18,768	18,300
	Harvest (Kg)	9,741,265	16,526,720	19,388,325	14,582,736	26,095,800
	Unit Price (S/./kg)	0.93	1.00	1.10	1.17	1.20
	Sales (S/.)	9,059,376	16,526,720	21,327,158	17,061,801	31,314,960
Asparagus	Planted Area (ha)	903	860	855	776	1,102
	Unit performance (kg/Ha)	6,725	9,892	8,036	7,713	9,343
	Harvest (Kg)	6,072,675	8,507,120	6,870,780	5,985,288	10,295,986
	Unit Price (S/./kg)	2.81	3.08	2.93	3.04	2.79
	Sales (S/.)	17,064,217	26,201,930	20,131,385	18,195,276	28,725,801
Alfalfa	Planted Area (ha)	574	578	651	651	776
	Unit performance (kg/Ha)	16,871	21,645	29,926	39,072	44,161
	Harvest (Kg)	9,683,954	12,510,810	19,481,826	25,435,872	34,268,936
	Unit Price (S/./kg)	0.23	0.23	0.36	0.39	0.40
	Sales (S/.)	2,227,309	2,877,486	7,013,457	9,919,990	13,707,574
Avocado	Planted Area (ha)	347	347	638	703	938
	Unit performance (kg/Ha)	7,268	9,772	9,036	12,221	11,853
	Harvest (Kg)	2,521,996	3,390,884	5,764,968	8,591,363	11,118,114
	Unit Price (S/./kg)	1.30	1.51	1.75	2.08	2.25
	Sales (S/.)	3,278,595	5,120,235	10,088,694	17,870,035	25,015,757
Beets	Planted Area (ha)	408	553	539	522	777
	Unit performance (kg/Ha)	20,134	20,195	19,076	16,856	18,153
	Harvest (Kg)	8,214,672	11,167,835	10,281,964	8,798,832	14,104,881
	Unit Price (S/./kg)	0.16	0.33	0.22	0.44	0.43
	Sales (S/.)	1,314,348	3,685,386	2,262,032	3,871,486	6,065,099
Pumpkin	Planted Area (ha)	346	603	437	444	522
	Unit performance (kg/Ha)	31,021	30,992	30,925	30,582	32,939
	Harvest (Kg)	10,733,266	18,688,176	13,514,225	13,578,408	17,194,158
	Unit Price (S/./kg)	0.38	0.49	0.41	0.56	0.29
	Sales (S/.)	4,078,641	9,157,206	5,540,832	7,603,908	4,986,306
Tangerine	Planted Area (ha)	360	401	405	427	594
	Unit performance (kg/Ha)	25,918	27,493	33,723	31,727	34,887
	Harvest (Kg)	9,330,480	11,024,693	13,657,815	13,547,429	20,722,878
	Unit Price (S/./kg)	0.51	0.52	0.76	0.81	1.06
	Sales (S/.)	4,758,545	5,732,840	10,379,939	10,973,417	21,966,251
Others	Planted Area (ha)	2,434	1,897	2,161	1,830	1,994
Total	Planted Area (ha)	21,175	22,530	22,775	22,773	23,000
	Harvest (Kg)	133,980,431	160,348,378	165,411,327	175,251,877	219,973,709
	Sales (S/.)	142,197,073	175,982,668	206,799,102	227,048,475	242,249,071

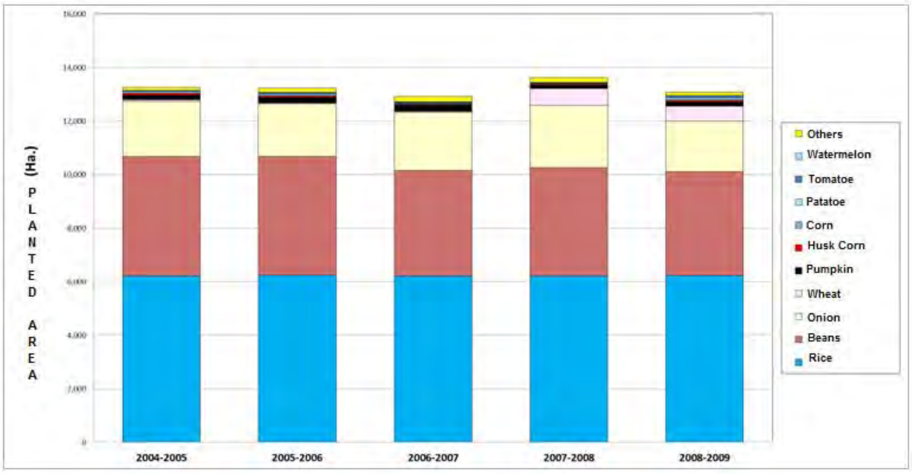


Figure 3.1.3-7 Planted Surface

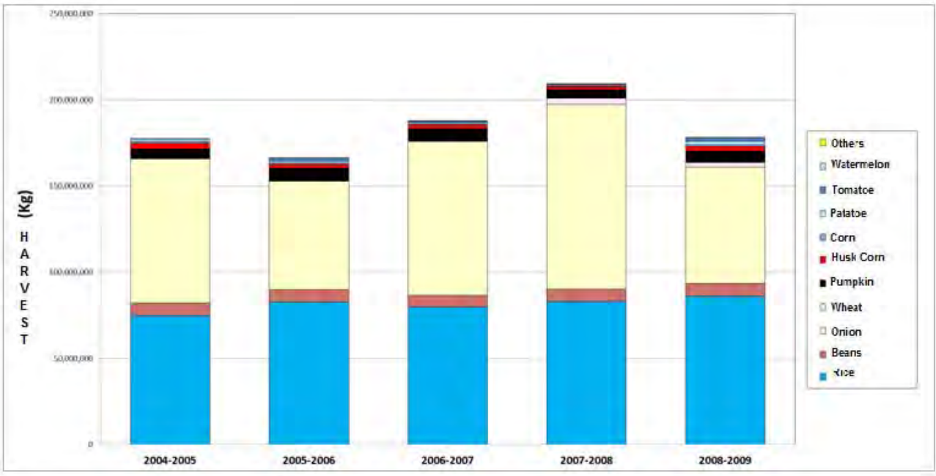


Figure 3.1.3-8 Harvest

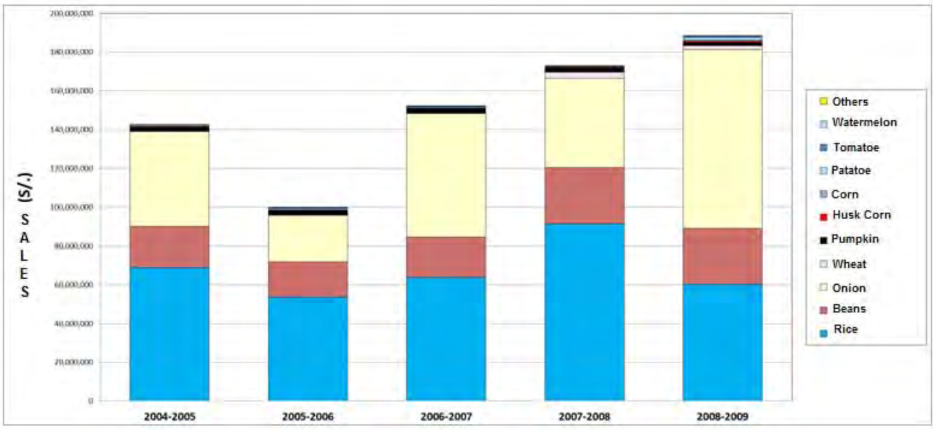


Figure 3.1.3-9 Sales

(4) Pisco River

1) Irrigation Sectors

Table 3.1.3-8 shows basic data on the irrigation commissions of the Pisco River. In the watershed of the Pisco River there are 19irrigation sectors, 6 irrigation commissions with 3,774 beneficiaries.

The surface managed by these sectors amounts 22,468 hectares.

Table 3.1.3-8 Basic data of the irrigation commissions

Irrigation Sectors	Irrigation Commissions	Areas under irrigation		Nº of Beneficiaries (People)	River
		ha	%		
Pisco	Casalla	2.276	10	513	Pisco
	El Pueblo Figueroa	756	3	138	
	Caucato	1.612	7	325	
	Chongos	453	2	74	
Independencia	Agua Santa - El Porvenir	469	2	63	
	Francia	931	4	126	
	Montalván	1.596	7	275	
	Manrique	1.555	7	288	
Chacarilla	Condor	1.970	9	315	
Dadelso					
Jose Olaya					
Mencia					
San Jacinto					
Urrutia					
Cabeza de Toro	Cabeza de Toro	6.123	27	633	
Murga	Murga - Casaconcha	1.383	6	273	
	La Floresta	303	1	51	
	Bernales	1.286	6	294	
	Miraflores	129	1	35	
	Chunchanga	460	2	75	
Humay	San Ignacio	333	1	56	
	Montesierpe	449	2	118	
	Pallasca Tambo Colorado	145	1	65	
	Huaya Letrayoc	238	1	57	
Total		**22.468**	**100**	**3.774**	

Source: Prepared by JICA Study Team, Users Board of Pisco, October 2011

2)Main crops

Table 3.1.3-9 shows the variation between 2004 and 2009 of the planted surface and the performance of main crops. In the Pisco River Watershed the planted area tends to be maintained or reduced due to crop surface reduction because of cotton. Instead of this, the area of alfalfa and corn (yellow) is increasing. The revenue was S/.132,512,157 in 2008-2009, which is the lousiest level reached in the last five years. This reduction is due mostly for the reduction of cotton crop and the low transaction price.
The main crops in this watershed are cotton, alfalfa and corn (yellow).

Table 3.1.3-9 Sowing and sales of main crops

	Variables	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Cotton	Planted Area (ha)	16,598	15,586	13,300	13,536	7,771
	Unit performance (kg/Ha)	2,123	1,923	2,104	2,209	2,166
	Harvest (Kg)	35,237,554	29,971,878	27,983,200	29,901,024	16,831,986
	Unit price (S/./kg)	2.13	2.18	2.81	2.76	1.95
	Sales (S/.)	75,055,990	65,338,694	78,632,792	82,526,826	32,822,373
Alfalfa	Planted Area (ha)	2,817	2,941	2,966	3,739	4,133
	Unit performance (kg/Ha)	31,965	29,626	30,485	24,078	25,770
	Harvest (Kg)	90,045,405	87,130,066	90,418,510	90,027,642	106,507,410
	Unit price (S/./kg)	0.10	0.10	0.10	0.10	0.10
	Sales (S/.)	9,004,541	8,713,007	9,041,851	9,002,764	10,650,741
Corn (yellow)	Planted Area (ha)	1,065	1,410	2,377	2,447	4,167
	Unit performance (kg/Ha)	7,289	6,960	8,197	8,665	8,262
	Harvest (Kg)	7,762,785	9,813,600	19,484,269	21,203,255	34,427,754
	Unit price (S/./kg)	0.60	0.63	0.77	0.85	0.73
	Sales (S/.)	4,657,671	6,182,568	15,002,887	18,022,767	25,132,260
Corn	Planted Area (ha)	813	2,188	1,272	1,605	2,088
	Unit performance (kg/Ha)	13,279	10,511	11,579	11,672	9,672
	Harvest (Kg)	10,795,827	22,998,068	14,728,488	18,733,560	20,195,136
	Unit price (S/./kg)	0.63	0.46	0.79	0.73	0.80
	Sales (S/.)	6,801,371	10,579,111	11,635,506	13,675,499	16,156,109
Asparagus	Planted Area (ha)	648	663	720	1,028	980
	Unit performance (kg/Ha)	6,654	7,231	6,491	4,375	4,788
	Harvest (Kg)	4,311,792	4,794,153	4,673,520	4,497,500	4,692,240
	Unit price (S/./kg)	3.13	3.02	3.65	2.65	2.79
	Sales (S/.)	13,495,909	14,478,342	17,058,348	11,918,375	13,091,350
Tangelo	Planted Area (ha)	311	331	367	367	367
	Unit performance (kg/Ha)	26,463	24,033	26,432	27,109	26,608
	Harvest (Kg)	8,229,993	7,954,923	9,700,544	9,949,003	9,765,136
	Unit price (S/./kg)	0.52	0.56	0.59	0.55	0.51
	Sales (S/.)	4,279,596	4,454,757	5,723,321	5,471,952	4,980,219
Paprika	Planted Area (ha)	223	354	461	310	209
	Unit performance (kg/Ha)	5,058	5,068	5,490	5,864	5,849
	Harvest (Kg)	1,127,934	1,794,072	2,530,890	1,817,840	1,222,441
	Unit price (S/./kg)	4.64	3.45	5.67	5.33	4.02
	Sales (S/.)	5,233,614	6,189,548	14,350,146	9,689,087	4,914,213
Tomatoe	Planted Area (ha)	306	349	307	258	293
	Unit performance (kg/Ha)	71,395	54,399	57,824	65,525	60,604
	Harvest (Kg)	21,846,870	18,985,251	17,751,968	16,905,450	17,756,972
	Unit price (S/./kg)	0.97	0.83	0.76	1.08	0.86
	Sales (S/.)	21,191,464	15,757,758	13,491,496	18,257,886	15,270,996
Grapes	Planted Area (ha)	136	174	192	218	230
	Unit performance (kg/Ha)	8,640	11,429	10,332	17,345	19,504
	Harvest (Kg)	1,175,040	1,988,646	1,983,744	3,781,210	4,485,920
	Unit price (S/./kg)	1.66	1.88	2.21	1.95	2.00
	Sales (S/.)	1,950,566	3,738,654	4,384,074	7,373,360	8,971,840
Lima beans	Planted Area (ha)	103	253	136	97	163
	Unit performance (kg/Ha)	1,055	1,062	1,230	1,212	1,020
	Harvest (Kg)	108,665	268,686	167,280	117,564	166,260
	Unit price (S/./kg)	3.34	2.80	2.95	3.65	3.14
	Sales (S/.)	362,941	752,321	493,476	429,109	522,056
Others	Planted Area (ha)	615	907	989	518	1,644
Total	Planted Area (ha)	23,635	25,156	23,087	24,123	22,045
	Harvest (Kg)	180,641,865	185,699,343	189,422,413	196,934,048	216,051,255
	Sales (S/.)	142,033,663	136,184,761	169,813,897	176,367,624	132,512,157

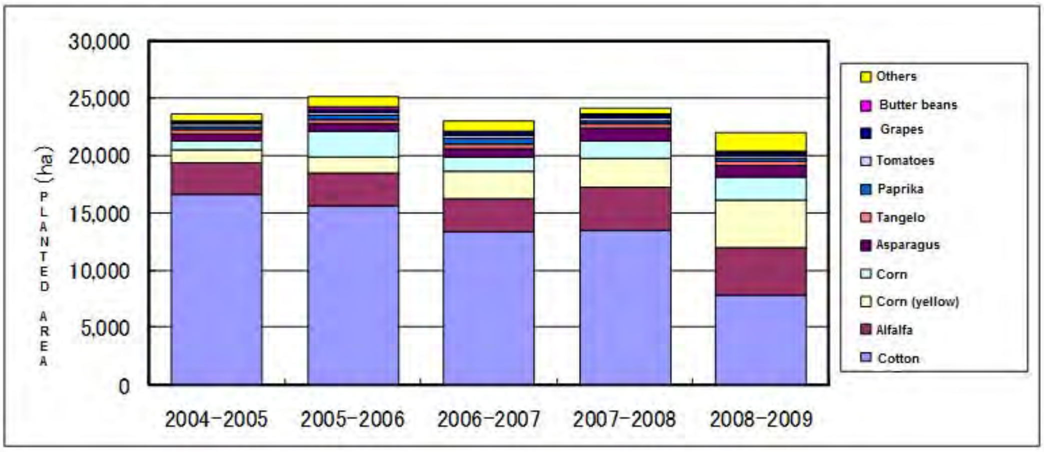


Figure 3.1.3-10 Planted Surface

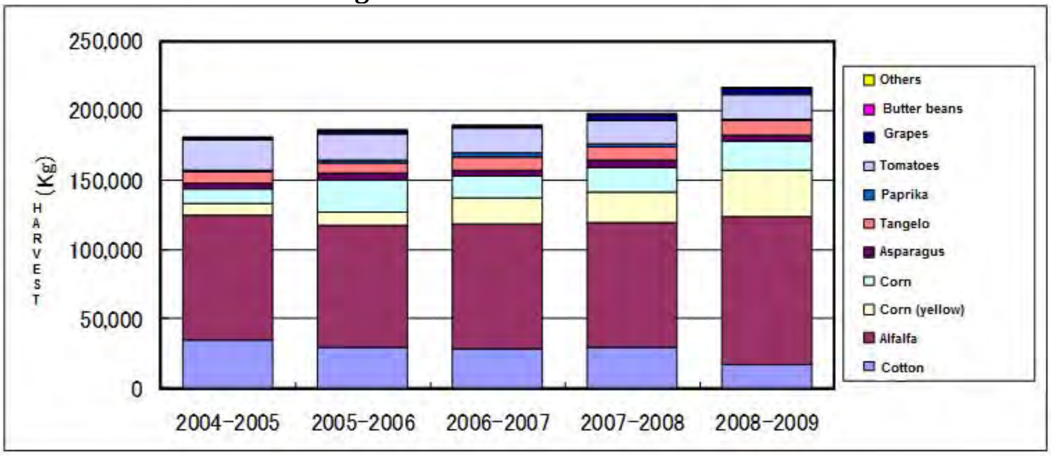


Figure 3.1.3-11 Harvest

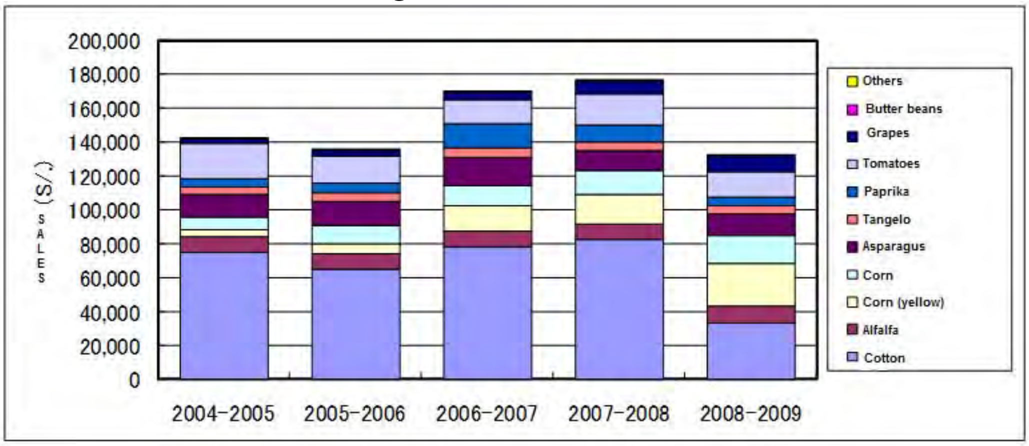


Figure 3.1.3-12 Sales

(5) Yauca River

1) Irrigation Sectors

Table 3.1.3-10 shows basic data on the irrigation commissions. In the Yauca River Watershed there are 3 irrigation sectors, 3 irrigation commissions with 557 beneficiaries. The surface managed by these sectors reach a total of 1,614 hectares.

Table 3.1.3-10 Basic data of the irrigation commissions

Irrigation Sectors	Irrigation Commissions	Areas under irrigation		Nº of Beneficiaries (People)	River
		ha	%		
Yauca	Yauca	523	32	350	Yauca
Mochica	Mochica	456	28	57	
Jaqui	Jaqui	635	39	150	
Total		**1.614**	**100**	**557**	

Source: Prepared by JICA Study Team, Users Board of Yauca, October 2010

2)Main crops

Table 3.1.3-11 shows the variation between 2004 and 2009 of the planted surface and the performance of main crops.

In the Yauca River Watershed, olive represents 70% of the planted area and between 80 to 90% of the profit, being the key product of this area.

The profits of 2007-2008 were a total of S/.24,808,192, duplicating compared to former years calculations, thanks to the increase of olives production.

Table 3.1.3-11 Sowing and sales of main crops

	Variables	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Olive	Planted Area (ha)	1,002	1,002	1,002	1,162	SD
	Unit Performance (kg/Ha)	6,009	4,846	3,604	11,635	SD
	Harvest (Kg)	6,021,018	4,855,692	3,611,208	13,519,870	
	Unit Price (S/./kg)	1.41	1.75	1.90	1.70	1.90
	Sales (S/.)	8,489,635	8,497,461	6,861,295	22,983,779	
Alfalfa	Planted Area (ha)	328	347	309	290	257
	Unit Performance (kg/Ha)	31,160	28,096	33,074	32,480	28,674
	Harvest (Kg)	10,220,480	9,749,312	10,219,866	9,419,200	7,369,218
	Unit Price (S/./kg)	0.09	0.10	0.10	0.10	0.10
	Sales (S/.)	919,843	974,931	1,021,987	941,920	736,922
Cotton	Planted Area (ha)	56	53	85	77	85
	Unit Performance (kg/Ha)	2,035	1,990	2,693	3,297	2,760
	Harvest (Kg)	113,960	105,470	228,905	253,869	234,600
	Unit Price (S/./kg)	2.20	2.00	2.70	2.54	1.82
	Sales (S/.)	250,712	210,940	618,044	644,827	426,972
Corn (yellow)	Planted Area (ha)	20	163	110	33	13
	Unit Performance (kg/Ha)	6,633	7,752	6,719	7,202	8,005
	Harvest (Kg)	132,660	1,263,576	739,090	237,666	104,065
	Unit Price (S/./kg)	0.52	0.50	0.70	1.00	0.70
	Sales (S/.)	68,983	631,788	517,363	237,666	72,846
Sweet potatoe	Planted Area (ha)	10	16	22	23	11
	Unit Performance (kg/Ha)	7,583	7,792	7,710	7,611	10,127
	Harvest (Kg)	75,830	124,672	169,620	175,053	111,397
	Unit Price (S/./kg)	0.59	0.60	0.75	0.83	0.92
	Sales (S/.)	44,740	74,803	127,215	145,294	102,485
Others	Planted Area (ha)	27	147	46	29	95
Total	Planted Area (ha)	2,522	3,189	3,037	2,864	
	Harvest (Kg)	49,052,450	47,090,300	47,103,115	56,176,725	41,216,009
	Sales (S/.)	42,792,095	41,282,962	47,588,416	66,174,879	35,998,549

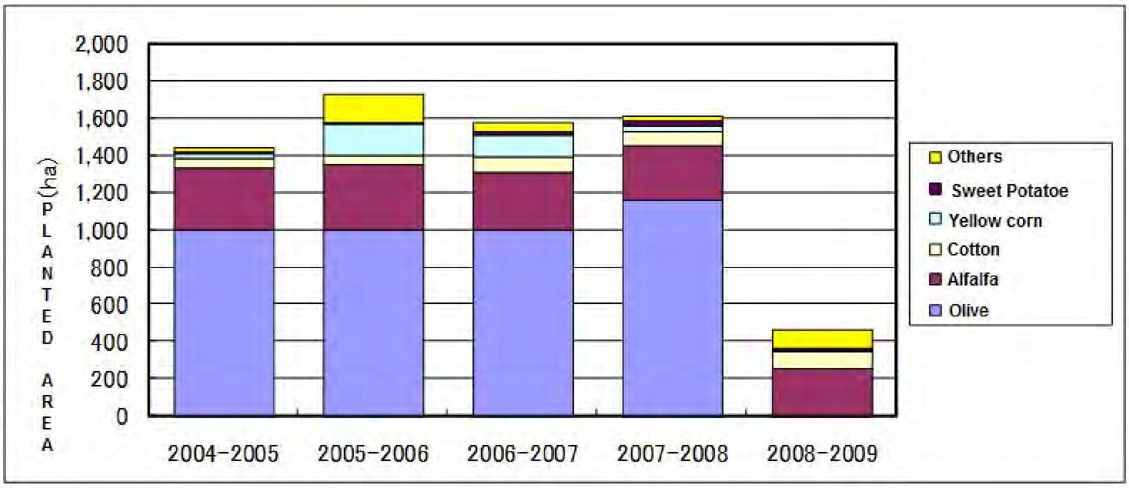


Figure 3.1.3-13 Planted Surface

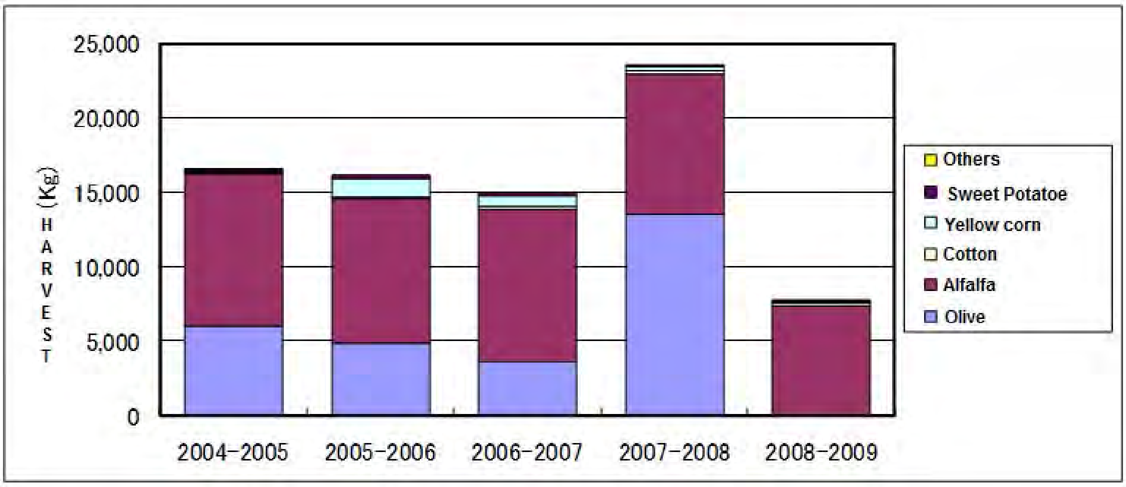


Figure 3.1.3-14 Harvest

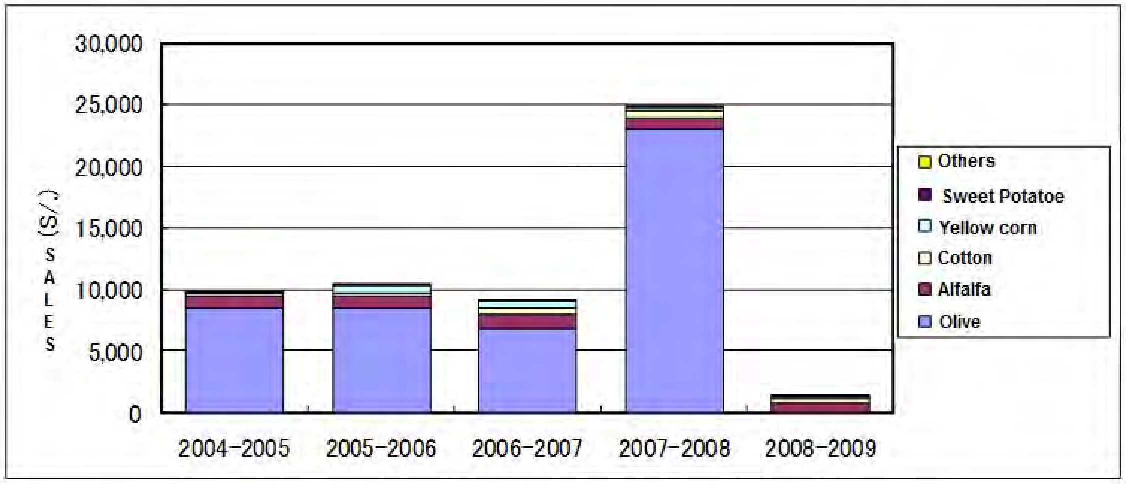


Figure 3.1.3-15 Sales

(6) Majes-Camana River

1) Irrigation Sectors

Table 3.1.3-12 and 3.1.3-13 shows basic data on the irrigation commissions of the Majes River and the Camana River, respectively. In the first one there are 45 irrigation sectors, 17 irrigation commissions with 2,519 beneficiaries. The surface managed by these sectors reach a total of 7,505 hectares.

In the watershed of the Camana River there are 38 irrigation sectors, 17 irrigation commissions with 3,388 beneficiaries. The surface managed by these sectors amounts 6,796 hectares.

Table 3.1.3-12 Basic data of the irrigation commissions in the Majes River

Irrigation Commissions	Irrigation sectors	Irrigated areas		Nº de Beneficiaries	River
		ha	%	(Person)	
Ongoro	Las Joyitas Las Palmas	8.08	0.11%	4	Majes
	Andamayo	94.35	1.26%	25	
	Luchea	35.26	0.47%	24	
	Ongoro	368.13	4.91%	65	
	Huatiapilla	367.26	4.89%	75	
	La Central	406.57	5.42%	66	
	El Castillo	623.05	8.30%	73	
	La Banda	4.15	0.06%	3	
	Jaran	3.52	0.05%	6	
Ongoro Bajo	Huanco Iquiapaza	4.46	0.06%	11	
	Huatiapilla Baja	103.62	1.38%	23	
	Alto Huatiapa	44.47	0.59%	20	
	Bajo Huatiapa	19.11	0.25%	8	
	Quiscay	17.84	0.24%	1	
Beringa	San Isidro	10.53	0.14%	3	
	Beringa	109.07	1.45%	80	
Huancarqui	La Collpa	14.93	0.20%	14	
	Huancarqui	342.56	4.56%	211	
Cosos	Cosos	125.43	1.67%	92	
Aplao	Aplao	232.26	3.09%	145	
	Bajos Aplao	11.50	0.15%	5	
La Real	Caspani	20.54	0.27%	18	
	La Real	172.07	2.29%	125	
Monte los Apuros	Monte los Apuros	370.86	4.94%	160	
Querulpa	Alto Maran Trapiche	131.78	1.76%	53	
	La Revilla Valcarcel	151.01	2.01%	50	
Tomaca	Tomaca	296.32	3.95%	54	
	El Rescate	92.34	1.23%	41	
Uraca	Uraca	688.81	9.18%	239	
Cantas Pedregal	Alto Cantas	162.87	2.17%	74	
	Bajo Cantas	147.09	1.96%	47	
Sogiata	Sogiata	522.66	6.96%	154	
San Vicente	San Vicente	230.68	3.07%	100	
	Caceres	57.31	0.76%	12	
Pitis	Pitis	93.10	1.24%	53	
	Escalerillas	155.61	2.07%	74	
Sarcas Toran	Sarcas Toran	777.69	10.36%	195	
	Hinojosa Pacheco	1.00	0.01%	2	
	Medrano	12.29	0.16%	7	
	La Cueva	6.24	0.08%	6	
	Callan Jaraba	37.91	0.51%	10	
	Sahuani	58.47	0.78%	17	
	Paycan	24.44	0.33%	6	
	Vertiente	2.29	0.03%	3	
El Granado	El Granado	345.45	4.60%	65	
Total		**7,504.98**	**100%**	**2,519**	

Source: Prepared by JICA Study Team, Users Board of Camana-Majes, September 2011

Table 3.1.3-13 Basic data of irrigation commissions in the Camana River

Irrigation Commission	Irrigation Sectors	Irrigated areas		Nº de Beneficiaries	River
		ha	%	(Person)	
Socso-Sillan	Huamboy	28.23	0.42%	8	Camana
	Puccor	13.30	0.20%	2	
	Pillistay	13.91	0.20%	6	
	Nueva Esperanza	27.31	0.40%	19	
	Socso	52.97	0.78%	15	
	Socso Medio	21.27	0.31%	12	
	Casias-Sillan	45.32	0.67%	20	
Sonay	Sonay	110.48	1.63%	34	
Pisques	Pisques	86.82	1.28%	39	
Characta	Soto	16.29	0.24%	4	
	Characta	174.35	2.57%	54	
Pampata	Naspas-Pampata	130.31	1.92%	21	
	Pampata-Baja	164.77	2.42%	27	
La Bombon	Tirita	15.67	0.23%	12	
	Montes Nuevos	49.41	0.73%	26	
	La Bombon	402.38	5.92%	265	
	Gordillo	8.14	0.12%	9	
	La Era	1.44	0.02%	4	
	La Rama Era I	45.53	0.67%	37	
	Toma Davila	58.20	0.86%	11	
El Alto	El Alto	314.57	4.63%	128	
Los Molinos	Los Molinos	435.97	6.41%	295	
El Medio	El Medio	477.98	7.03%	231	
	Los Castillos	44.36	0.65%	48	
	Flores	4.73	0.07%	5	
La Valdivia	El Desague	45.56	0.67%	55	
	La Lurin	17.35	0.26%	11	
	La Chingana	51.27	0.75%	33	
	La Valdivia	323.86	4.77%	196	
La Deheza	La Deheza	336.71	4.95%	228	
La Gamero	La Gamero	356.04	5.24%	257	
El Molino	El Molino	370.29	5.45%	302	
El Cuzco	El Cuzco	290.02	4.27%	261	
Montes Nuevos	Montes Nuevos	192.46	2.83%	123	
Huacapuy	Huacapuy	23.12	0.34%	21	
Pucchun	Mal Paso-Sta. Elizabeth	1070.90	15.76%	296	
	1er y 2do Canal Aereo	872.79	12.84%	202	
	Jahuay	102.11	1.50%	71	
Total		**6,796.19**	**100%**	**3,388**	

Source: Prepared by JICA Study Team, Users Board of Camana-Majes, September 2011

2)Main crops

Table 3.1.3-14 shows the variation between 2004 and 2009 of the planted surface and the performance of main crops.

In the Majes – Camana River Watershed, in 2004 the planted area, performance and sales decreased, but later increased so that during the period 2008-2009 profits were of S/.188,596,716. Main crops in this watershed were represented by: rice, beans, onions, corn and pumpkins.

Table 3.1.3-14 Sowing and sales of main crops

	Variables	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Paddy Rice	Sown surface (ha)	6,216	6,246	6,211	6,212	6,224
	Unit performance (kg/Ha)	12,041	13,227	12,841	13,370	13,823
	Harvest (Kg)	74,844,450	82,617,571	79,753,422	83,057,334	86,032,532
	Unit price (S/./kg)	0.92	0.65	0.80	1.10	0.70
	Sales (S/.)	68,868,814	53,701,421	63,802,738	91,354,778	60,222,772
Dried beans	Sown surface (ha)	4,458	4,433	3,947	4,045	3,886
	Unit performance (kg/Ha)	1,630	1,660	1,745	1,743	1,920
	Harvest (Kg)	7,264,349	7,359,607	6,888,684	7,051,876	7,460,849
	Unit price (S/./kg)	2.93	2.44	3.03	4.12	3.85
	Sales (S/.)	21,304,797	17,970,689	20,888,054	29,058,175	28,746,981
Onion	Sown surface (ha)	2,063	1,958	2,168	2,331	1,886
	Unit performance (kg/Ha)	40,552	32,073	41,231	46,034	35,840
	Harvest (Kg)	83,659,519	62,798,588	89,388,731	107,304,225	67,594,277
	Unit price (S/./kg)	0.58	0.38	0.71	0.43	1.37
	Sales (S/.)	48,800,305	24,067,447	63,582,270	46,002,256	92,290,918
Corn	Sown surface (ha)	50	30	34	618	558
	Unit performance (kg/Ha)	4,192	3,500	3,680	5,670	4,580
	Harvest (Kg)	209,600	105,000	125,120	3,503,916	2,555,501
	Unit price (S/./kg)	0.85	0.80	1.00	0.90	0.75
	Sales (S/.)	178,160	84,000	125,120	3,153,524	1,918,916
Pumpkin	Sown surface (ha)	193	223	217	129	159
	Unit performance (kg/Ha)	29,341	34,419	32,869	40,346	42,789
	Harvest (Kg)	5,662,900	7,675,350	7,132,607	5,204,624	6,803,456
	Unit price (S/./kg)	0.36	0.30	0.30	0.41	0.26
	Sales (S/.)	2,056,542	2,295,721	2,123,348	2,154,472	1,786,014
Chala Corn	Sown surface (ha)	55	35	38	29	44
	Unit performance (kg/Ha)	60,800	59,435	59,962	60,675	58,332
	Harvest (Kg)	3,344,000	2,080,242	2,278,540	1,759,566	2,566,613
	Unit price (S/./kg)	0.08	0.10	0.10	0.10	0.25
	Sales (S/.)	267,520	208,024	227,854	175,957	633,487
Sweet Corn	Sown surface (ha)	51	40	27	19	51
	Unit performance (kg/Ha)	16,980	17,694	18,053	18,201	18,223
	Harvest (Kg)	865,998	707,742	487,426	345,824	929,377
	Unit price (S/./kg)	0.30	0.40	0.61	0.32	0.58
	Sales (S/.)	259,799	283,097	296,066	111,028	536,123
Potato	Sown surface (ha)	39	38	22	22	65
	Unit performance (kg/Ha)	31,538	26,368	27,866	27,524	32,091
	Harvest (Kg)	1,230,000	1,002,000	613,045	605,531	2,085,916
	Unit price (S/./kg)	0.50	0.50	0.46	0.83	0.63
	Sales (S/.)	615,000	501,000	281,443	500,939	1,310,597
Tomato	Sown surface (ha)	5	45	36	11	48
	Unit performance (kg/Ha)	29,000	38,951	30,584	34,963	36,310
	Harvest (Kg)	145,000	1,752,790	1,101,025	384,597	1,742,875
	Unit price (S/./kg)	0.50	0.38	0.73	0.45	0.41
	Sales (S/.)	72,500	662,165	804,360	173,418	714,942
Watermelon	Sown surface (ha)	29	30	13	14	40
	Unit performance (kg/Ha)	9,862	17,265	12,920	13,087	13,718
	Harvest (Kg)	286,000	517,938	167,960	183,218	548,708
	Unit price (S/./kg)	0.30	0.40	0.40	0.47	0.80
	Sales (S/.)	85,800	207,175	67,184	86,112	438,966
Otros	Sown surface (ha)	95	153	204	190	116
Total	Sown surface (ha)	13,254	13,231	12,917	13,620	13,077
	Harvest (Kg)	177,511,816	166,616,828	187,936,560	209,400,711	178,320,104
	Sales (S/.)	142,509,238	99,980,740	152,198,437	172,770,659	188,599,716

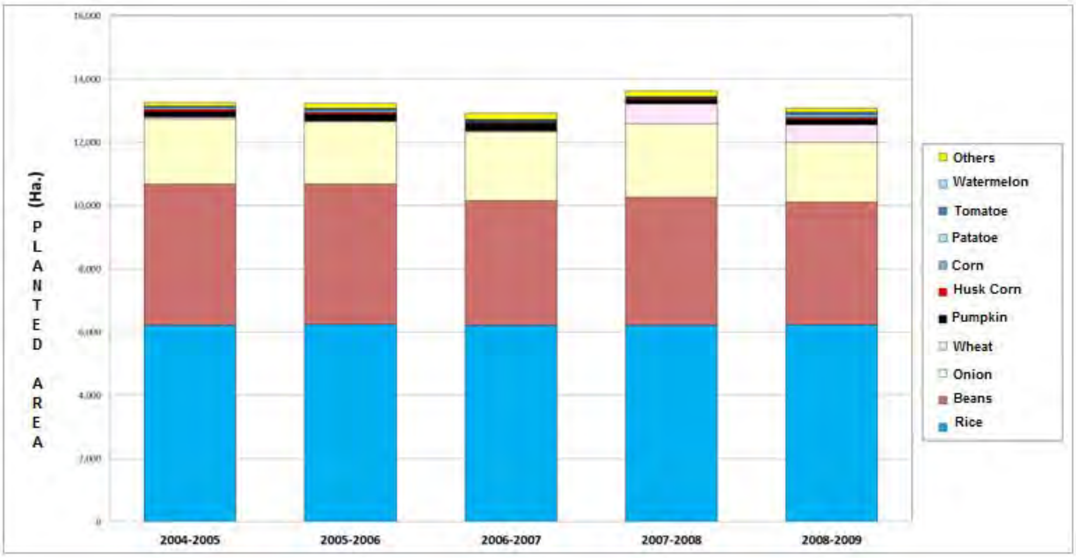


Figure 3.1.3-16 Planted Surface

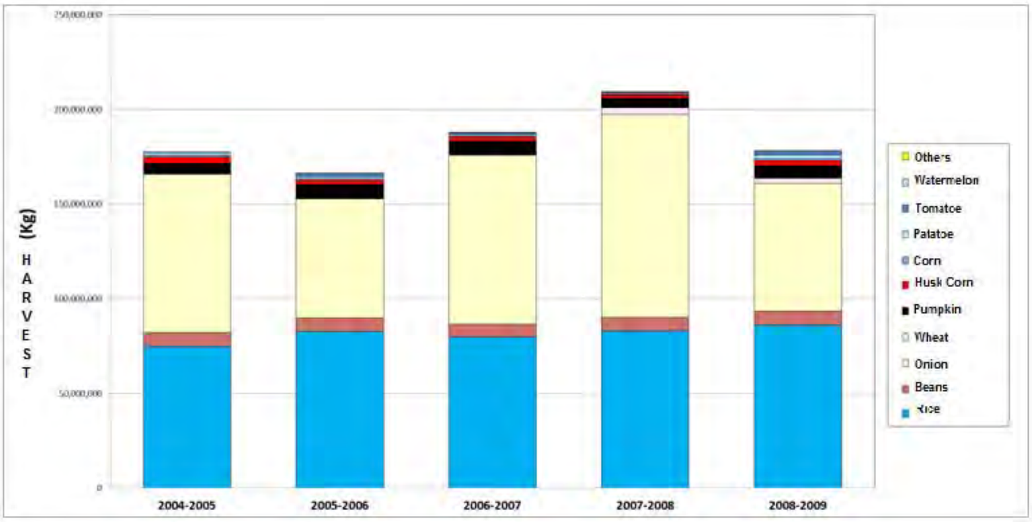


Figure 3.1.3-17 Harvest

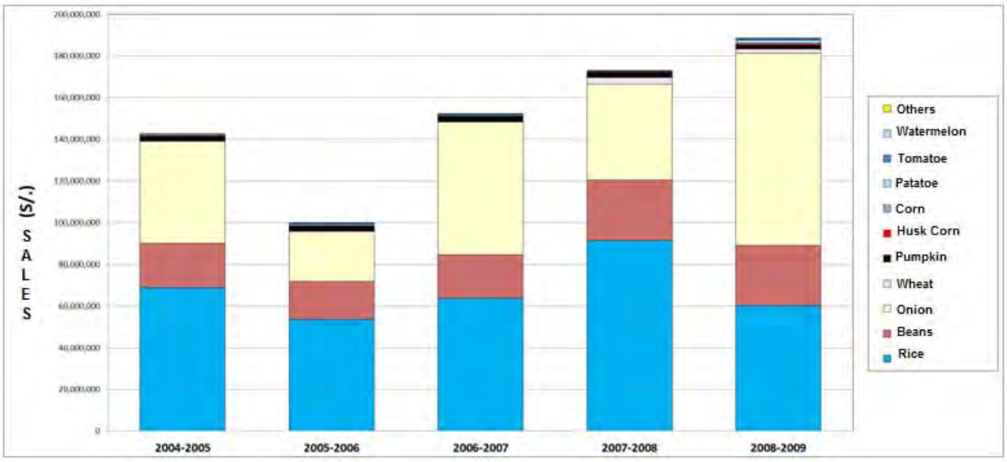


Figure 3.1.3-18 Sales

3.1.4 Infrastructure

(1) Chira River

1)Road Infrastructures

In Table 3.1.4-1 basic data of road infrastructure of the Piura Region is presented. In total there are 4,398km of roads, from which 857.0km (19.5%) is national highways, 578.2km (13.1%) regional roads and 2,962.8km (67.4%) are municipal roads.

Table 3.1.4-1 Road Infrastructure Data

Roads	Total length		Paving			
			Asphalted	Compacted	Non-compacted	Soil
National Road	857,0	19,5 %	664,5	126,5	29,0	37,0
Regional Road	578,2	13,1 %	144,8	159,0	68,1	206,3
Municipal Road	2962,8	67,4 %	134,3	51,7	313,6	2463,2
Total	4398,0	100,0 %	943,6	337,2	410,7	2706,5

2)Irrigation Channels

According to irrigation commissions, data was obtained about the type, name, location, used materials, operation conditions and other channel details, but not data from derivation channels discrimination, of 1st, 2nd and 3rd order, length and structure. About general data, see Data Book.

3)PERPEC

In Table 3.1.4-2 PERPEC implemented projects between 2006 and 2009 are shown.

Table 3.1.4-2 Implemented Projects by PERPEC

Nº	Year	Work name	Location				Description			Total cost (S/.)
			Departamt	Province	District	Town				
1	2006	El Litoral trunk drain cleanliness and desilting	Piura	Paita	Colan	Pueblo Nuevo de Colan	Drain desilting	8.4	Km	289,724.70
2	2006	El Rosario trunk drain cleanliness and desilting	Piura	Paita	Colan	Pueblo Nuevo de Colan	Drain desilting	6.28	Km.	195,520.00
3	2006	Santa Elena trunk drain cleanliness and desilting	Piura	Paita	Colan	Pueblo Nuevo de Colan	Drain desilting	7.92	Km.	240,640.00
4	2007	Chira river coastal defense, Jaguay de Poechos-Querecotillo-Sullana-Piura areas	Piura	Sullana	Querecotillo	Jaguey de Poechos	Rockfilling dike	0.6	Km	480,104.00
5	2007	Chira river coastal defense, La Cuarta de Mallares Marcavelica-Sullana-Piura areas	Piura	Sullana	Marcavelica	La cuarta Mallares	Rockfilling dike	0.5	Km	491,151.00
6	2007	Chira river coastal defense, La Playa-Garabato-Marcavelica-Sullana-Piura areas	Piura	Sullana	Marcavelica	Playa Garabato	Breakwaters with rock	0.1	Km	187,202.00
7	2008	Manifold 1 - drainage system hydraulic section recovery - Pueblo Nuevo de Colan (Contingency)	Piura	Paita	Colan	Pueblo Nuevo de Colan	Drain hydraulic section recovery	4.9	Km	217,414.00

8	2008	Mambre-La Bocana-Marcavelica drain hydraulic section recovery (Contingency)	Piura	Sullana	Marcavelica	Mallares	Drain hydraulic section recovery	7.02	Km	183,863.15
9	2008	Monte-Mallares-Marcavelica drain hydraulic section recovery (Contingency)	Piura	Sullana	Marcavelica	Mallares	Drain hydraulic section recovery	6.64	Km	167,832.88
10	2008	La Huaca II, La Huaca-Paita stage, rockfilling rehabilitation (Contingency)	Piura	Sullana	La Huaca	La Polvareda	Wet slope rehabilitation with rock acommodation	0.33	Km	258,772.00
11	2008	Viviate and Chira Palma - La Huaca drains hydraulic section recovery (Contingency)	Piura	Paita	La Huaca	Viviate	Drain hydraulic section recovery of Viviate and Chira Palma	3.9	Km	50,074.00
12	2008	Chira river coastal defense building on left margin, Santa Marcela – Viviate – La Huaca – Paita – Piura Areas (Contingency)	Piura	Paita	La Huaca	Viviate	Drain hydraulic section recovery	3900	Km	245,956.00
13	2008	Channel 4219C rehabilitation in Cieneguillo, centro de Sullana, Piura (Contingency)	Piura	Sullana	Sullana	Cineguillo	Coated channel rehabilitation	680	ml	146,993.00
14	2008	Chira river coastal defense building on right margin, La Polvadera, San Isidro, Pucusula - La Huaca - Paita - Piura Areas (Prevention)	Piura	Paita	La Huaca	La Polvadera, San Isidro, Pucusula-La Huaca	Building of 04 units of rock breakwaters	0.206	km	470,816.00
15	2008	Saman ravine coastal defense building, Mallares area, Marcavelica district, Sullana province (Prevention)	Piura	Sullana	Marcavelica	Mallares	Rock breakwater building	2	km	465,266.00

2) Cañete River

1) Road Infrastructures

Table 3.1.4-3 shows road infrastructures in the watershed of the Cañete River. In total there are 822.39km of roads, 265.89km of them (32.3%) are national roads, 59.96km (7.3%) regional roads, and 496.54km (60.4%) municipal roads.

Table 3.1.4-3 Basic data of road infrastructure

（Km）

Roads	Total Length		Paving			
			Asfphalted	Compacted	Non-compacted	Soil
National Roa	265.89	32.3%	205.75	60.14	0.00	0.00
Regional Roa	59.96	7.3%	10.40	49.56		
Municipal Ro	496.54	60.4%	39.83	213.18	211.37	32.16
Total	822.39	100.0%	255.98	322.88	211.37	32.16

2)Irrigation systems

Intake:
In Cañete River Watershed, there are 4 intakes from which Nuevo Imperial, La Foratleza and Palo Herbay are permanent

Irrigation Channels:
In Table 3.1.4-4, the gathered size of the existing irrigation channels is shown. Derivation channels of 1st, 2nd and 3rd order add up in total 1,232km, from this 80km are lagged (6% of the total amount).

Table 3.1.4-4 Existing Irrigation Channels

Irrigation Commission	Aduction Channels				Primary Channels				Secondary and Tertiary Channels			
	Quatity	Concrete (Km)	Without concrete (Km)	Total length (km)	Quatity	Concrete (Km)	Without concrete (Km)	Total length (km)	Quatity	Concrete (Km)	Without concrete (Km)	Total length (km)
Canal Nuevo Imperial	10.00	7.75	40.73	48.48	67.00	14.99	108.66	123.65	418.00	7.65	252.85	260.50
Canal Viejo Imperial	1.00	4.42	16.57	20.99	50.00	4.99	42.87	47.86	116.00	0.32	108.64	108.96
Canal San Miguel	5.00	4.74	42.69	47.43	73.00	10.98	70.58	81.56	114.00	12.39	67.46	79.85
Canal Maria Angola	3.00	3.52	24.47	27.99	56.00	2.80	59.29	62.09	68.00	0.42	38.40	38.82
Canal Palo Herbay	6.00	0.00	18.89	18.89	37.00	0.08	49.96	50.04	116.00	0.00	68.33	68.33
Canal Huanca	1.00	0.00	1.96	1.96	6.00	0.00	20.20	20.20	82.00	4.33	83.66	87.99
Canal Pachacamilla	2.00	0.00	5.27	5.27	4.00	0.00	3.42	3.42	15.00	0.00	28.28	28.28
Total	**28.00**	**20.43**	**150.58**	**171.01**	**293.00**	**33.84**	**354.98**	**388.82**	**929.00**	**25.11**	**647.62**	**672.73**

Drainage Channels:
In Table 3.1.4-5, the total size of the drainage channels according to the irrigation commissions is shown.

Table 3.1.4-5 Drainage Channels

Irrigation Commissions	DRAINAGE SYSTEM			
	Length Colector (m)	Main Length (m)	Secondary Length (m)	Total Length (m)
Nuevo Imperial	6,830	3,541	1,832	12,203
Viejo Imperial	0	0	0	0
San Miguel	25,164	25,289	8,732	59,185
Maria Angola	3,950	1,960	787	6,697
Palo Herbay	8,925	1,432	0	10,357
Huanca	23,553	5,694	866	30,113
Pachacamilla		992		2,292
CAÑETE VALLEY	**68,422**	**38,908**	**12,217**	**120,847**

3)PERPEC

Table 3.1.4-6 shows implemented projects by PERPEC between 2006 and 2009.

Table 3.1.4-6 Projects implemented by PERPEC

Nº	Year	Work name	Location				Description			Total cost (S/.)
			Department	Province	District	Town				
1	2006	Cañete river Coastal defense - Huacre area	Lima	Cañete	San Vicente de Cañete	Huacre	Dike structure	1	Km	250,482.00
2	2007	Cañete river upper basin Irrigation structure rehabilitation	Lima	Cañete	Colonia, Madean, Putinza, Yauyos, Huantan	Several	Channel sheathing	3.48	Km	201,250.00
3	2007	Cañete river medium basin infrastructure rehabilitation	Lima	Cañete	Zuñiga , Pacaran, Lunahuana	Several	Channel sheathing	1.66	Km	261,363.00
4	2007	Cañete river lower basin infrastructure rehabilitation	Lima	Cañete	San Vicente de Cañete, San Luis, Nuevo Imperial	Several	Chanel rehabilitation	12.56	Km	483,522.00
5	2007	Cañete valley drain rehabilitation and cleansing	Lima	Cañete	San Luis, San Miguel, Quilmana	Several	Rock filled dike	13.1	Km	169,363.00
6	2007	Mala valley irrigation and drain infrastgructure rehabilitation	Lima	Cañete	Mala-San Antonio	Santa Cruz de Flores, Mala , Sta Cruz de Flores, La Huaca	Channel sheathing	1.7	Km	219,502.00
7	2007	Mala river Coastal defense Area: Santa Clorinda	Lima	Cañete	Mala	Mala	Rock filled dike	1	Km	459,280.00
8	2008	Cañete river provisional coastal defense; areas: Carlos V, Sta. Teresa (Contingency)	Lima	Cañete	San Vicente de Cañete	Carlos V , Sta Teresa	Stream cleaning	1.6	Km.	282,794.55
9	2008	Mala river provisional coastal defense; areas: San José, Las Animas (Contingency)	Lima	Cañete	Mala	San Jose, Las Animas	Stream cleaning	1	Km.	207,713.00
10	2008	Mala river channeling and coastal defense Area : Correviento - Rinconada (Contingency)	Lima	Cañete	Mala	Correviento - Rinconada	Rock filled dike	0.56	Km	324,009.64

(3) Chincha River

1) Road Infrastructures

Table 3.1.4-7 shows road infrastructures in the watershed of the Chincha River. In total there are 453.27km of roads, 81.39km of them (18.0 %) are national roads, 227.16km (50,1%) regional roads, and 144.72km (31,9%) municipal roads.

From National roads, 40.75km are paved and in good state and the 40.64km that rest are in inadequate conditions.

From National roads, 20.02km are paved and in good state and the 207.14km that rest are in inadequate conditions

From National roads, 25.42km are paved and in good state and the 119.3km that rest are in inadequate conditions

Table 3.1.4-7 Basic data of road infrastructure

（Km)

Roads	Total Length		Paving			
			Asphalted	Compacted	Non-	Soil
National roads	81.39	18.0%	40.75	40.64		
Regional roads	227.16	50.1%	20.02		207.14	
Municipal roads	144.72	31.9%	25.42		70.30	49.00
Total	453.27	100.0%	86.19	40.64	277.44	49.00

2)PERPEC

Table 3.1.4-8 shows implemented projects by PERPEC between 2006 and 2009.

Table 3.1.4-8 Projects implemented by PERPEC

Nº	Year	Work name	Location				Description			Total cost (S/.)
			Department	Province	District	Town				
1	2006	Coastal defense of Chico River in Canyar	Ica	Chincha	Chincha	Canyar	Dike conformation	0.05	km	50,000.00
2	2006	Coastal defense of Chico River, Partidor Conta area	Ica	Chincha	Alto Laran	Partidos conta	Netting dike with cushion	0.23	Km	187,500.00
3	2007	Coastal defense of right margin Matagente River, ronceros alto area and on the left margin of Chico river in Ayacucho area, in Alto Laran district, Chincha province - Ica Region	Ica	Chincha	Chincha Baja	Chincha Baja	Dike with gavions and /or cushion	2.5	Km	517,979.00
4	2007	Main channel rehabilitation of Ñoco irrigation	Ica	Chincha	Alto Laran	Primeros 5km del canal, Huampullo, bajo y Alto y vuelta el Coche, Tunel a 200m de la Bocatoma	Channel sheathing	0.1	Km	43,109.00
5	2007	Channels rehabilitation of Alto Laran - High part Area	Ica	Chincha	Alto Laran	Huachinga Condores	Channel box rehabilitation	0.477	Km	130,264.00
6	2007	Pampa Baja, Belen and Chochocota channels cleanliness	Ica	Chincha	El Carmen	Pampa Baja, Belen , Chochocota	Channel cleanliness	12.63	Km	91,372.00
7	2008	Provisional coastal defense in Matagente River, La Pelota area, Del Carmen district and Ica Department (Contingency)	Ica	Chincha	El Carmen	La Pelota	Dike conformation with dragging material	1.5	Km	107,735.00
8	2008	Left and right margins coastal defense of Chico River, Canyar Area, Chincha Baja district, Chincha Province, Ica Region (Contingency)	Ica	Chincha	Chincha	Canyar	Dike conformation with coating of anti-scouring cushion	850	ml	695,900.00
9	2008	Coastal defense of Matagente River, Punta La Isla - Ronceros Alto - Ganaderos Los Angeles Areas, El Carmen district, Chincha Province, Ica Region (Prevention)	Ica	Chincha	El Carmen	La Isla - Ronceros Alto - Ganaderos Los Angeles	Rockfill dike	1460	ml	583,294.00
10	2009	Coastal defense on the right margin of Chico River, El Taro area, Alto Laran district, Chincha province, Ica region	Ica	Chincha	Alto Larán	Chamorro, Atahualpa	Netting dike of Chico River	200	ml	290,222.00

(4) Pisco River

1) Road Infrastructures

Table 3.1.4-9 shows irrigation infrastructures of Pisco River. There are 41 intakes, 41 main channels and 167 secondary channels.

Table 3.1.4-9 Irrigation infrastructure

Nº	STRUCTURE		QUANTITY
1	INTAKE		41
2	CHANNEL	MAIN	41
		SECONDARY	167
3	WATERWORKS		11
4	SEWERS		73
5	SPILLWAY		6
6	DUMP		105
7	FALLS		163
8	CANOES		85
9	COVERED CONDUCT		2
10	BRIDGES	PEDESTRIAN	36
		VEHICLE	381
11	QUICK		10
12	TRAP		3
13	METER		39
14	TUNNELS		32

Source: JICA Study Team

2)PERPEC

Table 3.1.4-10 shows implemented projects by PERPEC between 2006 and 2009.

Table 3.1.4-10 Projects implemented by PERPEC

Nº	Year	Work name	Location				Description			Total cost (S/.)
			Department	Province	District	Town				
1	2006	Pisco River coastal defense - Condor area	Ica	Pisco	Independencia	Cóndor	Channel conformation	0.5	Km.	186,723.00
2	2007	Hydraulic infrastructure protection with coastal defense on right margin of Pisco River, Manrique area, Independece District, Pisco Province - Ica Region	Ica	Pisco	Independencia	Manrique	Dike with gavions and /or cushion	0.84	Km	501,939.72
3	2007	Channel and drains conduction capability restitution on right margin of Pisco River	Ica	Pisco	Independencia	Several	Channel box replacement	17.03	Km	145,810.00
4	2007	Main channel cleanliness Chunchanga- Murga-Pisco Area	Ica	Pisco	Humay	Chunchanga	Channel box replacement	2.824	Km	42,700.00
5	2007	Channel and drains conduction capability restitution on left margin of Pisco River	Ica	Pisco	Independencia	Varias	Channel box replacement	10.91	Km	92,504.00
							Drains Rehabilitation	6.307	Km	
6	2007	Slide rehabilitation of Huaya,Tambo colorado and Miraflores derivation channels - Pisco	Ica	Pisco	Humay	Varias	Intake rockfilling	0.051	Km	52,003.00
7	2007	Main and secondary channels rehabilitation in the Huancano-Pampano High area of Pisco River	Ica	Pisco	Huancano	Varias	Channel sheathing	0.544	Km	71,219.00
8	2007	Rehabilitation in Cabeza de Toro and Storage pools fixing for agricultural supply purposes in Cabeza de Toro - Pisco River	Ica	Pisco	Independencia	Cabeza de Toro	Replacement and fixing of pools	55	und.	106,819.00
9	2008	Coastal defense with short breakwaters with tumbling rocks right margin (several areas) Pirsco river (Contingency)	Ica	Pisco	Independencia	Several Areas	Building of 23 breakwaters of 40 mts.	23	Unid	107,735.00
							Dike conformation	1	Km	
10	2008	Derivation channel protection in Chunchanga (Contingency)	Ica	Pisco	Pisco	Chunchanga	Desilting	400	ml	279,240.00
							Dike with rockfilling	200	ml	
11	2008	Coastal defense with aims of San Ignacio intakes protection on the right margin and Bernales on the left margin of Pisco River, Bernales area, Humay district, Pisco province (Prevention)	Ica	Pisco	Humay	Bernales	Rockfilling dike	260	ml	435,781
							Rock breakwaters	19	und	
							Dike conformation	520	ml	

(5) Yauca River

1) Irrigation Infrastructures

In Yauca River there are a total of 48 intakes, from which 2 are permanent. Derivation channels of firs, second and third order add up to 191.96km, from which 24.14km (12.6%) are lagged.

Table 3.1.4-11 Existing Irrigation Channels

JUNTA DE USUARIOS	COMISION DE REGANTES	BOCATOMA			CANAL DE DERIVACION				CANAL DE PRIMER ORDEN				CANAL SEGUNDO ORDEN				CANAL TERCER ORDEN				TOTAL DEL SISTEMA			
		Nº	TIPO (cantidad) Permanente	TIPO (cantidad) Rústico	Nº	Revestido (km)	sin Revestido (km)	Longitud Total (km)	Nº	Revestido (km)	sin Revestido (km)	Longitud Total (km)	Nº	Revestido (km)	sin Revestido (km)	Longitud Total (km)	Nº	Revestido (km)	sin Revestido (km)	Longitud Total (km)	Nº Totales de Canales	Revestido (km)	sin Revestido (km)	Longitud Total (km)
Sub Distrito de Riego Acarí	Chaviña	1	1		1	2.708	1.372	4.080	1	0.000	1.336	1.336				0.00				0.000	2	2.71	2.71	5.42
	Acari Bajo	10	1	9	10	4.882	10.673	15.555	5	4.562	6.324	10.886	1	0.00	2.50	2.50				0.000	16	9.44	19.50	28.94
	Acari Pueblo	1	1	0	1	2.540	0.000	2.540	1	4.000	0.000	4.000	7	2.48	14.49	16.96	2	0.000	0.842	0.842	11	9.02	15.33	24.34
	Chocavento	2		2	2	0.250	1.850	2.100	2	4.500	6.000	10.500				0.00				0.000	4	4.75	7.85	12.60
	Molino	3	1	2	3	6.360	1.125	7.485	2	3.300	3.200	6.500	1	0.00	0.60	0.60				0.000	6	9.66	4.92	14.58
	Huarato Amato Visija	8		8	8	1.800	15.847	17.647				0.000				0.00				0.000	8	1.80	15.85	17.65
	Malco	2		2	2	3.000	2.350	5.350	2	0.000	1.500	1.500				0.00				0.000	4	3.00	3.85	6.85
	Huanca	3		3	3	2.700	11.827	14.527				0.000				0.00				0.000	3	2.70	11.83	14.53
	Lisahuacchi	12		12	12	0.000	36.430	36.430				0.000				0.00				0.000	12	0.00	36.43	36.43
	SUBTOTAL	**42**	**4**	**38**	**42**	**24.24**	**81.47**	**105.71**	**13**	**16.36**	**18.36**	**34.72**	**9**	**2.48**	**17.58**	**20.06**	**2**	**0.00**	**0.84**	**0.84**	**66**	**43.08**	**118.26**	**161.34**
Bella Union		1	1		1	17.75	2.053	19.803													1	17.75	2.05	19.80
	Lateral 1	1	1					0	1	5.584	3.216	8.8	5	2.476	5.497	7.973				0	6	8.06	8.71	16.77
	Lateral 2	1	1					0	1	2.35	6.35	8.7	4	1.25	4.79	6.04				0	5	3.60	11.14	14.74
	Lateral 3	1	1					0	1	8.825	0	8.825	4	1.45	6.7	8.15				0	5	10.28	6.70	16.98
	SUBTOTAL	**4**	**4**	**0**	**1**	**17.75**	**2.05**	**19.80**	**3.00**	**16.76**	**9.57**	**26.33**	**13.00**	**5.18**	**16.99**	**22.16**	**0.00**	**0.00**	**0.00**	**0.00**	**17**	**39.69**	**28.61**	**68.29**
Sub Distrito de Riego Yauca	Yauca	9	2	7	9	5.75	15.55	21.30	9	1	7.96	8.96	3	0.65	3.91	4.56					21	7.40	27.42	34.82
	Mochica	1	0	1	1	2.50	11.00	13.50	0	0	0	0	0	0.00	0.00	0.00					1	2.50	11.00	13.50
	Jaquí	13	0	13	13	14.24	27.72	41.96	5	0	4.35	4.35	0	0.00	0.00	0.00					18	14.24	32.07	46.31
	San Luis Palca	11	0	11	11	0.00	35.80	35.80	0	0	0	0	0	0.00	0.00	0.00					11	0.00	35.80	35.80
	Lampalla	12	0	12	12	0.00	48.82	48.82	0	0	0	0	0	0.00	0.00	0.00					12	0.00	48.82	48.82
	Cuesta Chaqui	2		2	2	0.00	12.70	12.70	0	0	0	0	0	0.00	0.00	0.00					2	0.00	12.70	12.70
	SUBTOTAL	**48**	**2**	**46**	**48**	**22.49**	**151.59**	**174.08**	**14**	**1**	**12.31**	**13.31**	**3**	**0.65**	**3.91**	**4.56**	**0**	**0**	**0**	**0**	**65**	**24.14**	**167.81**	**191.95**
TOTAL		**94**	**10**	**84**	**91**	**64.48**	**235.117**	**299.597**	**30**	**34.121**	**40.236**	**74.357**	**25**	**8.302**	**38.478**	**46.78**	**2**	**0**	**0.842**	**0.842**	**148**	**106.903**	**314.673**	**421.576**

2)PERPEC

No PERPEC project has been implemented in Yauca River between 2006 and 2009.

(6) Majes-Camana River

1) Road Infrastructures

Table 3.1.4-12 shows road infrastructures in the watershed of the Majes River. In total there are 981.291 km of roads, 282.904 km of them (28.8 %) are national roads, 208.163 km (21.2 %) regional roads, and 490.223 km (50,0 %) municipal roads.

Table 3.1.4-13 shows road infrastructures in the watershed of the Camana River. In total there are 574.039 km of roads, 143.608 km of them (25.0 %) area national roads, 365.940 km (63.8 %) regional roads, and 64.491 km (11.2 %) municipal roads.

Table 3.1.4-12 Basic data of road infrastructure in the Majes River

Roads	Total Length (Km)		Paving (Km)			
			Asphalted	Trail Road	Gravel Road	Path
National Road	282.904	28.83%	64.400	173.842		44.662
Regional roads	208.164	21.21%			2.727	205.437
Municipal roads	490.223	49.96%		10.321		479.902
Total	981.291	100.00%	64.400	184.163	2.727	685.339

Table 3.1.4-13 Basic data of road infrastructure in the Camana River

Roads	Total Length (Km)		Paving (Km)			
			Asphalted	Trail Road	Gravel Road	Path
National Road	143.608	25.02%	114.748	28.860		
Regional roads	365.940	63.75%	16.100	82.610		267.230
Municipal roads	64.491	11.23%	1.040	6.677		56.774
Total	574.039	100.00%	131.888	118.147		324.004

2)Irrigation systems

Table 3.1.4-14 shows data on existing irrigation systems in watershed of the Majes - Camana River. There are 58 water inlets and 79 water direct inlets. Besides, there are 58 main channels, 128 primary ones, 54 secondary and 5 tertiary. Main channels have an accumulated length of 167.24 km. Lagged channels amount 3,498 km, while 334,019 km have no lagging.

3)PERPEC

Table 3.1.4-15 shows implemented projects by PERPEC between 2006 and 2009.

Table 3.1.4-14 Present conditions of irrigation channels

IRRIGATION COMMISSION	Number of Water Inlets	Number of Direct Water Inlets	N° of Intakes and sluicegates at CD level				Number of channels				Long. de C.D. (Kms.)	Total System Length	
			Housing inlets	N° of sluicegates	Lateral inlets	N° of sluicegates	C.D.	1er.	2do.	3er.		Lagged (Kms.)	Rustic (Kms.)
ONGORO	5	5	63	35	25	25	5	25	6	0	30.064	0.363	69.600
ONGORO BAJO	3	6	49	0	4	0	3	4	1	0	9.841	0.600	11.586
	2	0	29	0	2	0	2	2	0	0	5.530	0.000	7.880
BERINGA	1	2	37	0	4	0	1	4	3	0	3.976	0.000	9.140
COSOS	1	0	47	2	6	2	1	6	1	0	5.933	0.000	9.660
APLAO	2	0	39	1	10	1	2	10	3	0	7.401	0.000	20.483
HUANCARQUI	3	0	36	0	10	0	3	10	12	2	7.653	0.000	29.180
TOMACA	3	0	47	0	1	0	3	1	0	0	6.664	0.000	7.604
LA REAL	2	0	71	0	9	0	2	9	3	1	6.508	0.360	12.884
	0	4	0	0	0	0	0	0	0	0	0.000	0.000	0.000
MONTE LOS PUROS	1	1	66	2	7	1	1	7	5	1	4.941	0.000	16.766
	0	8	0	0	0	0	0	0	0	0	0.000	0.000	0.000
QUERULPA	5	2	78	2	4	0	5	4	0	0	7.439	0.000	10.457
	4	3	71	0	3	0	4	3	0	0	5.225	0.000	6.944
URACA	1	0	34	9	3	1	1	3	7	1	7.930	0.090	20.886
	8	23	48	0	1	0	8	1	1	0	8.011	0.000	8.616
SOGIATA	1	0	42	0	8	0	1	8	2	0	7.650	0.000	16.920
	0	9	0	0	0	0	0	0	0	0	0.000	0.000	0.000
SAN VICENTE	1	0	26	0	7	3	1	7	2	0	3.925	0.000	9.655
	2	2	21	0	0	0	2	0	0	0	3.100	0.000	3.100
CANTAS PEDREGAL	2	0	33	4	6	1	2	6	4	0	4.770	2.085	15.512
PITIS	2	0	97	0	5	0	2	5	1	0	6.252	0.000	11.385
	1	1	8	0	0	0	1	0	0	0	0.160	0.000	0.160
SARCAS - TORAN	6	2	76	2	8	0	6	8	2	0	18.801	0.000	28.412
	1	11	10	0	0	0	1	0	0	0	0.940	0.000	0.940
EL GRANADO	1	0	15	0	3	0	1	3	1	0	4.526	0.000	6.249
TOTAL	58	79	1,043	57	126	34	58	126	54	5	167.240	3.498	334.019

Table 3.1.4-15 Projects implemented by PERPEC

Nº	YEAR	Work	Location				Description			Total Cost (S/.)
			Departament	Province	District	Town				
1	2006	Construction of a Rockfill Dike - Huantay Sector	Arequipa	Camana	Ocoña	Huantay	Conformacion de Dique	0.27	Km	150,000.00
2	2006	Construction of breakwaters and rockfill dikes in the Majes Valley	Arequipa	Castilla	Aplao y Uraca	El Granado	Rockfill Dike	0.2	Km.	607,186.00
3	2006	Construction of Coastal Defense - Quilca Valley Sector	Arequipa	Camana	Quilca	El Platanal	Conformacion de Dique	0.36	Km.	81,305.00
4	2006	Majes River Coastal Defense - Montes Sector	Arequipa	Castilla	Aplao	El Monte	Conformacion de Dique	0.34	Km.	96,000.00
5	2006	Construction of Coastal Defense - Ocoña Valley, Jayhuiche Sector	Arequipa	Camana	Mariano Nicolas Valcarcel	Jayhuiche	Rockfill Dike	0.27	Km.	149,992.00
6	2006	Construction of rockfill dike - Zurita Sector	Arequipa	Camana	Ocoña	Zurita	Conformacion de Dique	0.3	Km.	151,484.00
7	2006	Construction of Coastal Defense - Ocoña Valley, Santa Rita Sector	Arequipa	Camana	Ocoña	Santa Rita	Conformacion de Dique	0.3	Km.	149,487.00
8	2007	Construction of coastal defense - Querulpa Tomaca Sectors	Arequipa	Castilla	Aplao, Huancarqui	Querulpa Tomaca	Breakwater with Rock	0.67	Km	380,233.00
9	2007	Construction of dike with breakwaters - El Platanal Sector, Quilca District, Province of Camana - Arequipa	Arequipa	Camana	Quilca	El Platanal	Breakwater with Rock	0.42	Km	259,174.00
10	2008	Construction of Provisional Coastal Defense Construcción in the Majes River - Los Puros Sector, Aplao District, Province of Castilla - Arequipa (Contingency)	Arequipa	Castilla	Aplao	Los Puros	Construction of Dike and Breakwaters	0.18	Km	117,215.00
11	2008	Construction of Provisional Coastal Defense in the Ocoña River - Santa Rita Sector, Ocoña District, Province of Camana - Arequipa (Contingency)	Arequipa	Camana	Ocoña	Santa Rita	Construction of Dike and Breakwaters	0.23	Km	97,066.00
12	2008	Construction of Provisional Coastal Defense in the Majes River - San Vicente and Sacramento Sectors, Uraca District, Province of Castilla - Arequipa (Contingency)	Arequipa	Castilla	Uraca	San Vicente y Sacramento	Construction of Dike and Breakwaters	0.3	Km	124,952.00
13	2008	Construction of rockfill dike - Sonay Sector (Prevention)	Arequipa	Camana	Nicolas de Pierola	Sonay	Descolmatacion y conformacion de dique	0.4	Km	230,058.00
14	2008	Construction of coastal defense - Anchalo Huacan Sector - Ocoña Valley (Prevention)	Arequipa	Camana	Ocoña	Huancan	Rockfill Dike	0.26	Km	123,352.00
15	2008	Construction of Rockfill Dike - Huantay Sector - Ocoña Valley (Prevention)	Arequipa	Camana	Ocoña	Huantay	Rockfill Dike	0.28	Km	117,348.00

3.1.5 Real flood damages

(1) Damages on a nationwide scale

Table 3.1.5-1 shows the present situation of flood damages during the last five years (2003-2007) in the whole country. As observed, there are annually dozens to hundreds of thousands of flood affected inhabitants.

Table 3.1.5-1 Situation of flood damages

		Total	2003	2004	2005	2006	2007
Disasters	Casos	1,458	470	234	134	348	272
Victims	personas	373,459	118,433	53,370	21,473	115,648	64,535
Victims dof housing	personas	50,767	29,433	8,041	2,448	6,328	4,517
Dead	personas	46	24	7	2	9	4
Partially destroyed housings	Housing	50,156	17,928	8,847	2,572	12,501	8,308
Totally destroyed housings	Housing	7,951	3,757	1,560	471	1,315	848

Source : Compedio estadisticos de SINADECI

Peru has been hit by big torrential rain disasters caused by the El Niño Phenomenon. Table 3.1.5-2 shows damages suffered during the years 1982-1983 and 1997-1998 with extremely serious effects. Victims were approximately 6,000,000 inhabitants with an economic loss of about US$ 1,000,000,000 in 1982-1983. Likewise, victims number in 1997-1998 reached approximately 502.461 inhabitants with economic loss of US$ 1,800,000,000. Damages in 1982-1983 were so serious that they caused a decrease of 12 % of the Gross National Product.

Table 3.1.5-2 Damages

Damages	1982-1983	1997-1998
Persons who lost their homes	1.267.720	—
Victims	6.000.000	502.461
Injured	—	1.040
Deceased	512	366
Missing persons	—	163
Partially destroyed houses	—	93.691
Totally destroyed houses	209.000	47.409
Partially destroyed schools	—	740
Totally destroyed schools	—	216
Hospitals and health centers partially destroyed	—	511
Hospitals and health centers totally destroyed	—	69
Damaged arable lands (ha)	635.448	131.000
Head of cattle loss	2.600.000	10.540
Bridges	—	344
Roads (km)	—	944
Economic loss ($)	1.000.000.000	1.800.000.000

"–": No data

(2) Disasters in the watersheds object of this study

Table 3.1.5-3 summarizes damages occurred in the region, that the presents study is part of.

Table 3.1.5-3 Disasters in the Region

Piura

0

Años	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Media
ALUD																	0	
ALUVION																	0	
DERRUMBE									6	1	2	1		1			11	
DESLIZAMIENTO		1		2		1	4		5		1	6	5	7	5	3	40	
HUAYCO				1				1	1			1					4	
TOTAL DESASTRES DE SEDIMENTOS	0	1	0	3	0	1	4	1	12	1	3	8	5	8	5	3	55	3
TOTAL INUNDACIONES	0	0	5	51	9	3	5	14	3	5	6	14	8	22	0	1	146	9

Lima

Años	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Media
ALUD																	0	
ALUVION																	0	
DERRUMBE									14	4	17	32	15	22	10	23	137	
DESLIZAMIENTO	1	3	1	4	2	1	3	4	5	4	2	1	5	5	2	7	50	
HUAYCO	6		2	17	17	4	2	11	8	4	0	7		3	3	3	87	
TOTAL DESASTRES DE SEDIMENTOS	7	3	3	21	19	5	5	15	27	12	19	40	20	30	15	33	274	17
TOTAL INUNDACIONES	2	2	1	23	21	9	15	5	13	11	7	10	11	4	4	0	138	9

Ica

Años	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Media
ALUD																	0	
ALUVION																	0	
DERRUMBE											2						2	
DESLIZAMIENTO									2	1				1			4	
HUAYCO	2		2		5	2				2	1	1	3	1		1	20	
TOTAL DESASTRES DE SEDIMENTOS	2	0	2	0	5	2	0	0	2	3	3	1	3	2	0	1	26	2
TOTAL INUNDACIONES	4	4	0	13	14	1	2	0	0	1	1	0	4	6	1	0	51	3

Arequipa

Años	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Media
ALUD																1	1	
ALUVION											5						5	
DERRUMBE						1	1	1								1	4	
DESLIZAMIENTO		1		1	1	2	1	1	4	3	4	2			1	2	23	
HUAYCO	6	1	7	14	3	2	4				2	2	1		9	3	54	
TOTAL DESASTRES DE SEDIMENTOS	6	2	7	15	4	5	6	2	4	3	11	4	1	0	10	7	87	5
TOTAL INUNDACIONES	3	1	42	6	44	2	15	3	1	2	2	3	0	1	3	3	131	8

Total de 4 dept.

Años	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Media
ALUD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
ALUVION	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	5	
DERRUMBE	0	0	0	0	0	1	1	1	20	5	21	33	15	23	10	24	154	
DESLIZAMIENTO	1	5	1	7	3	4	8	5	16	8	7	9	10	13	8	12	117	
HUAYCO	14	1	11	32	25	8	6	12	9	6	3	11	4	4	12	7	165	
TOTAL DESASTRES DE SEDIMENTOS	15	6	12	39	28	13	15	18	45	19	36	53	29	40	30	44	442	28
TOTAL INUNDACIONES	9	7	48	93	88	15	37	22	17	19	16	27	23	33	8	4	466	29

3.1.6 Investigation of Study Sites

JICA Study Team made some technical visits to the selected watersheds and identified some challenges on flood control through visits and interviews to regional government authorities and irrigation associations on damages suffered in the past and the problems each watershed is currently facing.

(1) Chira River

Critical points:

- Special Project Chira-Piura was elaborated 40 years ago
- Poechos dam is being operated for hydraulic generation, drinking water supply, irrigation water and for tilapia farming
- One of the objectives of the dam is to protect Chira and Piura communities against floods

- Communities were affected in 1983 due to floods caused by El Niño and as solution dikes have been built. In 1998 floods, also caused by El Niño, communities almost did not suffered any damage, but the dikes were eroded by a total of 5km. There are works that are still "provisional" due to the lack of economic resources
- The design flow was modified from 5.000m^3/s to 7.600m^3/s (return period of 100 years)
- The discharge valve of the Poechos dam is deteriorated by flow effects that drop from the floodgate and is one of the critical points

(Current site conditions: at the moment of the technical visit)

○ Section of the eroded dike caused by El Niño (D1011～D1013)

- In the technical visit it was noted that the affected section had been totally built and repaired

○ Section of the eroded dike caused by El Niño (D1020)

- In the technical visit it was noted that the affected section had been almost totally repaired but some banks were not protected
- Protected elements are agriculture lands (vegetables and cotton) and natural gas production areas. This natural gas installations are part of the private sector, but this resource is used in the near thermal power generation plant
- The bed of the area has reduced 2 meters due to 1998 floods
- For floods it is important to take measures not only to bear peak flow but also for a 3.000m^3/s flow because the river has this flow for a pretty long time
- The tide causes a variation between 1 and 1.2 meters

○ Section of the eroded dike caused by El Niño (D2040)

- During the technical visit it was noted that the affected section had been almost totally built and repaired, but some banks were not protected

○ Section of the eroded dike caused by El Niño (D2052)

- During the technical visit it was noted that there is a section (km 24.5 – 27) which dike is still provisional and that the banks were not protected enough

○ Section of the eroded dike caused by El Niño (D3110, D4130)

- During the technical visit it was noted that the affected section had been almost totally built and repaired, but some banks were not protected

○ Eroded bank (km 11.5 – 12.5, right bank)

- The eroded area extended due to 2008 floods. There is a road along the river that connects communities of the lower watershed (Vichayal, Miramar and Vista Florida) and this will be damaged in future floods

○ Eroded bank 2 (km 73, right bank)

- Great banana plantations are along the river in this area
- There is an approx 5km path where crops lands have been lost due to the banks erosion

○ Eroded bank 3 (km 98, right bank)

- ➢ Miguel Checa Channel is built along the river in this area for irrigation purposes, with a 70m^3/s flow
- ➢ Erosion continues and it is probable that the channel is eroded by future floods

○ Sullana Intake (km 64)

- ➢ During field recognizance it was noted that on the right bank, between the fixed dams for flood control the sediments were gathering and that there was dense vegetation too. If no adequate measures are taken, the water will not flow through the fixed dams and may overload the mobile dam (intake) of sand and damage it

○ Erosion under Poechos dam (km 99.5)

- ➢ During field recognizance it was noted that on the left bank immediately below the discharge mouth the area was severely eroded, with the risk of collapsing if no measures are taken. Currently, the immediate affected areas under the dam have been repaired provisionally (bank protection, etc)

(Others)

○ Poechos Dam interview

- ➢ There are 3 floodgates. The maximum discharge flow is between 5.000 and 5.500m^3/s. Power dissipation is done through ski jumps. Immediately under the discharge mouth there is an eroded area of 25 meters
- ➢ During El Niño floods 3800m^3/s were discharged. The flow in Sullana downstream was between 6.000 and 6.5000m^3/s
- ➢ For electrical power, 200 m^3/s are being discharged and this same amount of water is used for irrigation of the lower watershed
- ➢ 80m^3/s are being discharged to Piura for agriculture, industrial and human consumption use
- ➢ Previously, there were breakwaters immediately downstream the dam, which were destroyed by water discharge
- ➢ It is the biggest dam of the country, with a storage capacity of 800 million MT
- ➢ 50% of the Poechos dam has sediments, reaching a critical level (400 million MT according to a total of 800 million MT), and there is no concrete measure for its solution
- ➢ Periodic sediment lifting is being done

○ Interview results on dike construction works

- ➢ The sub-base crown materials have been obtained from Macacara. The rest of materials were obtained from agricultural lands of both banks
- ➢ Protection stones from the dike were obtained from Cabo Mesa

○ Interview results on early alert system

- ➢ There is an early alert system for Piura River. However, for Chira River there is not even a plan

(Next, we present data collected through interviews about the Piura River System)

- There are 12 stations within Piura River (7,500km^2)
- These 12 stations have automatic pluviometers with satellite telemetry
- Apart from the 12 mentioned stations, there are 30 manual type stations with radio communication system
- Data will be analyzed with NAXOS program
- The current system emits an alert within the 48 hours, it has been used since 2002
- Until 2008 a radio communication system was used, but in 2008 the solar panels were stolen from the central station, in which data from other stations was gathered, being inoperative. That is how the satellite telemetry system was installed
- Currently, station's data is transmitted by satellite
- The precipitated water of the Piura River upper watershed delays its arriving, due to which the system predicts the water level in the lower watershed 48 hours after rain occurs. In case of 2,000m^3/s, the arrival time is approximately 12 hours
- The alert is emitted when the flow surpasses 1,500m^3/s
- The system divides the Piura River Watershed in 720 segments
- On the floods of 2002, with a flow of 3.800m^3/s, the foreseen flow was about 3.600m^3/s
- Floods data are transmitted from the Chira-Piura Special Project to Civil Defense
- Half the watershed belongs to Ecuador, so the pluviometer has to be installed there too
- The major problem right now is the constant stealing of solar panels. Currently, surveillance has been hired in the two affected stations, also the panels have been secured properly against robbery

(2) Description of the visit to the study sites

Figure 3.1.6-1 shows pictures of main sites visited.

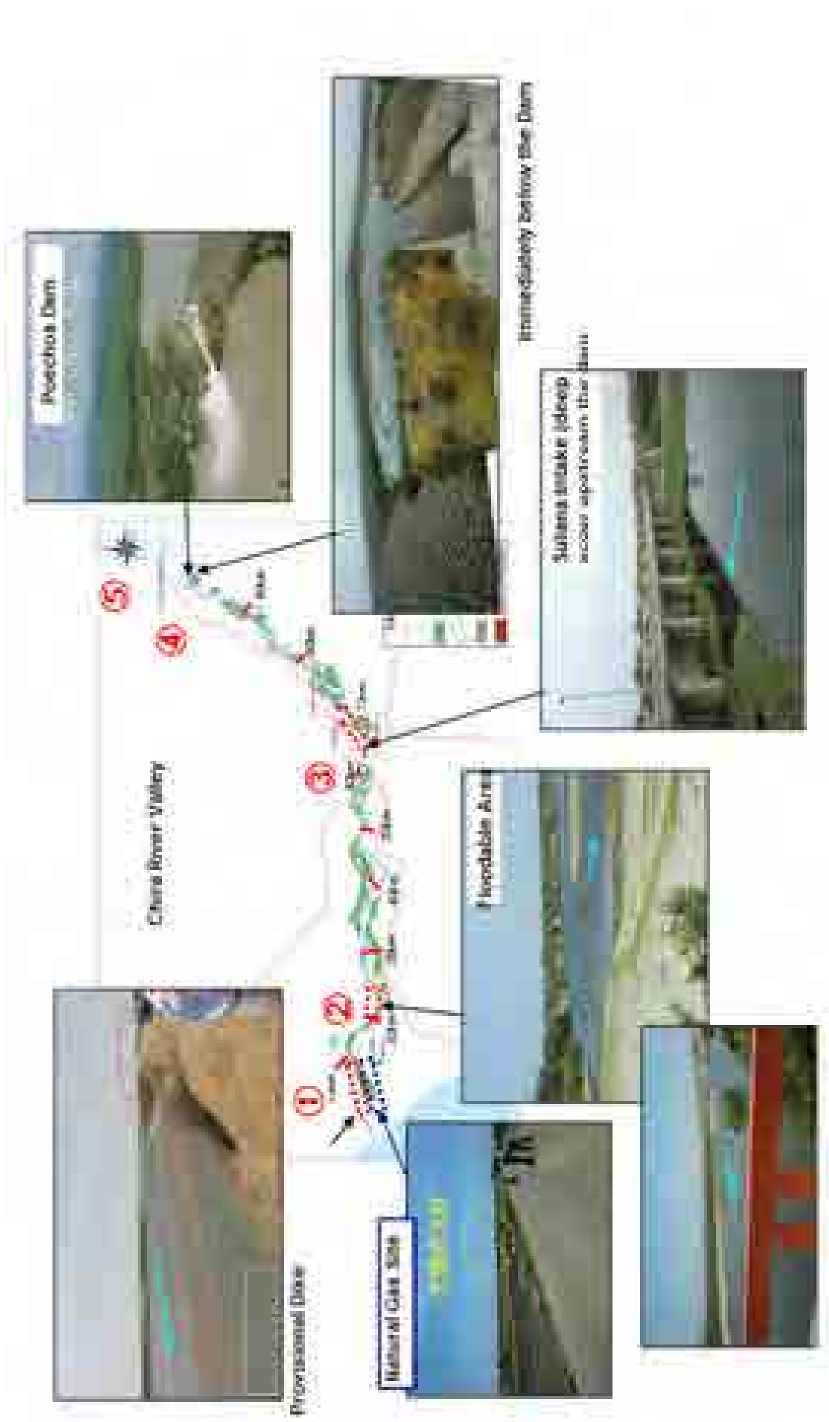


Figure 3.1.6-1 Visit to the Study Site (Chira River)

(3) Challenges and measures

The following Table shows challenges and possible solution measures for flood control considered at this moment, based on the results of technical visits.

1) Challenge 1: Frequent banks erosion for floods caused by El Niño

Current situation and challenges	・Necessary measures were taken on the affected area due to 1983 El Niño. In 1998 event, also by El Niño, no floods occur but the dike was eroded ・Currently, the flow design with modified design is being reviewed, but due to the lack of economic resources, the situation is being controlled by a provisional dike ・There are only 8 sections of the affected dike that have been studied and their metering is a great challenge
Main elements to be conserved	・Agricultural lands (main product: cotton and banana) ・Natural gas fields (12 currently exploited fields which resources are used to generate electricity in the area)
Basic measures	・Elevate the provisional dike's height and execute bank protection works ・Protect the floor (measure against bed height reduction)

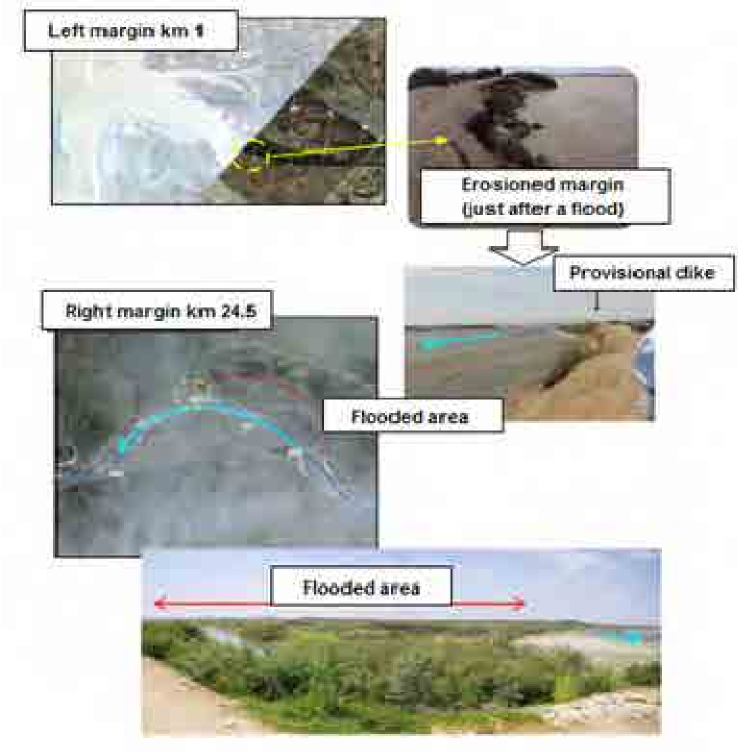


Figure 3.1.6-2 Local conditions related with Challenge 1 (Chira River)

2) Challenge 2: Frequent bank erosion due to El Niño floods

Current situation and challenges	・Several bank erosion damages occurred in the floods of 1998 due to El Niño ・There are several crops fields, roads and irrigation channels that are un-protected, and susceptible to be severely damaged if erosion continues
Main elements to be conserved	・Crop lands (main product: bananas) ・Main regional road ・Main irrigation channels
Basic measures	・Execute bank protection works to control erosion expansion

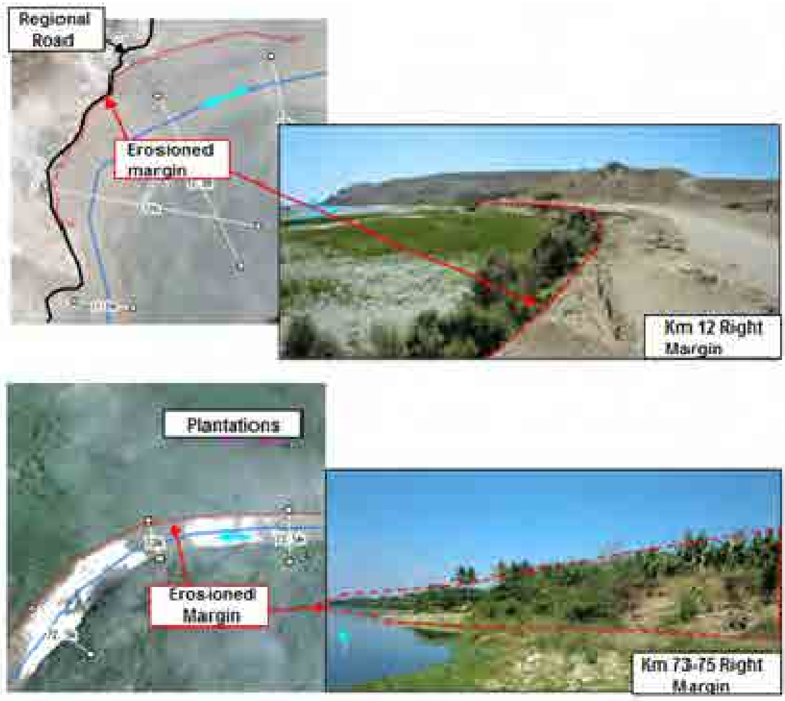


Figure 3.1.6-3 Local conditions related with Challenge 2 (Chira River)

3) Challenge 3: Direct dike erosion due to the water's discharge

Current situation and challenges	・The left margin immediately downwards the dam has been erosioned during floods water discharges ・It is probable that the dam is affected if floods of the same magnitude occur ・Currently, the immediate eroded sector under the dam is being provisionally repaired (margin protection works)
Main elements to be conserved	・Dam's body
Basic measures	・Built retarding reservoirs (to reduce floods peak stream) ・Built an intake (to integrate the existing small works)

Figure 3.1.6-4 Local conditions related with Challenge 3 (Chira River)

(2) Cañete River

Critical points:

- ➢ The area under Irrigation Commission control begins in SOCSI (Km 25) downwards
- ➢ Due to El Niño phenomenon, floods of 800m3/s happened. There is a monitoring place in SOCSI, where the normal stream is between 7 and 250m3/s
- ➢ The bridge on the Panamericana Road was impassable due to the

sediments accumulation during the event. Also, the river flooded upstream the bridge when the level of water rose on the bridge. The overflow produced agricultural land erosion and the width of the river grew to 200mt. This section (only the critical section) has been protected with a dike built by PERPEC

- ➢ Downstream Panamericana Road, the river's width grows year after year
- ➢ Under the Irrigation Commissions' jurisdiction there are 4 intakes. From these four, three did not suffer important damages due to the El Niño Phenomenon because they were made of concrete. The only intake that was not made of concrete is being manually repaired
- ➢ There is a hydroelectric plant upstream SOCSI

(Other: visited sites by the Study Team)

○ Panamericana (km 4.3)

- ➢ The floods of 1998 reached over the bridge, the ricer flow grew approximately 2mt due to this event
- ➢ The bridge was re-built around the sixties. The former bridge was destroyed by 1960 El Niño Phenomenon
- ➢ Currently, a new bridge is being built in the Panamericana Road downstream the current bridge

○ Overflowing section (km 7.5)

- ➢ This is one of the three overflowing sections that exist in this area (Lucumo, Cornelio and Carlos Quinto). All of which overflow on their right bank
- ➢ The built dike 10 years ago was dragged by floods and has been re-built 5 years ago by Civil Defense
- ➢ The water and sediments that have overflow extend on agricultural lands, destroying all crops
- ➢ The scour product of floods cause dike collapse, this leads flooding.

○ Fortresa Intake: km 10.2)

- ➢ Was repaired in 2001
- ➢ This intake has not suffered serious damages from the El Niño Phenomenon
- ➢ The beneficiary area reaches 6,000 ha

○ Nuevo Imperial Intake: km 24.5)

- ➢ The flow up to 150m3/s enters the intake and the excess is naturally derived to the left bank
- ➢ During El Niño Phenomenon of 1998 accumulated sediments in the intake stopped the water entrance and the water could not be taken for more than a month
- ➢ Agricultural lands of the right bank 500mt upstream the intake were flooded. It is possible that on the next El Niño Phenomenon floods erosion the road along the river

○ Stream observation Station (SOCSI: km 27.2)

- ➢ There is a SENAMI Observation Station
- ➢ The flow in the rainy season of an ordinary year is approximately

250 m3/s, which grow up to 350 m3/s during the El Niño Phenomenon of 1998

- Since 1986, the flow speed on the bridge is being monitored every year (The flow is measured by calculating the flow speed per meter over the bridge). Every data is delivered to SENAMI

(2) Description of the visit to the study sites

Figure 3.1.6-5 shows pictures of main sites visited.

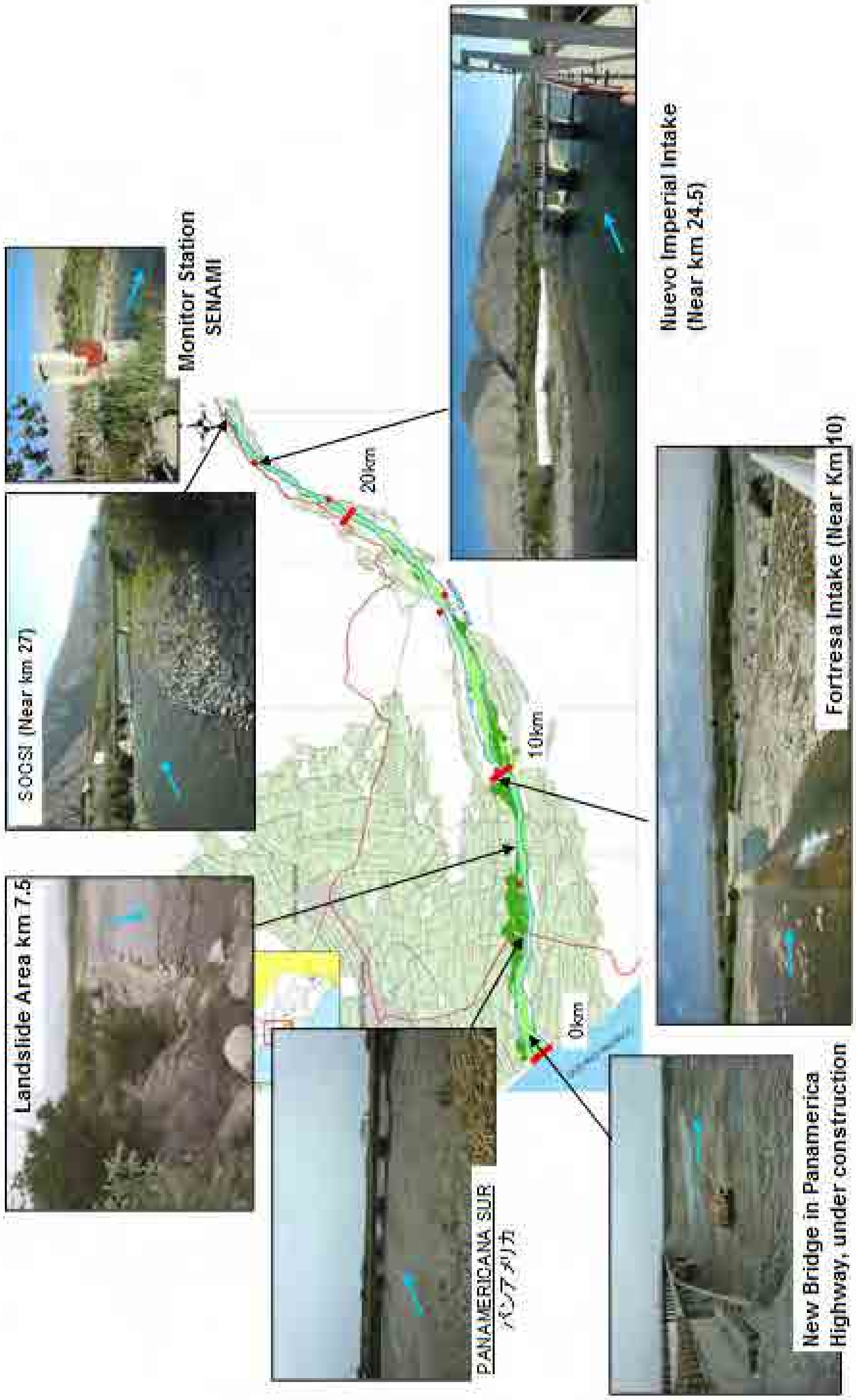


Figure 3.1.6-5 Visit to the Study Site (Cañete River)

(3) Challenges and measures

The following Table shows challenges and possible solution measures for flood control considered at this moment, based on the results of technical visits.

1) Challenge 1: Intake and bank erosion (km 24-25)

Current situation and challenges	・During 1998 floods, accumulated sediments in the intake stopped water taking for more than a month. It is probable that this repeats, so, the measures to control the Entrance of sediments must be controlled ・Upstream the dam, banks have been eroded by the overflows that happened in the past, causing agricultural land loss. Because the eroded section is near the road, future overflows that may happen with the same magnitude are risk to destroy vial infrastructure
Main elements to be conserved	・Road ・Intake
Basic measures	・Derivation Works building upstream the intake, aiming to control adequate flow distribution during overflowing ・Measures execution against bank erosion (breakwater, etc.)

Figure 3.1.6-6 Local conditions related with Challenge 1 (Cañete River)

2) Challenge 2: Overflowing area (around km 7.5)

Current situation and challenges	・1998 floods destroyed the dike causing loss on agriculture field ・In this area there are three destroyed sections of the dike (all of them on the right bank) ・The water's greater impact area is on km 7.5, right bank. The fast and great flow causes scouring of the bed and consequently, the dike's destruction. Currently, the dike has been repaired, but there is still risk of destruction if great floods take place
Main elements to be conserved	・Crop land (main products: apple, grapes, cotton)
Basic measures	・Dike and bank protection building for bank erosion control

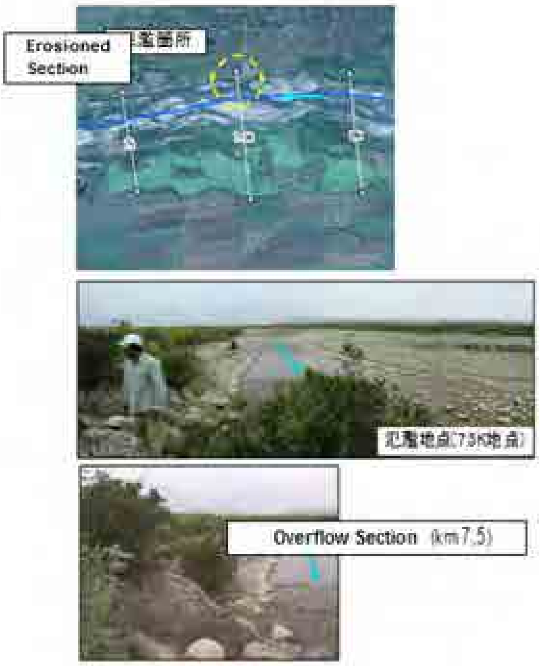


Figure 3.1.6-7 Local conditions related with Challenge 2 (Cañete River)

3) Challenge 3: Narrow Section (km 4.3)

Current situation and challenges	In 1998 floods, the river overflowed, flooding Panamericana Highway. The sediment accumulation did not allow transit temporarily ・Panamericana Highway coincides with the narrow section of the river. In this section, the water level rises upstream accumulating sediments and causing overflowing ・Only the critical section (approx. 200 m) has been protected with a dike, but not the other sections
Main elements to be conserved	・Panamericana Highway ・Crop land (main products: apples, grapes and cotton)
Basic measures	・It is not possible to execute bridge repair works at the moment, due to which it is necessary to take other actions to ensure the necessary hydraulic capacity (bed drilling, etc)

Figure 3.1.6-8 Local conditions related with Challenge 3 (Cañete River)

(3) **Chincha River**

(Critical conditions)

- The stream has only a capacity of 100m3/s to flow, and when overflowing of 1.200 m3/s happened, the river overflowed
- Basically, the river's water must be derived in a relation 1:1, and this relation is changed when overflowing occurs. If these can be adequately maintained regarding its derivation, the problem would be solved
- There are 2 critical sections: Km15 of Chico River and Km16 of Matagente River
- There is a 16Km section (between Km 10 and 16) of Matagente River that is very sedimented, this may lead to an overflow
- Chico River overflows on curvy section on Km 15
- The overflow water floods very quickly up to the lower watershed due to the local slope
- When the three intakes stop working, the producers can not irrigate their lands
- The three intakes were built in 1936. The derivation works in the upstream extreme was built in 1954
- River has water from January to March; the rest of time, from groundwater
- There are 7 reservoirs at 180km upstream, with a total capacity of $104\times10^6m^{3.}$ The water is collected between January and July and is given since August
- According to the Water Society President, Matagente River overflowing was a problem more than 20 years ago since he lives in the area. The bed is continuing to rise at a 4 to 5 meters pace in the last 50 years. A dike was built to control overflowing
- The problem takes place annually, since December until the end of March. Every year, 10 floods of 5 to 6 hours each take place (max 12 hours). When floods are frequent, derivation works are obstructed on one side and this overflows water
- It is a elevated bed river
- All the upper watershed area is constituted by collapse area
- The overflow water from the river returns to it through local channels
- Sometimes, channels overflow water leads to flood in Chincha
- Main products are cotton and grapes
- The stream is measures by upstream derivation works

(Other: visited sites by the Study Team)

○ Chamorro Bridge (Matagente River)
- Finish built in 1985

○ Matagente Bridge (Matagente River)
- Built to allow a 200m3/s flow (initially projected for $550m^3/s$)
- There is a project to elongate the dike until the flood area downstream

○ Intake (Matagente River)

- ➢ Water intake is between January and March
- ➢ All the water is taken, this River is depleted in this season. Since dam's water is been taken, there is no need to stop flowing downstream

○ Chico River Intake (Chico River)

- ➢ There is a purifying plant, but currently it is not working

(2) Description of the visit to the study sites

Figure 3.1.6-9 shows pictures of main sites visited.

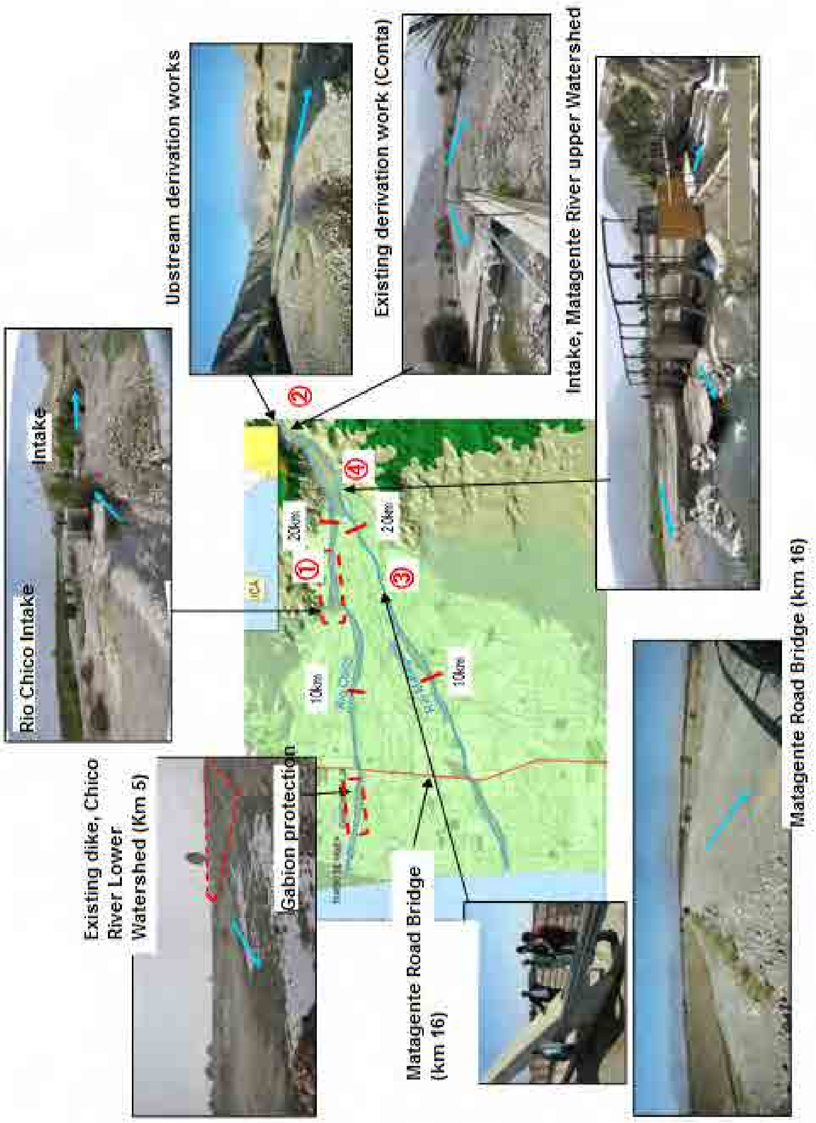


Figure-3.1.6-9 Visit to the Study Site (Chincha River)

(3) Challenges and measures

The following Table shows challenges and possible solution measures for flood control considered at this moment, based on the results of technical visits.

1) Challenge 1: Derivation works (Km 24)

Current situation and challenges	・The problem is from December to March. Approximately, 10 floods of 5 to 12 hours happen. Max flow in El Niño event reached 1.200m^3/s. ・According to design the river water must be derived within a relation 1:1, and this relation dose not happen when frequent overflows take place
Main elements to be conserved	・Lower watershed crop area ・Urban Area of Chincha
Basic measures	・Rehabilitation of destroyed installations and existing dikes reinforcement ・Extend longitudinal dike upstream of the intake ・Channels rehabilitation upstream of the intake

Figure 3.1.6-10 Local conditions related with Challenge 1 (Chincha River)

2) Challenge 2: Intake (km 21 of Matagente)

Current situation and challenges	・Water intake is in January through March. This was built in 1936 ・It is one of the most important intakes in the area
Main elements to be conserved	・Lower basin crop land (main products: cotton and grapes)
Basic measures	・Compact the bed immediately Downstream the deteriorate intake, repair the longitudinal dike and reinforce the existing dike

Figure 3.1.6-11 Local conditions related with Challenge 2 (Chincha River)

3) Challenge 3: Intake (Rio Chico, km 15)

Current situation and challenges	・Water intake is in January through March. This was built in 1936 ・In the past water has overflow on the left bank ・Channel width is reduced near the intake, gathering overflows in this area
Main elements to be conserved	・Lower basin crop land (main products: cotton and grapes)
Basic measures	・Rehabilitate the existing dike (repair and reinforce deteriorate parts of the dam) ・Stable scour of overflows through increase and rehabilitation of channels

Figure 3.1.6-12 Local conditions related with Challenge 3 (Chincha River)

(4) Pisco River

(On critical points)

- The 1st critical point is 1.5 km downstream the bridge (km7). Flooded water floods the left bank's community. There is no dike under this point (1,5km from the bridge)
- The 2nd critical point is 11.5km away, where flood to the left bank is produced
- There is an intake on km 14.5. The work itself is not destroyed, but what is destroyed is the protection constructed on the right bank. There is a water channel connected to the urban area and an irrigation channel that covers all the left bank
- There are cement blocks criss-crossed on the left bank (km 12.5 and 13.5)
- The bed has elevated 3 meters approximately in the last 40 years (between 1970 and 2010)
- 40 years ago the dike existed but no floods existed. Nowadays, the dike exists and it produces floods
- There is purify plant and an intake on km 28
- The 3rd critical point is on km 20.5. Conduction tubes were dragged when the flood occurred on this area
- There are 5 reservoirs upstream, with a total capacity of 54 x 106m^3.
- When El Niño occurred in Quitasol, 50km upstream, always produces floods

(Others: visited sites by the Study Team)

○ Intake, km 27.5

- Currently 7m3/s of water are taken (to supply 620 ha of agricultural lands)
- A bank against overflowing was built on the right bank
- Flood season: December through March

○Flood point, km 5,5

- Bank protection works were executed using track type tractors, hydraulic shovels and trailers. The stones were brought from upstream the intake
- With this section 500m3/s of water will flow (during El Niño a 700m3/s flow was reduced and we adopted the minimum value of such event)
- The left bank's area is private property, but it was decided to adopt this width considering that is not necessary to buy the land
- There are cement blocks criss-crossed up to the bed's height + 2meters
- There is no other disaster prevention plan in this area
- We are planning to build a new bridge 100meters downstream the existing bridge in km7 (Panamericana Highway)
- The project's building cost of the dike + cement blocks installation (L=800mts on both banks) is estimated in S/. 960.000 (equivalent to 30 million Japanese yens)

○Km 13.5 (Floodable area)

- A new dike on the exterior of the former dike is being built on the left bank. However, the work was stopped without being finished. The soil of the area was originally crop soil and then passed to be State land, 2 years was this area abandoned
- The construction cost of the dike of 600 meters is $850.000

○Casaya Intake

- The intake was not destroyed by floods, but the right bank protection did

○Murga Bridge

- Left bank protection was not destroyed during 1998 floods, but was destroyed during the February 1999 event. The penetration depth was approx. 1meter

○Montalbán Intake

- The intake was destroyed due to 1998 floods. Previously, the upstream bed was elevated and the high waters entered into the right bank (where the intake is) destroying the floodgate
- Water level reaches chest height
- Right bank’s channel was buried
- The river’s width at the intakes area is 90m approx., which is narrower than the upstream and downstream sections. The land of the left bank is private property
- The value of agricultural lands is approx. $5,000 per hectare (10,000 m^2).

○Francia Intake (between km 19.5 and km 20)

- Because this area is not protected, both banks flooded
- The bed has risen in the last years
- Limit demarking of private properties has been investigates by MINAG in 1998. Originally, this work was done by INRENA and then passed to MINAG. It is probable that there is similar information in another watershed

(2) Description of the visit to the study sites

Figure 3.1.6-13 shows pictures of main sites visited.

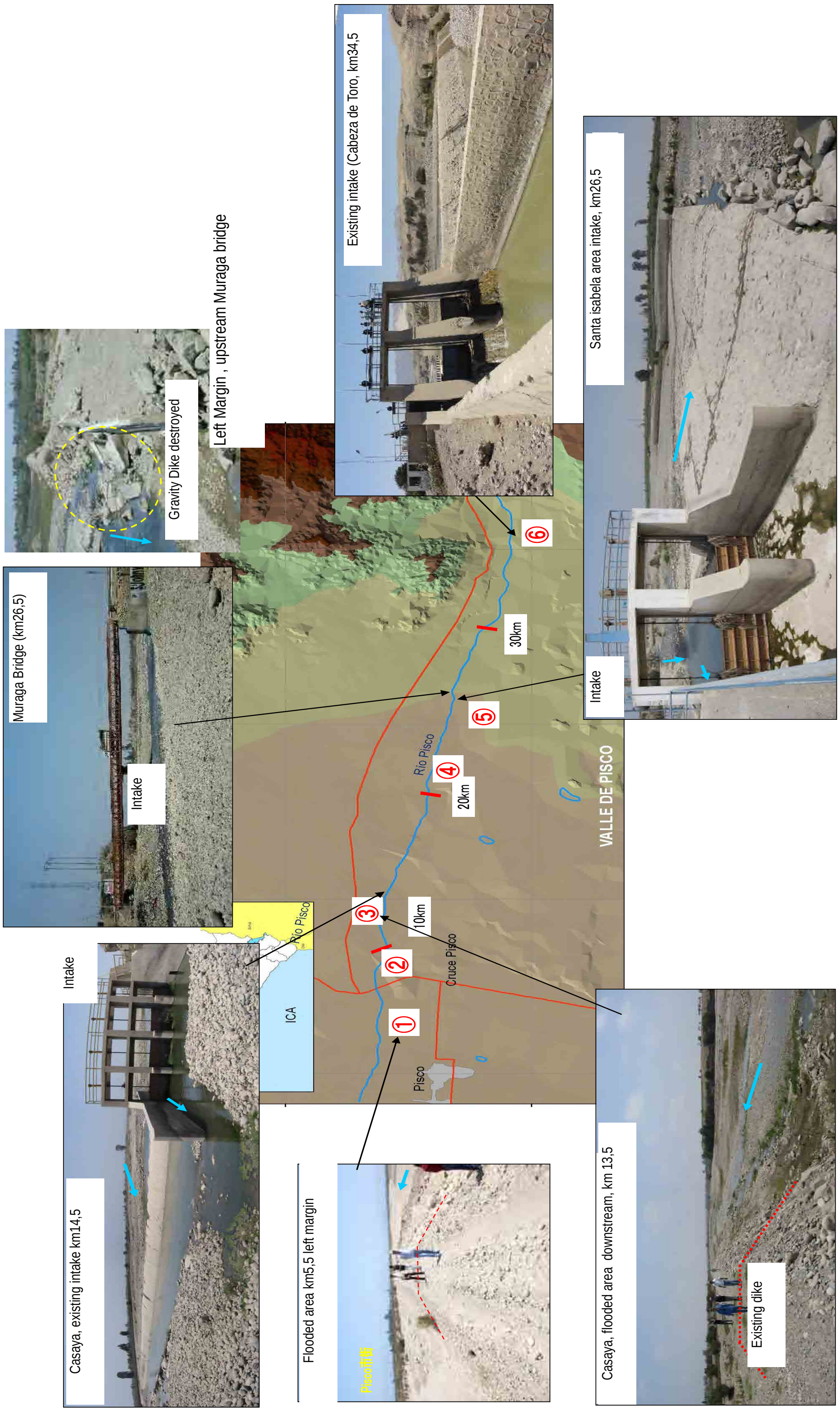


Figure 3.1.6-13 Visit to the Study Site (Pisco River)

(3) Challenges and measures

The following Table shows challenges and possible solution measures for flood control considered at this moment, based on the results of technical visits.

1) Challenge 1: Flood area (km 5.5)

Current situation and challenges	・A flood of 700 m^3/s was registered during El Niño ・Pisco Municipality was flooded by the overflow of the left bank in km 5.5 ・The bed has been rising up approx 3meters in the past 40 years ・The dike needs to be extended to the lower region, but there is no actual concrete plan
Main elements to be conserved	・Agricultural lands ・Pisco urban area
Basic measures	・Construct a dike on the non-protected section ・Bank protection works

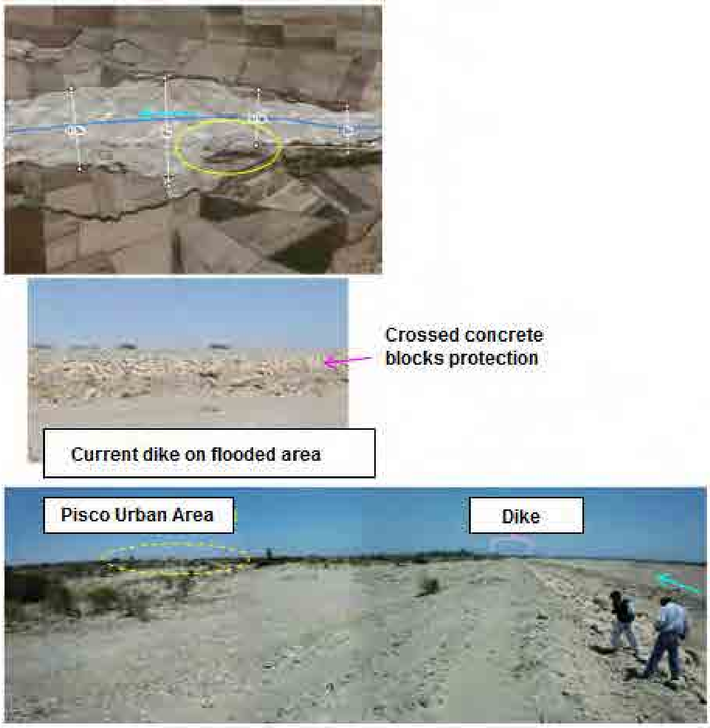


Figure 3.1.6-14 Local conditions related with Challenge 1 (Pisco River)

2) Challenge 2: Intake (km 26.5)

Current situation and challenges	・During El Niño in 1998, the overflow waters gathered on the intake and destroyed it. Also, the channels were buried ・Currently, the intake and the channel have been repaired ・The river’s width to the intake’s height is 90meters and is narrower Downstream than upstream (between 250 and 500meters)
Main elements to be conserved	・Agricultural lands (main products are not known currently)
Basic measures	・Rehabilitate destroyed installations and reinforce the existing dike ・Stable water flow throughout widening and rehabilitation of channels, buying the necessary lands

Figure 3.1.6-15 Local conditions related with Challenge 2 (Pisco River)

3) Challenge 3: Flooding area (km 34.5)

Current situation and challenges	・One time the water has overflow from the right bank, upstream the intake, and this event left several sediments amounts gathered ・A dike upstream the intake was built alter the floods
Main elements to be conserved	・Agricultural lands (main product: corn)
Basic measures	・Rehabilitate the intake ・Build retardation reservoirs upstream the intake

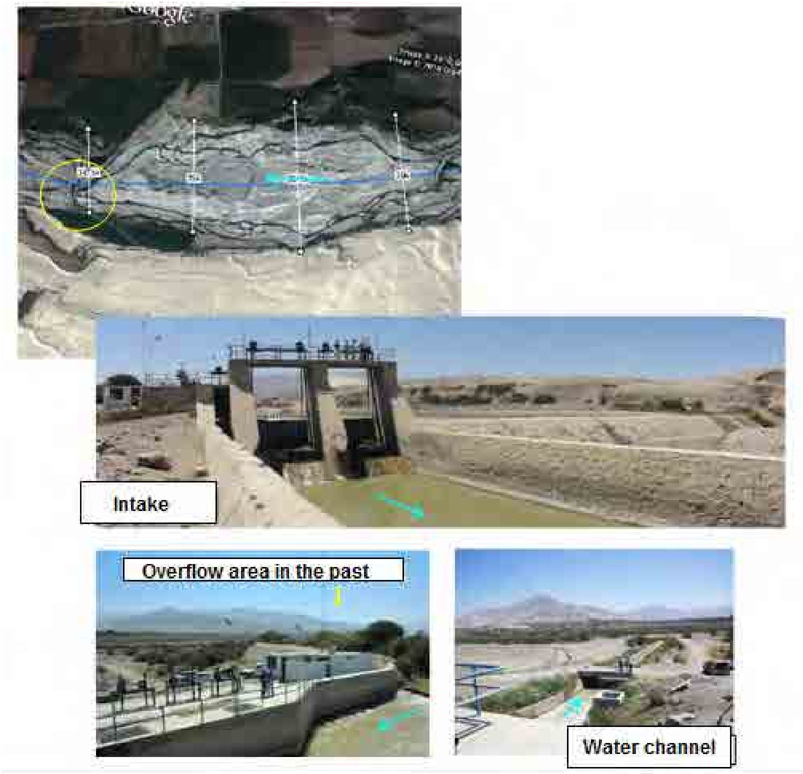


Figure 3.1.6-16 Local conditions related with Challenge 3 (Pisco River)

(5) Yauca River

○ Lowest watershed's bridge

- Main crop is olive
- 400 olives, approximately of 100 years were overthrown by the river's overflow a couple of years ago
- The river's bed elevated due to El Niño floods in 1998
- The maximum water level was reached during 1983 el Niño, which water raised up to the upper section of the bridge on Pan-American Highway

○ San Francisco

- Small olives trees are seen downstream this area, this was the affected area by lasts year's floods
- Olives may be harvested 8 years after the trees are planted. Trees with more than 20 to 30 years have more to harvest. There are trees of 100 to 500 years
- From one tree you can obtain a harvest of approx. 200 to 250 kg/year. There are 100 trees per hectare. The cost of 1 kg is about 3.5 soles
- The lower watershed sector has an approx. extension of 400 hectares

○ Mochica Intake

- 1700L/s are taken
- There are 580 hectares of olives in the middle watershed
- The harvest volume is 80kg/year per tree (max 200kg). In an abundant harvest year, a hectare may pay up to 10,000kg
- There is a Dam in Ayacucho, upstream, where water is discharged for a month between August and September
- The total capacity of this dam is 23 x 106 m^3
- This dam has been built 120 years ago, it has cracks and water leaks. This dam had been used in Yauca and another community until 2006, then another community was added, but it cannot supply more communities any longer
- MINAG determines the water discharge period from the dam
- It is hoped to give the maximum use to the water. It is better to control the water from the river's bed
- The fluvial terrace is used without authorization for agriculture production, which is an issue
- The bed continues to raise

○ Bridge in the narrow section (last bridge on the Yauca River upper watershed)

- From this point upwards is Jaqui sector
- There are 490 hectares of olives and 14 intakes
- Floods destroy intakes leaving them out of service

○ Intakes

- Flood water reaches olives
- The channel upstream the intake is destroyed due to floods

- Water volume has been decreasing in the past 15 years, so much that producers have been planting olives even near the river bed
- Every Jaqui channels are made of masonry and are destroyed every time a flood occurs. All 14 channels have been destroyed with the same frequency (it does not happen that some of them are destroyed and some are left ok)

○ Drinking water Intake
- It was finished building last year

○ Purification Plant
- It was finished recently
- Currently, chemical treatment is not being done
- Water is used for human consumption in Jaqui, downstream

(2) Description of the visit to the study sites

Figure 3.1.6-17 shows pictures of main sites visited.

Figure 3.1.6-17 Visit to the Study Site (Yauca River)

(3) Challenges and measures

The following Table shows challenges and possible solution measures for flood control considered at this moment, based on the results of technical visits.

1) Challenge 1: Floodplain area (km 7.0 downstream)

Current situation and challenges	・Main product is olive ・Urban area is relatively in a high elevation so direct risk of floods and overflowing is reduced. The elements to be protected are the trees and hydraulic installations ・A dike is built empirically and partially, but banks are eroded and flood may affect the olives
Main elements to be conserved	・Agricultural lands (main product: olive)
Basic measures	・Repair existing dike ・Execute bank protection Works (banks erosion control) ・Build retarding reservoirs

Figure 3.1.6-18 Local conditions related with Challenge 1 (Yauca River)

2) Challenge 2: Water intake point in the middle watershed (km 25.0)

Current situation and challenges	・The fluvial terrace of the opposite bank began to be cultivated recently, so, overflows will be on the right bank ・As main problem that has to be solved, the flood impact on the intake is mentioned, also the right bank's erosion were the highway passes is mentioned too
Main elements to be conserved	・Olives (from this area and from the lower watershed)
Basic measures	・Reinforce the intake ・Execute bank protection works (right bank erosion control) ・Built retarding reservoirs (buying lands from the opposite bank)

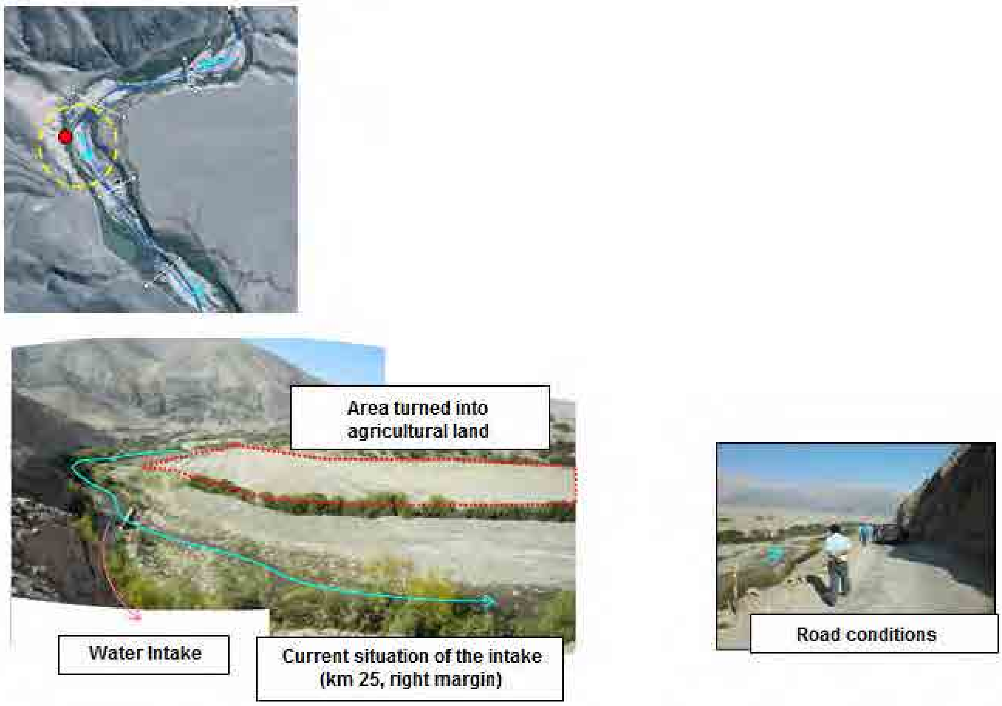


Figure 3.1.6-19 Local conditions related with Challenge 2 (Yauca River)

3) Challenge 3: Upper watershed intake point (km 27.0 upper watershed)

Current situation and challenges	･ There are several relatively simple intakes ･ Some of these intakes are destroyed and require to be repaired every time a flood takes place
Main elements to be conserved	･ Olives (from this area and from the lower watershed)
Basic measures	･ Built retarding reservoirs (to reduce floods peak stream) ･ Built an intake (to integrate the existing small works)

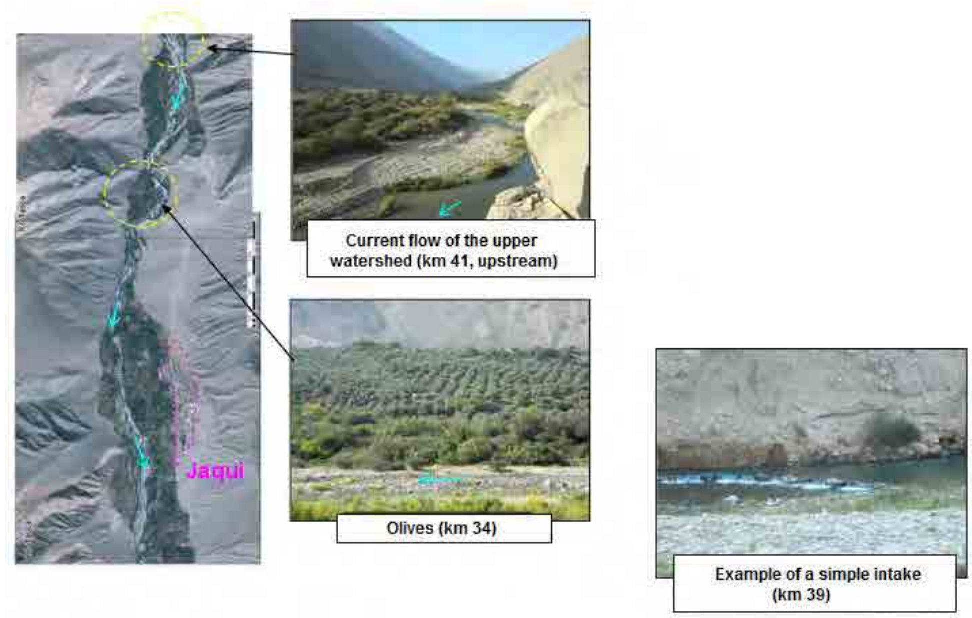


Figure 3.1.6-20 Local conditions related with Challenge 3 (Yauca River)

(6) Majes-Camana River

(General conditions of the watershed)

- The jurisdiction area of Camana covers from the river mouth to 39 km upstream
- The dike was constructed thirty years ago by the irrigation commission, but there are various eroded parts
- 99% of rice crops are commercialized in Lima's market
- Flow is measured once a day. The maximum historical flow was form 1,200 to 1,500 m^3/s. Floods last almost a week
- There are some colonial ruins in the upper area at the left riverbank

between km 2 and 6

(On critical points)

○ Obstruction of the river mouth

- ➢ The formation of the gravel bank in the river mouth caused by beach waves obstructs water flow in the river mouth (obstruction in the river mouth). The construction of a longitudinal dike along the sea side has been considered in order to control this situation. The gravel bank disappeared with floods and reappeared between June and December
- ➢ The path km 2.5 – km 4.5 burst its banks the same year El Niño Phenomenon hit, 1998. The right bank also did burst in the past
- ➢ Riverbed elevation

○ Path with lower dike (left bank between km 6 and km 7.5).

- ➢ The dike at the left bank is particularly low between km 6 – 7.5 (LA BOMBOM)
- ➢ There are arable lands between the dike at the left bank and the river downstream in the Camana Bridge that can eventually be removed for being illegal. As to the arable lands outside the dike, the negotiation might be complicated
- ➢ The riverbed has elevated more than a meter

○Erosion in the riverbank around the channel (left bank between km 12– 13)

- ➢ There is an arm water inlet for Camana's drinking water by km 13
- ➢ There is a channel that goes from the water inlet along the river. The river's left bank is seriously eroded at km12, endangering the adjacent channel

○ Scour of bridge piers (by km 26)

- ➢ There is a local community at the right bank of the river, by km 26 (SONAI) with 40 households. There is a suspension bridge constructed a year ago with semi-eroded piers because of floods, presenting collapse risks with following floods

○ Other parts presenting problems

- ➢ The left bank dike at km 3 is eroded and has been provisionally repaired
- ➢ There is an unprotected part at km 14.2
- ➢ There is a path whose left bank is being eroded at km 19 (CHARACTA)
- ➢ The left bank dike at km 26.5 is eroded
- ➢ A left bank dike at km 28 needs to be constructed
- ➢ Arable lands at km 29 of the left bank are eroded (CULATA DE SIYAN)
- ➢ The left bank at km 30 is being eroded and needs protection (FUNDO CASIAS)
- ➢ A dike at km 33.5 needs to be constructed given that annually the water inlet and the irrigation channels get flooded
- ➢ A 1km dike needs to be constructed at the right bank of km 34
- ➢ A 2km dike needs to be constructed at km 37.5 downstream in order to protect the water inlet and adjacent arable lands (80 ha) of the left bank (HUAMBOY)
- ➢ A 1km dike needs to be constructed at km 39 downstream in order to protect the water inlet and adjacent arable lands (80 ha) of the right bank (HUAMBOY)

2) Majes River

(Critical points)

○ Areas overflowing (right bank at km 104)

- ➢ A 500m dike needs to be constructed at the right bank
- ➢ Elements to be protected: arable lands (ONGORO BAJO)
- ➢ Landslide occurred on 1977 left arable lands buried at river banks.

Accumulated sediment in the river course was dragged downstream by river level rise

○ Fluvial erosion (right river bank, km 101)
- Arable lands were eroded by 1997 floods
- The elements to be conserved are arable lands (HUATIAPILLA BAJA)
- The current dike (600 m) at the right river bank needs to be extended between 500 and 800 m

○ Fluvial erosion (right river bank, km 88.5)
- River banks have been eroded by the floods in February 2011 dragging also part of a house (which is still being occupied)
- The elements to be conserved are arable lands and houses (BERINGA)
- The existing dike (1 km) as well as protection works at the right river bank need to be prolonged 600 m

○ Dike erosion (right river bank, km 84.5)
- The dike at the right river bank is being progressively eroded year by year, and if measures are not taken, this could affect the adjacent bridge (Huancarqui Bridge)
- The dike has been repaired in an improvised way, but it needs a pertinent measure as river bank protection, etc
- The elements to be conserved are arable lands and the bridge (APLAO)
- The town of Aplao, the biggest city hall in Majes, has 18 thousand inhabitants, and Huancarqui at the other side of the river, crossing the bridge, has 5 thousand inhabitants

○ Unprotected stretch (right river bank, between km 70.5 and km 71)
- Currently an 800m dike is being constructed financed by the regional government. However, other 1,3 km are considered to be built in order to protect approximately 30 houses located in lower lands of the lower watershed
- Last August 2010, the area was flooded after eight years
- The elements to be conserved are arable lands and private houses (EL DEQUE)
- There is an irrigation channel upstream, conducting water to arable lands (700 ha) downstream. The water inlet is being eventually repaired, to be finished in 15 days
- Big rocks for river bank protection are extracted and transported from a quarry in Aplao

○ Overflowed stretch (both river banks, between km 60 and km 62)
- It is necessary to construct 2km dikes at the left river bank and 1.5 dikes at the right river bank
- Elements to be conserved are arable lands (Pitis at the left river bank and San Vicente at the right river bank)

○ Overflowed stretch (left river bank, between km 58 and km 58.5k)
- A dike needs to be constructed at the left river bank
- The elements to be conserved are arable lands (ESCALERILLAS)

○ Fluvial erosion (left river bank between km 55 and km 56.5k)
- Agriculture lands are being progressively eroded year by year by floods
- Elements to be conserved are arable lands (SARCAS)
- Part of the area has been flooded in 1998 by 1,500 m^3/s floods, forcing three small communities to move from lower lands to upper ones
- The river overflowed in February 2011 by floods of 800 m^3/s

○Other parts presenting problems
- A dike is looked to be built at the left river bank, between km 81.5 and km 82 (HUANCARUQUI)
- A dike is looked to be built at the right river bank, between km 81.5 and km

82 (CASPANI)

- Parts between km 75–km 75.5k and km 71–km 71.5 are unprotected at the left river bank (TOMACA)
- The stretch km 73.5 – km 74 is unprotected at the right river bank (QUERULPA)
- A dike is looked to be built at the left river bank, between km 49 and km 51.5 (PAMPA BLANCA)

(2) Description of the visit to the study sites

Figure 3.1.6-21and Figure 3.1.6-22 show pictures of main sites visited.

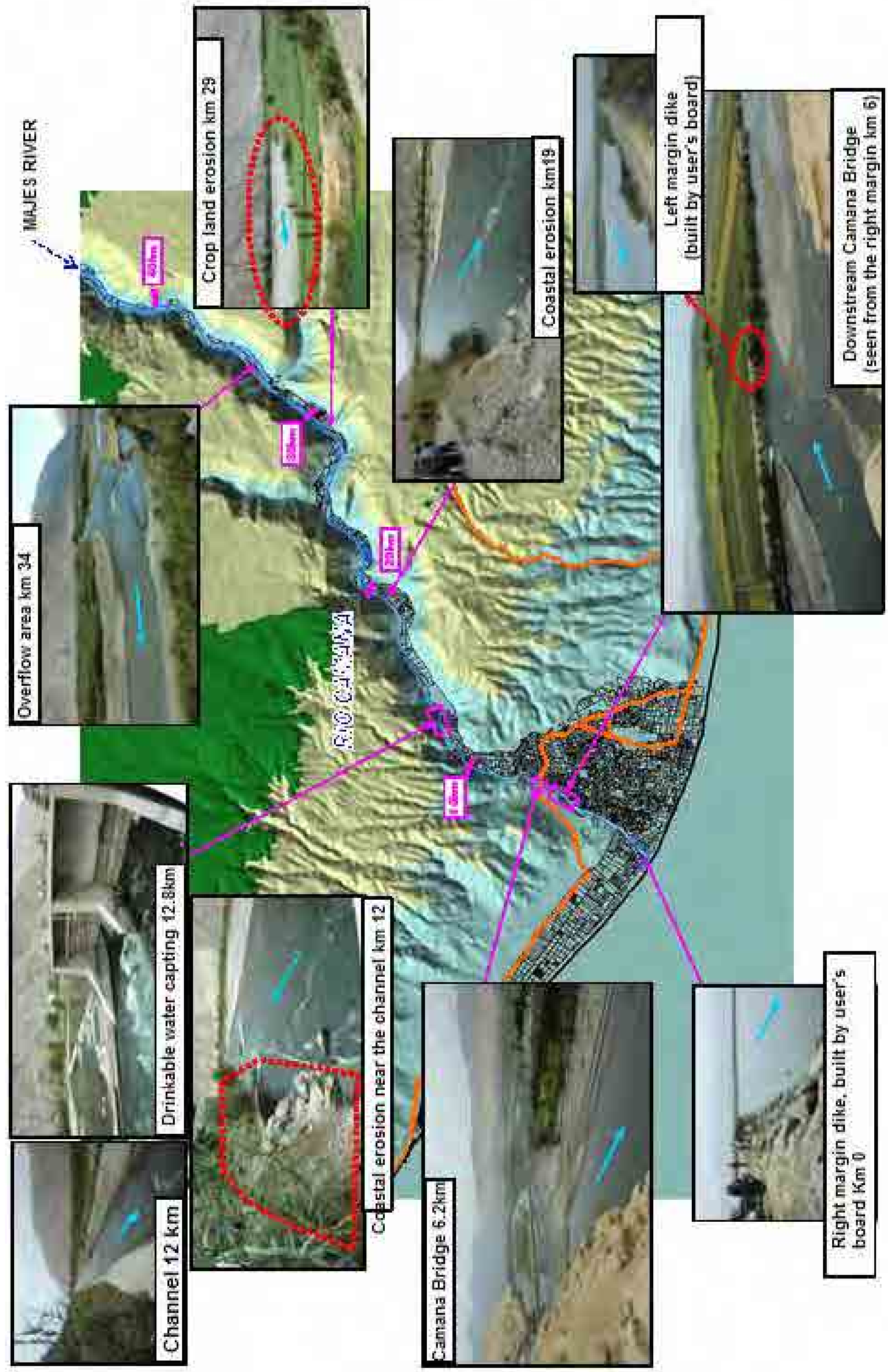


Figure -3.1.6-21 Visit to the Study Site (Camana River)

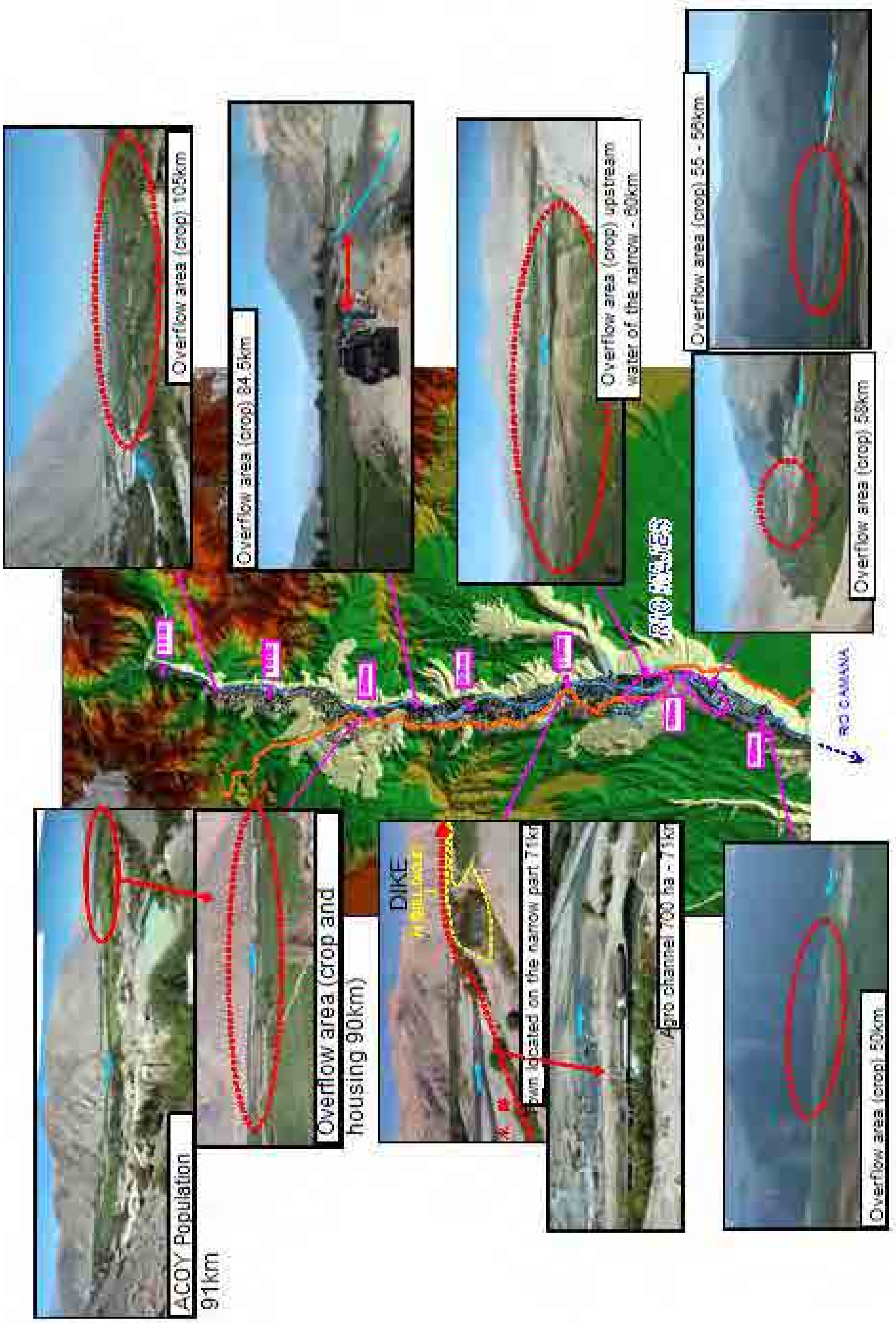


Figure 3.1.6-22 Visit to the Study Site (Majes River)

(3) Challenges and measures

The following Table shows challenges and possible solution measures for flood control considered at this moment, based on the results of technical visits.

1) Challenge 1: Deterioration of the existing dike caused by fluvial erosion (km 0 - 5 of the Camana River)

Current situation and challenges	・The existing dike which control corresponds to the Irrigation Commission of Camana has been constructed about 30 years ago with their own resources. There are several eroded parts ・ The dike is low upstream and downstream of Camana Bridge at km 6, putting at flood risk arable lands and urban area
Main elements to be conserved	・Urban area of Camana ・Arable lands (main crop: rice)
Basic measures	・Construction of dikes and riverbank protection

Figure 3.1.6-23 Local conditions related with Challenge 1 (Camana River)

2) Challenge 2: Fluvial erosion impact on the drinking water inlet (Camana River, km 12)

Current situation and challenges	・There is an inlet for the drinking water service to Camana at km 13, as well as a channel along the river ・Currently the left bank at km 12 is eroded and if not taking correct measures, this could affect the adjacent channel
Main elements to be conserved	・Channel for drinking water
Basic measures	・Reinforcement of the existing dike and riverbank protection

Figure 3.1.6-24 Local conditions related with Challenge 2 (Camana River)

3) Challenge 3: Overflow of the narrow upper stretch (Majes River, km 60-km 62)

Current situation and challenges	・The hydraulic capacity is reduced given the narrowing of the river, causing flood damages on arable lands of the upper areas ・There is a new bridge at the narrow area of the river. Parts are unprotected at both margins presenting high overflow risks
Main elements to be conserved	・Arable lands (main crop: rice)
Basic measures	・Construction of dikes and river margin protection

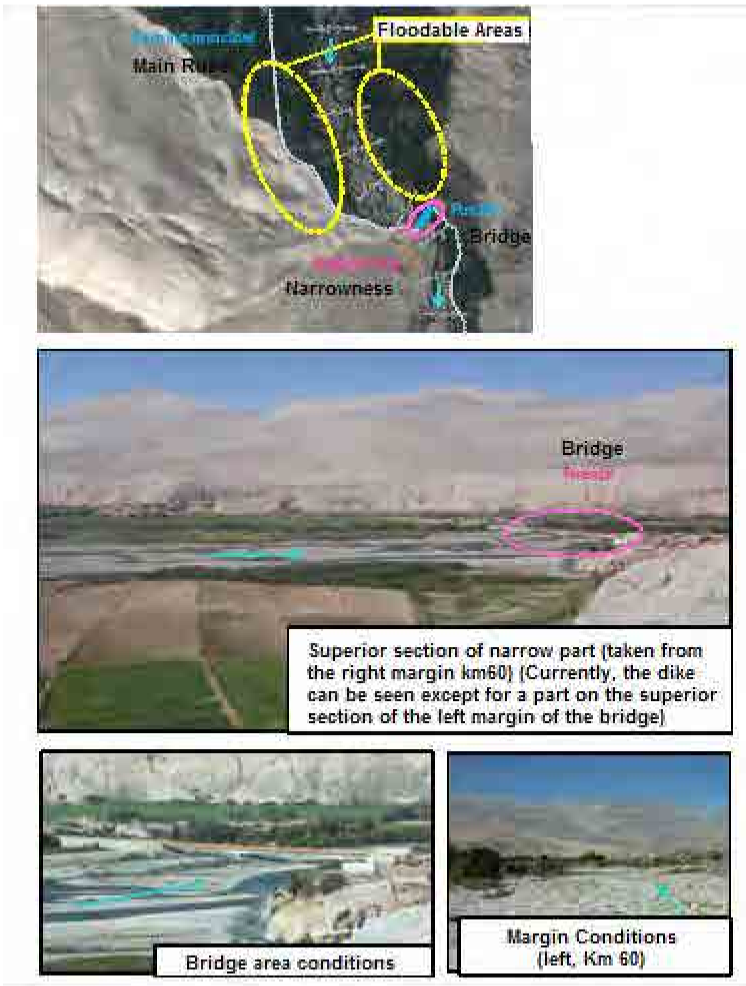


Figure 3.1.6-25 Local conditions related with Challenge 3 (Majes River)

4) Challenge 4: Overflowing towards rural zone (Majes River km 70.5–km 71)

Current situation and challenges	・There is a community, Deque, along the riverside, in the narrow section, 30 houses in the low lands ・Even though it is true that the higher section of this community is protected by a dike, there is a section downstream which is unprotected, with higher risk of overflowing ・There is a water intake to supply irrigation water to 700ha of crop land, which is also exposed to flood risk
Main elements to be conserved	・Houses, water intake for irrigation ・Croplands (main crop: rice)
Basic measures	・Construction of dikes and protection of banks

Figure 3.1.6-26 Local conditions related to Challenge 4 (Majes River)

5) Challenge 5: Impact of fluvial erosion to the bridge (Majes River km 84.5)

Current situation and challenges	・The dike of the right bank is progressively eroded year by year, and if no measure is taken, it could affect the next bridge downstream (Huancariqui bridge) ・This bridge is an important path which connects Aplao, the larger town of Majes (with a population of 18 thousand inhabitants), and Huancarqui (with a population of 5 thousand inhabitants)
Main elements to be conserved	・Bridge (Huancarqui) ・Croplands (main crop: rice)
Basic measures	・Construction of dikes and protection to the banks

Figure 3.1.6-27 Local Conditions related to Challenge 5 (Majes River)

6) Challenge 6: Damages from fluvial erosion to the community (Majes River km 88-km 88.5)

Current situation and challenges	・The river banks are progressively eroded per year due to the risings and floods of February 2011, which dragged a house ・Currently, the banks are unprotected and if the appropriate measures are not taken, it may worsen the damages, so taking measures is urgently needed
Main elements to be conserved	・Houses ・Croplands (main crop: rice)
Basic measures	・Construction of dikes and protection to the banks

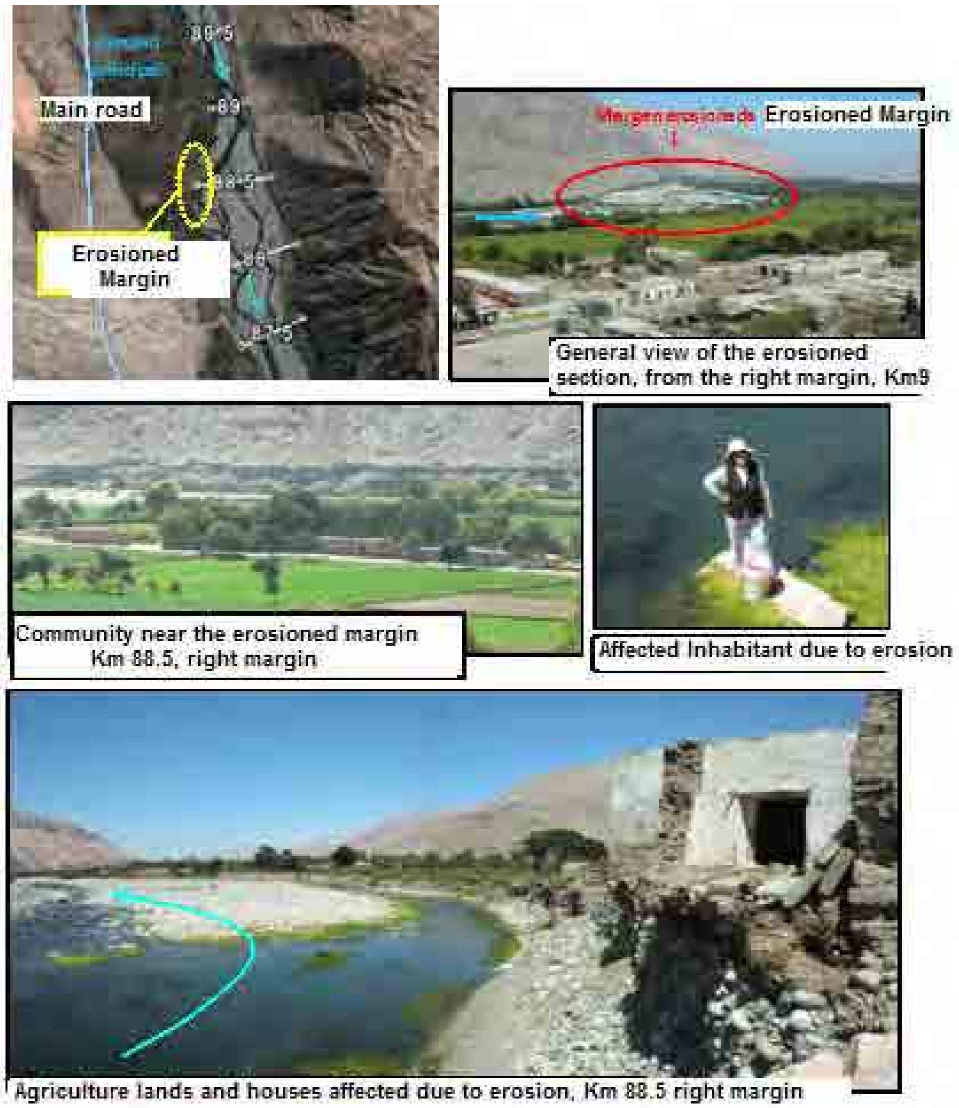


Figure 3.1.6-28 Local conditions related to Challenge 6 (Majes River)

3.1.7 Current situation of vegetation and reforestation

(1) Current Vegetation

1) Cañete, Chincha, Pisco and Yauca Watershed

The most recent information about the classification of vegetation is that carried out by FAO on 2005, with the collaboration of National Institute of Natural Resources of the Ministry of Agriculture (INRENA[1] in Spanish). According to this study the 1995 Forest Map was used as database and its Explanatory Guide prepared by INRENA and the Forest General Direction. Likewise, the National Planning Institute and the National Bureau of Natural Resources Evaluation (ONERN in Spanish) prepared the Budget, Evaluation and Use of Natural Resources of the Coast which describes the classification of the vegetation and the coast flora.

Pursuant to the 1995 Forest Map and its explanations, the Cañete, Chincha, Pisco, Yauca watersheds extend from the coast to the Andean mountains; usually, featuring different vegetal coverage according to the altitude. From coast up to the 2,500m.a.s.l (Cu, Dc) have scarce vegetation. Some meters above in altitude, some scrubland can be noticed. Among 2500 and 3500m.a.s.l there are only scarce bushes disseminated in the area due to the rains. These bushes disappear due to the low temperatures and are seen again in the herbaceous areas. However, in zones close to the rivers, high trees have grown, even in arid zones.

Table 3.1.7-1 List of representative vegetable forming in the watersheds extending from the coast to the Andean mountains

Symbol	Life Zone	Distribution of Altitude	Rainfall	Representative Vegetation
1)Cu	Coast Crop Lands	Coast	Almost none.	Coastal crops
2)Dc	Coast Desert	0～1,500 m.a.s.l	Almost none, there are mist zones.	Almost none, there are vegetation slopes
3)Ms	Dry Thicket	1,500～3,900 m.a.s.l	120～220mm	Cactus and grass
4)Msh	Subhumid Forest	North-center: 2,900～3,500 m.a.s.l Inter Andean 2,000～3,700 m.a.s.l	220～1,000mm	Perennial bushes, less than 4m high
5)Mh	Humid Forest	North: 2,500～3,400 m.a.s.l South 3,000～3,900 m.a.s.l	500～2,000mm	Perennial bushes, less than 4m high
6)Cp	Puna grass	Approx 3,800 m.a.s.l	No description	Gramineae
7)Pj	Scrubland	3,200～3,300 m.a.s.l Center-South up to 3,800 m.a.s.l	South zone with low rainfall: less than 125mm East springs: higher than 4,000mm	Gramineae
8)N	Ice-capped mountains		—	—

Source: Prepared by the JICA Team base don the Forest Map. 1995

2) Majes-Camana Watershed

According to vegetation formation map of 1995, the vegetation distribution in this watershed is similar to the 4 watersheds described in number 1). The difference among this watershed with the rest is: i) absence of Cu (arid and semiarid zones), ii) existence of hills "Lo" and iii) existence of Bf (wetlands).

The explanations that are only for this watershed, and not the rest, are the following. In Figure 3.1.7-5 a vegetation formation map is show of the Majes-Camana River.

i) Lo: Hills

It goes from 0 to 1000m.a.s.l, from coastal desert of Peru to Chile. In winter (May to September) the hazel from the sea allows the development of plants communities. It is characterized for *Tillandsia spp,* tara (*Caesalpinea spinosa*), amancaes fower (*Ismene amancae*), cactus (*Haageocereus spp.),* clover (*Oxalis spp*.), wild potatoe (*Solanum spp*) among others. On the other hand, the coastal desert area is 11% of Peruvian territory, 2.000

[1] Subsequently, INRENA was dissolved and its functions were assumed by the Wild Forest and Fauna General Direction.

km along the coast, also the area has 14,000km2. The coastal hills area couldn't be found in this study.

ii) Bf: Wetlands

From 3,900 to 4,800 m.a.s.l , its topography is basically flat lands, with mils slopes and slight depressions. They are in areas where there are springs and have permanent water the whole year. It's characterized for species such as champa (*Distichia muscoides*), sillu - sillu (*Alchemilla pinnata*), libro-libro (*Alchemilla diplophylla*), chillihua (*Festuca dolichophylla*), crespillos (*Calamagrostis curvula*), tajlla (*Lilecopsis andina*), sora (*Calamagrostis eminens*), ojho pilli (*Hipochoeris stenocephala*) among others. These plants are short and the fauna, American camelids (llama, alpaca, vicuña and guanaco) feed from them.

(3) Chira River Watershed

According to 1995 forestry map and its explanations, Chira River area is very different from the other 4 watersheds and has a lot of dry forest. There are three types of forests in this watershed: i) Dry Forest Savanna Type (Bs, Sa), ii) Hills dry forest (Bs co) and iii) Mountain dry forest (Bs, mo) which distributes according altitudes (see Table 3.1.7-1). The main specie that constitutes dry forest savanna type is Algarrobo (*Prospis pallida*). In general, these forests have tall trees and short bushes. Species that form hill and mountain dry forest are very similar; being predominant the deciduous trees of approx 12 meters height. On the river shore, evergreen trees also grow with more than 10cm of DAP, due to the existence of the freatic water table near the surface. Once the dry forest is destroyed it is very difficult to recover it by a natural process, due to the unfavorable conditions. Mountain humid forest is characterized by the variety of species that are part of it, mostly are less than 10m height

Table 3.1.7-2 List of representative vegetable forming in the Chira watersheds

Code	Names	Altitudes	Precipitations	Representative Vegetation
1)Bs sa	Dry forest savanna type	0 and 500 m.a.s.l	160 and 240mm	Algarrobo forest (evergreen). In heights deciduous trees, bushes and cactus also appear
2)Bs co	Hill dry forest	400 and 700 m.a.s.l	230 and 1,000mm	Similar to mountain dry forest
3)Bs mo	Mountains dry forest	500 and 1,200 m.a.s.l	230 and 1,000mm	Mainly trees with leaves forming approx 12m height forests
4)Bh mo	Mountain humid forest	From the higher Amazon regions to the northern part of the country, up to 3200m.a.s.l In the south-center region of Peru: Andes east side up to 3.800m.a.s.l	Frequent mist cause cloud forests	Lots of vegetations including high trees (10mt approx), palm trees of 2 to 4 meters and herbaceous species
Also, coastal desert is observed (DC, Cu), sub-humid bush (Msh -Mh).				

Source: Prepared by the JICA Team based on the Forest Map. 1995

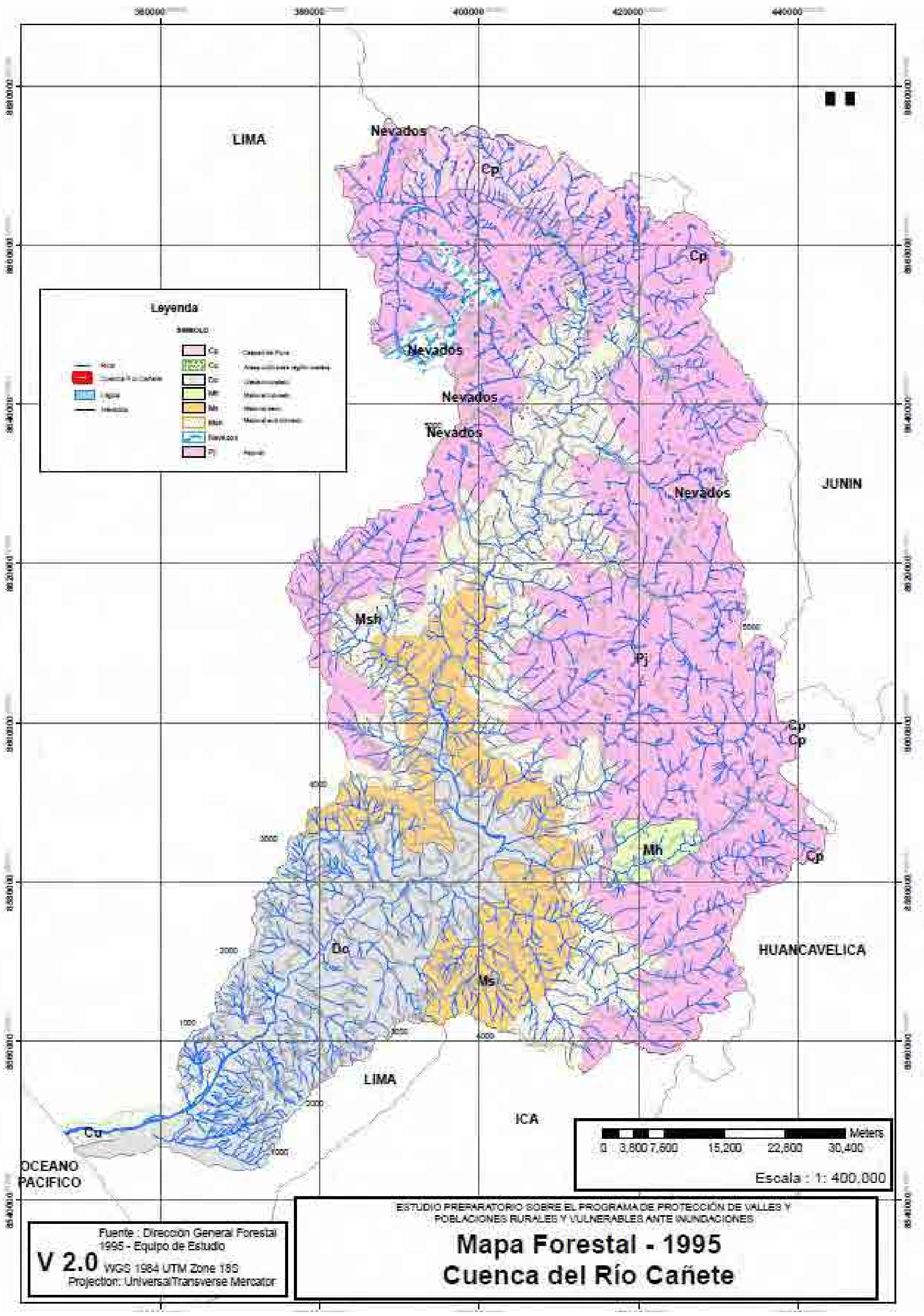


Figure 3.1.7-1 Cañete River Watershed Forestry Map

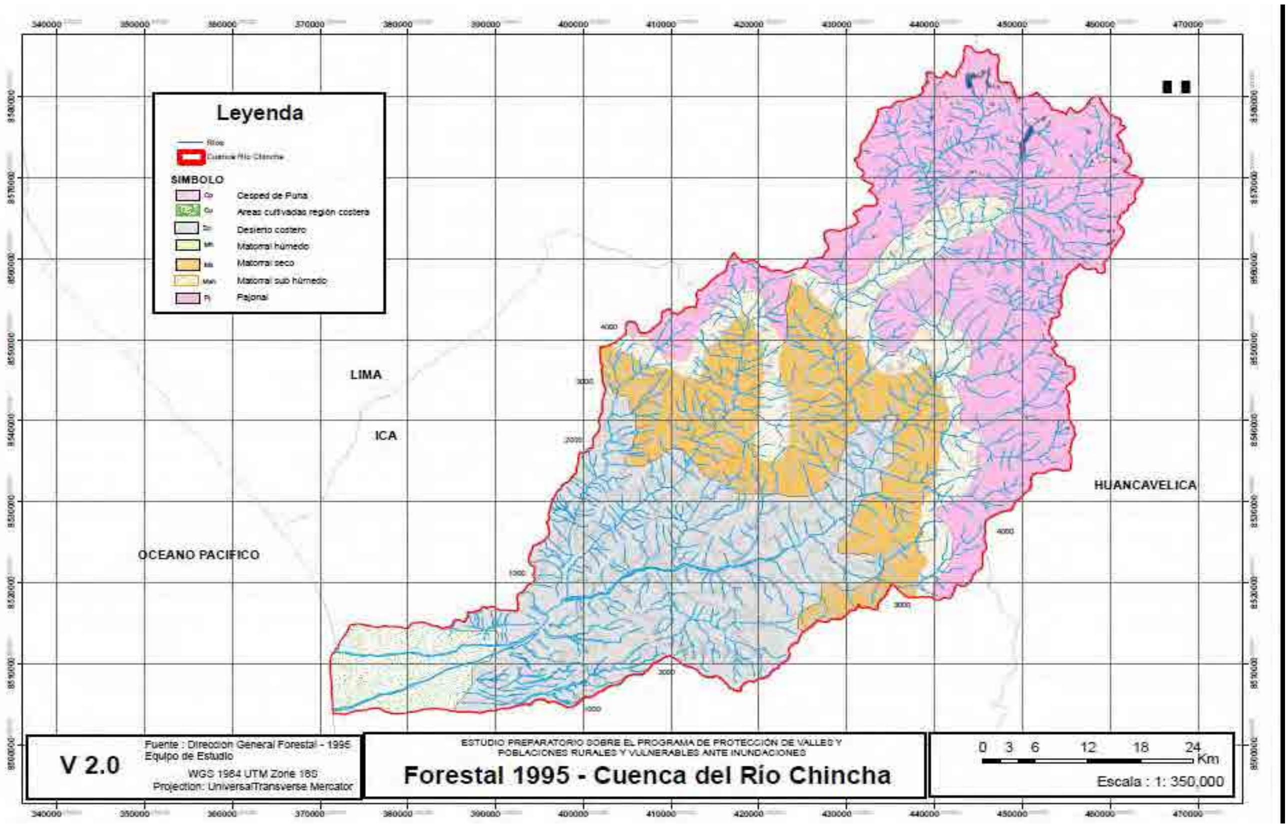


Figure 3.1.7-2 Chincha River Watershed Forestry Map

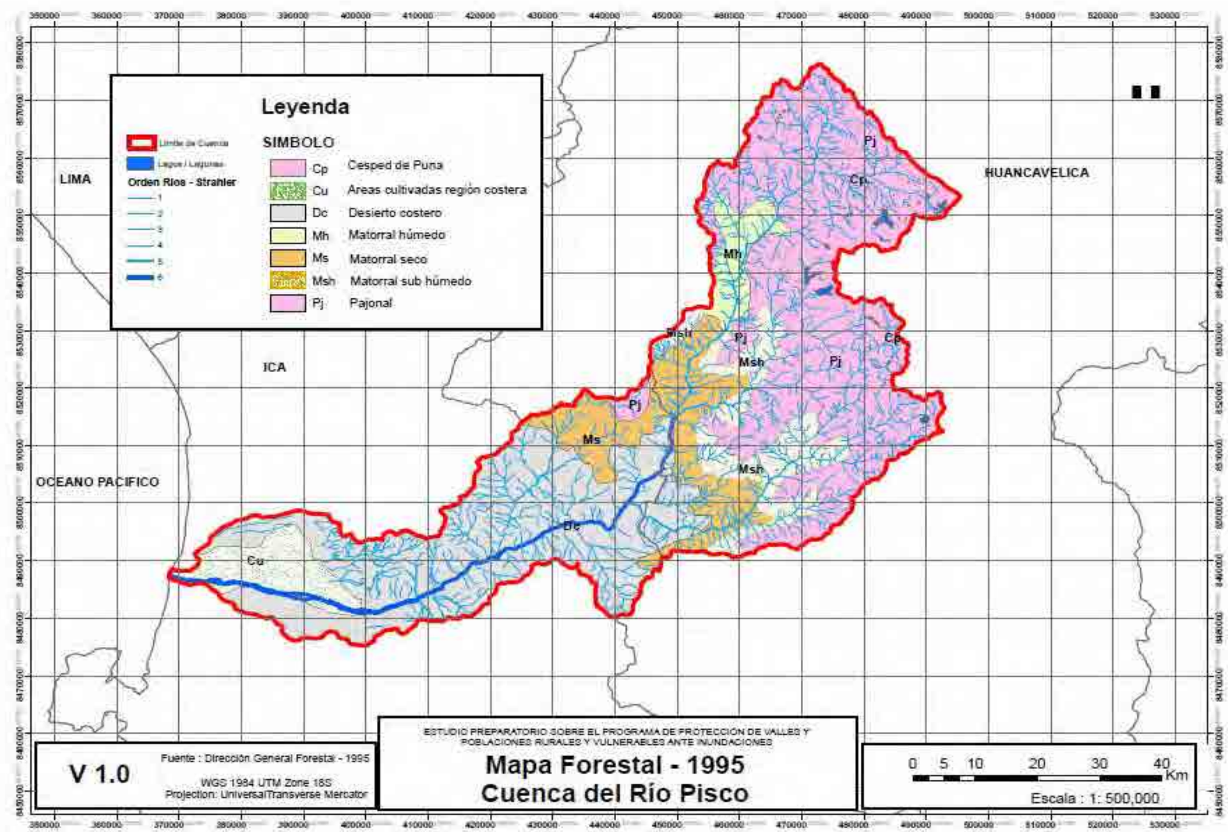


Figure 3.1.7-3 Pisco River Watershed Forestry Map

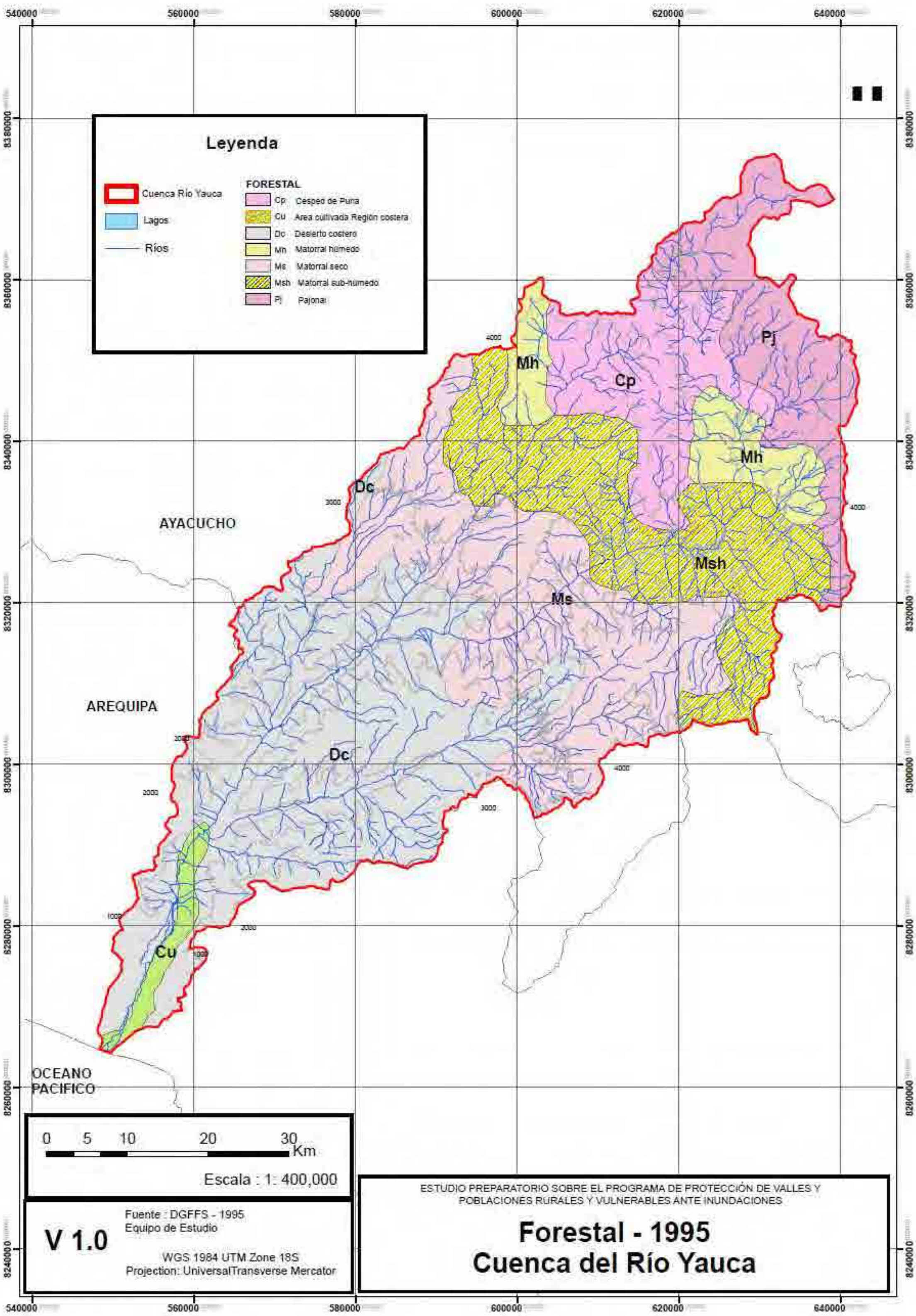


Figure 3.1.7-4 Yauca River Watershed Forestry Map

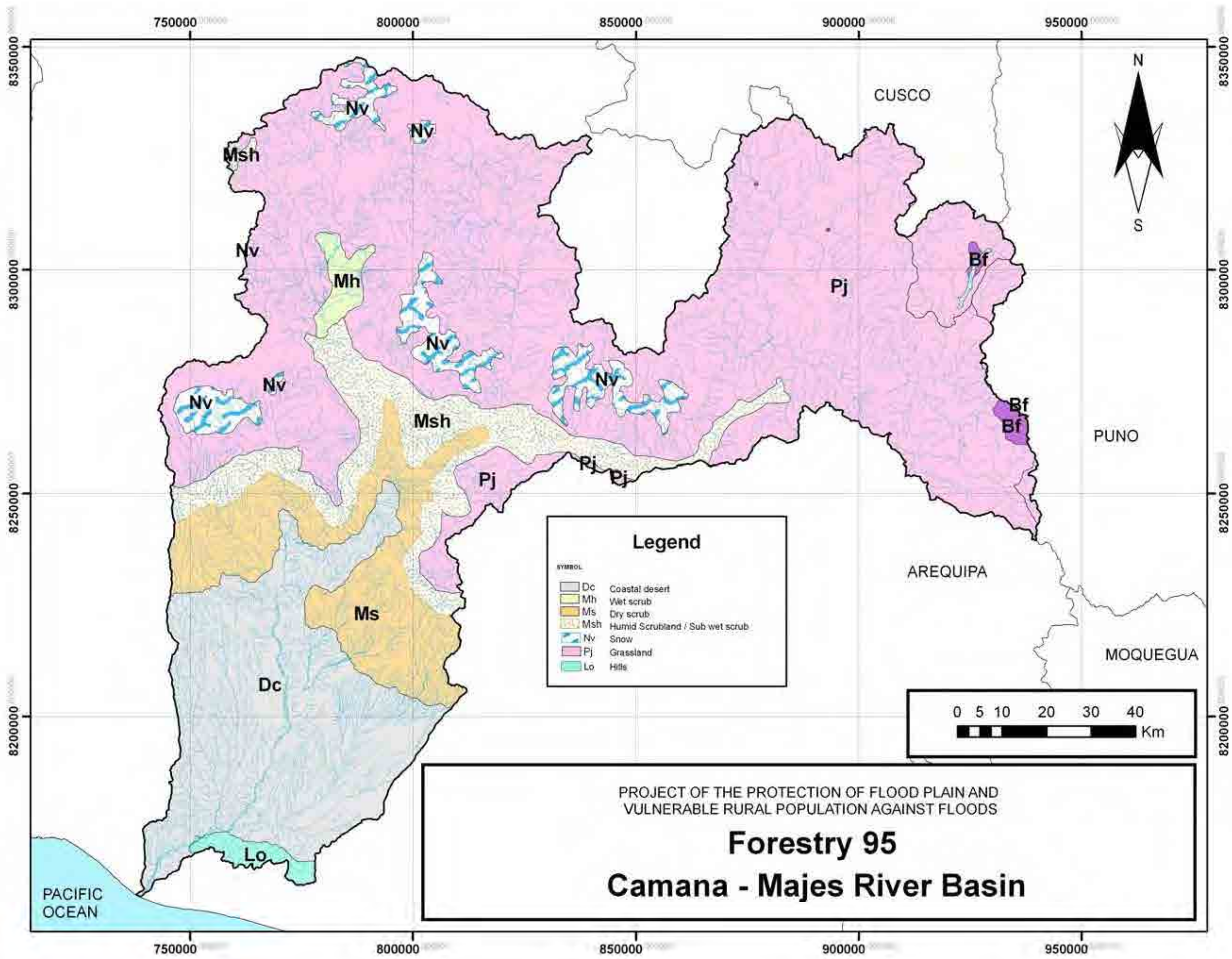


Figure 3.1.7-5 Majes-Camana River Watershed Forestry Map

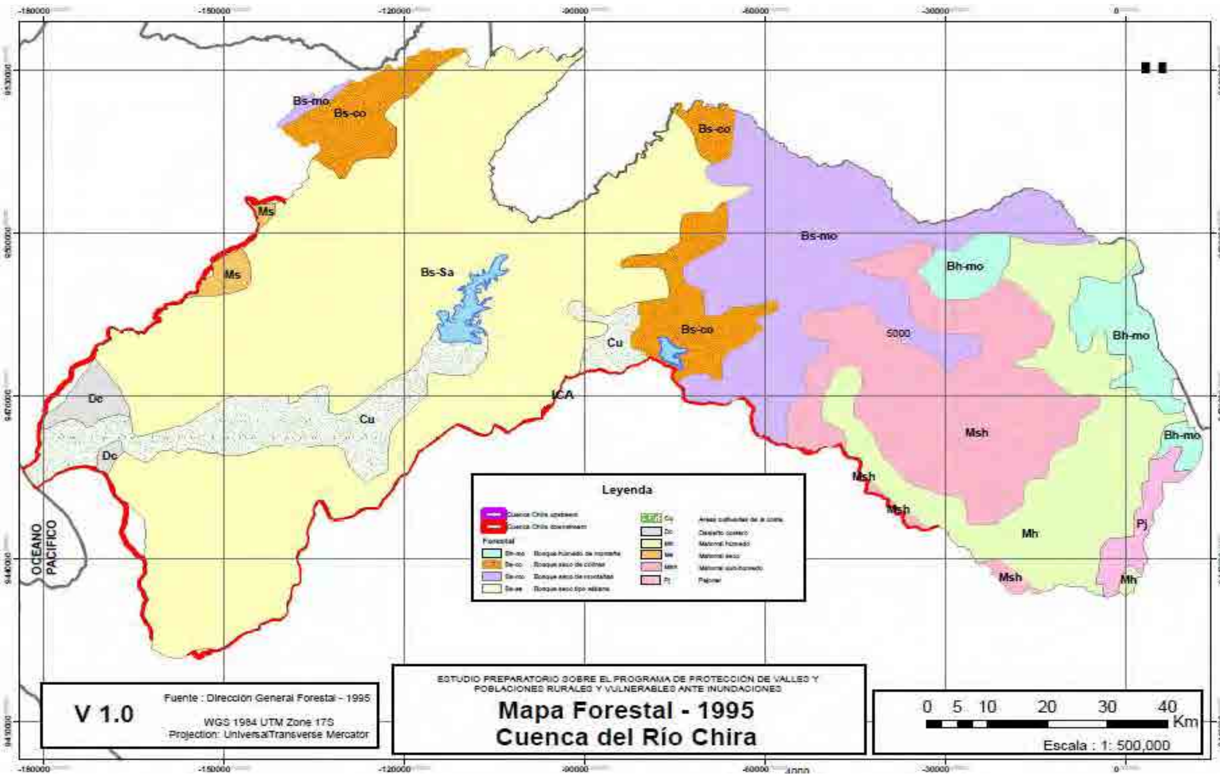


Figure 3.1.7-6 Chira River Watershed Forestry Map

(2) Area and distribution of vegetation

1) Cañete, Chincha, Pisco and Yauca Watersheds

The present study was determined by the surface percentage that each vegetation formation occupies on the total watershed's surface, overcoming the INRENA study results of 1995 to the GIS (see Tables 3.1.7-3 and Figures 3.7.2-1 to 4). Then, the addition of each ecologic life zone's surface, outstanding the coastal desert (Cu, Pj) dry bushes (Ms) and puna grass (Cp, Pj) was calculated. In Table 3.1.7-3 it is shown the percentage of each ecologic area. It is observed that the desert occupies 30% of the total area, 10% or 20% of dried grass and puna grass 50%. Bushes occupy between 10 to 20%. They are distributed on areas with unfavorable conditions for the development of dense forests, due to which the surface of these bushes is not wide. So, natural conditions of the four watersheds of Chincha River are set. In particular, the low precipitations, the almost non-fertile soil and accentuated slopes are the limiting factors for the vegetation growth, especially on high size species.

Table 3.1.7-3 Area of each classification of vegetation (Cañete, Chincha, Pisco, and Yauca river watersheds)

Watersheds	Vegetation								
	Cu	Dc	Ms	Msh	Mh	Cp	Pj	N	Total
(Surface: hectares)									
Cuenca Río Pisco	217,88	1.354,39	469,99	381,55	140,01	672,59	1,035,68	0,00	4,272,09
Cuenca Río Chincha	169,98	1.010,29	642,53	365,18	0,00	854,74	261,17	0,00	3,303,89
Cuenca Río Cañete	61,35	1.072,18	626,23	1,024,77	70,39	187,39	2,956,65	66,78	6,065,74
Cuenca Río Yauca	69,48	1.433,26	990,99	730,67	234,49	428,64	435,04	0,00	4,322,57
Total	518,69	4.870,12	2.729,74	2.502,17	444,89	2.143,36	4.688,54	66,78	17.964,29
(Porcentaje frente a la superficie de la cuenca: %)									
Cuenca Río Pisco	5,1	31,7	11,0	8,9	3,3	15,7	24,2	0,0	99,9
Cuenca Río Chincha	5,1	30,6	19,4	11,1	0,0	25,9	7,9	0,0	100,0
Cuenca Río Cañete	1,0	17,7	10,3	16,9	1,2	3,1	48,7	1,1	100,0
Cuenca Río Yauca	1,6	33,2	22,9	16,9	5,4	9,9	10,1	0,0	100,0
Total	2,9	27,1	15,2	13,9	2,5	11,9	26,1	0,4	399,9

Source: Prepared by the JICA Team based on the INRENA1995 Forest Map of

Table 3.1.7-4 Area and percentages of each classification of vegetation gathered (Cañete, Chincha, Pisco and Yauca rivers watershed)

Watershed	Ecologic Zones					
	Desert,etc. (Cu, Dc)		Desert,etc. (Cu, Dc)		Desert,etc. (Cu, Dc)	
(Percentage: %)						
Pisco	36.8	11.0	12.2	40.0	0.0	100.0
Chincha	35.7	19.4	11.1	33.8	0.0	100.0
Cañete	18.7	10.3	18.1	51.8	1.1	100.0
Yauca	34.8	22.9	22.3	20.0	0.0	100.0
Total	30.0	15.2	16.4	38.0	0.4	100.0

2) Majes-Camana River Watershed

This watershed, as the Cañete watershed, has the same results in INRENA study since 1995 and these were put on GIS. So, the area percentage of each vegetation classification in the watershed was obtained. (Table 3.1.7-5)

Table 3.1.7-5 Area of each classification of vegetation (Majes-Camana River watershed)

Distribution	Classification of vegetation								
	Lo	Dc	Ms	Msh	Mh	Bf	Nv	Pj	Total
Area of distribution of vegetation (km^2)	104,54	3108,12	1570,08	1334,76	155,20	66,16	641,44	10069,21	17.049,51
Watershed area percentage (%)	0,6	18,2	9,2	7,8	0,9	0,4	3,8	59,1	100,0

Source: Prepared by the JICA Team based on the INRENA1995 Forest Map

If the classification is added to this result, Table 3.1.7-3 is obtained. The characteristic of the vegetation classification of the Majes-Camana River watershed consists of low percentages of thicket areas (less than 9%); on the other hand, there are high percentages of scrublands (less than 60%). The altitude of high watershed of Rio Majes consists of more than 4,000 m.a.s.l, which cover most of the scrublands.

Table 3.1.7-6 Area and percentages of each classification of vegetation gathered (Majes-Camana river watershed)

EE	Desserts and others (Lo,Dc)	Dry thicket (Ms)	Scrublands (Msh, Mh)	High elevation hills (Cp/Pj)	Ice-capped mountain (N)	Total
Vegetation area (km^2)	3.212,66	1.570,08	1.489,96	10.135,37	641,44	17.049,51
Watershed area percentage (%)	18,8	9,2	8,7	59,4	3,8	99,9

In Figure 3.1.7-7 the percentage distribution of vegetation formations in the five watersheds is shown (Cañete, Chincha, Pisco, Yauca and Majes-Camana). In the 1st four watersheds, wetlands represent only 13 to 24%, while in Majes-Camana is even more reduced (less than 9%).

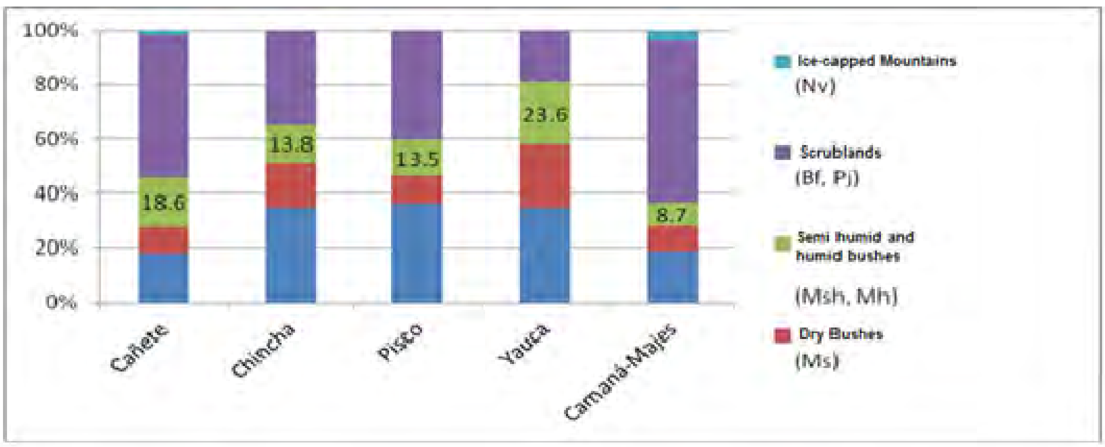


Figure 3.1.7-7 Watershed comparison (percentage among vegetal formations)

3) Chira River Watershed

The present study was determined by the surface percentage that each vegetation formation occupies on the total watershed's surface, overcoming the INRENA study results of 1995 to the GIS (see Tables 3.1.7-2 and Figure 3.7.2-6). Then, the addition of each ecologic life zone's surface, outstanding the coastal desert (Cu, Pj), dry grass (Ms), bushes (Msh, Mh), dry forest (Bs-sa, Bs-co, Bs-mo), humid mountain forest (Bh-mo) and puna grass (C-A, Pj). Table 3.1.7-8 shows the percentage of each ecologic area.

Table 3.1.7-7 Vegetation formation surface of the watershed's surface (Chira River)

	Vegetation											
	Cu	Dc	Ms	Msh	Mh	Bs-sa	Bs-co	Bs-mo	Bh-mo	C-A*	Pj	Total
(Surface: hectares)												
High Watershed	714,92	105,81	59,34	142,28	139,47	2.668,16	185,40	222,87	0,00	0,00	0,00	4.238,25
Low Watershed	31,70	0,00	0,00	1.205,16	1.021,28	1.889,54	473,16	1.164,53	401,54	90,25	112,57	6.389,73
Total	746,62	105,81	59,34	1.347,44	1.160,75	4.557,70	658,56	1.387,40	401,54	90,25	112,57	10.627,98
(Percentage %)												
High Watershed	16,9	2,5	1,4	3,4	3,3	63,0	4,4	5,3	0,0	0,0	0,0	100,2
Low Watershed	0,5	0,0	0,0	18,9	16,0	29,6	7,4	18,2	6,3	1,4	1,8	100,1
Total	7,0	1,0	0,6	12,7	10,9	42,9	6,2	13,1	3,8	0,8	1,1	100,1

Source: Prepared by the JICA Team based on the INRENA1995 Forest Map

Table 3.1.7-8 Ecologic Life Areas Percentage (Chira River)

Zones	Ecologic Life Zones							
	Deserts (Cu, Dc)	Dry bushes (Ms)	Bushes (Msh, Mh)	Dry Forests (Bs-sa, -co, -mo)	Mountain Humid Forests (Bh-mo)	Water bodies (C-A)	Grasslands (Pj)	Total
(Percentage: %)								
High Watershed	19,4	1,4	6,6	72,6	0,0	0,0	0,0	100,0
Low Watershed	0,5	0,0	34,8	55,2	6,3	1,4	1,8	100,0
Total	8,0	0,6	23,6	62,1	3,8	0,8	1,1	100,0

Source: Prepared by the JICA Team based on the INRENA1995 Forest Map

Comparing the 4 remaining watersheds (Cañete, etc), the coastal desert occupies a low percentage (approx 10%) and dry bushes do not even reach 1%. The other bushes occupy approx 20%. The dry forest represents 60% and this is what characterizes the vegetation of the Piura River Watershed.

(3) Forest area variation

1) Forestry Surface Variation according to Department

Although a detailed study on the variation of the forest area in Peru has not been performed yet, the National Reforestation Plan Peru 2005-2024, Annex 2 of INRENA shows the areas deforested per department until 2005. In Table 3.1.7-9 the accumulated forestry surface is shown of the regions of Arequipa, Ayacucho, Huancavelica, Ica, Lima and Piura. However, the information only covers a part. In Ayacucho, Huancavelica and Piura approximately 100,000ha, 10,000 and 10,000 of forests disappeared respectively.

Table 3.1.7-4 Area Deforested Until 2005

Department	Area (ha)	Area deforested accumulated (ha) and the percentage of such area in the department area (%)	Post-Felling Situation	
			Non used Area (ha)	Used area(ha)
Arequipa	6.286.456	-	-	-
Ayacucho	4.326.169	97.992 (2,3 %)	73.554	24.438
Huancavelica	2.190.402	11.112 (0,5 %)	11.112	-
Ica	2.093.457	-	-	-
Junín	4.428.375	628.495 (14,2 %)	289.504	338.991
Lima	3.487.311	-	-	-
Piura	3.580.750	9.958 (0,3 %)	5.223	4.735

Source: National Reforestation Plan, INRENA, 2005

2) Forestry Surface Variation according to Watershed

(a) Cañete, Chincha, Pisco and Yauca Watersheds

The variation of the distribution of vegetation was analyzed, comparing the FAO data from the study performed in 2005 (prepared based on satellite Figures from 2000) and the results of the 1995 INRENA study (prepared base on satellite Figures from 1995). (See Table 3.1.7-10).

Analyzing the variation of the surface of each vegetation formation, it is observed that the vegetation has reduced in the arid zones (desert and cactus: Cu, DC and Ms) and bushes (Msh, Mh) and Ice-capped (N) increased.

Table 3.1.7-10 Changes in the areas of distribution of vegetation from 1995 to 2000 (Cañete and other three watersheds)

Watersheds	Vegetation Formations								
	Cu	Dc	Ms	Msh	Mh	Cp	Pj	N	Surface of the watershed
(Surface: hectares)									
Pisco	-3,59	-3,44	-50,99	46,88	7,01	-9,52	13,65	—	4.272,09
Chincha	-5,09	-19,37	-95,91	86,85	3,55	-5,54	35,51	—	3.303,89
Cañete	-13,46	-28,34	-50,22	7,24	23,70	34,89	-2,18	28,37	6.065,74
Yauca	-20,22	33,63	-10,87	34,13	21,15	-42,62	-15,20	—	4.322,57
Sub-total (a)	-42,36	-17,52	-207,99	175,10	55,41	-22,79	31,78	28,37	17.964,29
Current Surface (b)	518,69	4.870,12	2.729,74	2.502,17	444,89	2.143,36	4.688,54	66,78	17.964,29
Percentage (a/b) %	-8,2	-0,4	-7,6	+7,0	+12,5	-1,1	+0,7	+42,5	

Source: Prepared by the JICA Study Team based on the studies performed by the INRENA 1995 and FAO 2005

(b) Majes-Camana River Watershed

See Table 3.1.7-11 for the vegetation distribution surface variation of Majes-Camana River. Since 1995 to 2000, semi-humid and humid bushes decreased in 30km2 (2.3%) and 5km2 (3.2%) respectively; grasslands (Pj), ice-capped (Nv) have decreased significantly in 364km2 (3.6%) and 60km2 (9.4%) respectively. Wetlands (Bf) are increasing in 12km2 (18.2%). The area with the most increase is the coastal desert (Dc) with approx 40km2 (13%).

Table 3.1.7-11 Changes in the areas of distribution of vegetation from 1995 to 2000 (Majes-Camana Watershed)

Area	Vegetation							
	Lo	Dc	Ms	Msh	Mh	Bf	Pj	Nv
Year 1995 (km2) (a)	104,54	3.108,12	1.570,08	1.334,76	155,20	66,16	10.069,21	641,44
Year 2000 (km2) (b)	131,55	3.512,24	1.586,48	1.304,54	150,25	78,18	9.705,02	581,25
Changes (b-a) (km2) (c)	27,01	404,12	16,40	-30,22	-4,95	12,02	-364,19	-60,19
Change Percentage (%) (c/a)	25,8	13,0	1,0	-2,3	-3,2	18,2	-3,6	-9,4

(4) Current situation of forestation

(a) Cañete, Chincha, Pisco and Yauca Watersheds

As indicated before, the climate conditions of four watersheds (Cañete, Chincha, Pisco and Yauca River watersheds) do not improve high trees species development, so natural vegetation is not distributed; this only happens in the banks where the phreatic water table is near the surface.

So, due to the difficult situation of finding a good spot to grow trees is why reforestation great projects have not happened in this area. There is no reforest project known with commercial aims.

In the lower and medium watersheds, trees are planted mainly for three objectives: i) reforest along the river to prevent disasters; ii) for agricultural lands protection from wind and sand; and iii) as perimeter for housings. In any case, the surface is much reduced. The most planted specie is Eucalyptus and is followed by *Casuarinaceae*. The use of native species is not very common. On the other hand, in the Mountain region, reforesting is done for logging, crops protection (against cold and livestock entrance) and to protect the recharge water areas. There are mostly eucalyptus and pines. Many reforest projects in the Mountain region have been executed following PRONAMACHS (currently, AGRORURAL). Such program gives throughout AGRORURAL seedlings to the community, which are planted and monitored by producers. There is also a reforest program implemented by the regional government, but in a very reduced way. In this case, the program establishes the needs to achieve consensus from the community to choose the areas to be reforested. However, in general, mostly all farmers want to have greater crop lands and achieving consensus always takes more time. Another limiting factor is the cold weather on altitudes greater than 3.800m.a.s.l. In general, no information has been able to be collected on reforestation projects to date, because these files were not available.

The National Reforestation Plan (INRENA, 2005) registers forestation per department from 1994 to 2003, from which the history data corresponding to the environment of this study was searched (See Table 3.1.7-12). It is observed that the reforested area increased in 1994, drastically decreasing later. Arequipa, Ica and Lima are departments located in the coast zone with scarce rainfall, thus the forestation possibility is limited, besides the scarce forest demand. On the other hand, Ayacucho, Huancavelica and Junin that are located in the Mountains, and there is a lot of demand of timber and agriculture lands and livestock protection; also, rain is very abundant. However, for the above mentioned reasons, the reforested surface is reduced in these areas too.

Table 3.1.7-12 History registry of forestation 1994-2003

(Units: ha)

Departaments	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total
Arequipa	3.758	435	528	1.018	560	632	nr	37	282	158	7.408
Ayacucho	14.294	9.850	3.997	8.201	2.177	6.371	4.706	268	2.563	220	52.647
Huancavelica	12.320	1.210	2.587	2.061	294	7.962	6.001	545	1.035	0	34.015
Ica	2.213	20	159	159	89	29	61	15	4	1	2.750
Junín	38.064	921	3.781	8.860	2.597	4.412	718	995	556	752	61.656
Lima	6.692	490	643	1.724	717	1.157	nr	232	557	169	12.381
Piura	7.449	971	2.407	3.144	19.070	2.358	270	1.134	789	48	37.640

Source: National Reforestation Plan, INRENA, 2005

(b) Majes-Camana River Watershed

According to the obtained information throughout Agrorural interviews, the forestry experiences are shown in Table 3.1.7-13. Forestry has been done in 4 places, in much reduced areas and mostly experimental forestry. On the other hand, Conservancy Nature NGO currently performs vegetation recovery activities in Hills of the Peruvian Coastal Areas.

Table 3.1.7-13 Forestry Experiences (Arequipa Department)

Year	Plantation Site	Executor Unit	Planted Species	Area (ha)	Observations
1992	Arequipa	Univ. Nac. San Agustín	Native Species	2	Forestry Diagnosis and Possibilities
2004	Usuña, Bellavista Polobaya district, Prov. Arequipa	AGRORURAL	Eucalyptus, pine, cypress	3	
2005	Arequipa	Tesis de Universidad	molle	0,5	

3.1.8 Current situation of soil erosion

(1) Information gathering and basic data preparation

1) Information Gathering

During this study the data and information indicated in Table 3.1.8-1 was collected in other to know the current situation of the sediment production behind the Study Area.

Table 3.1.8-1 List of collected information

	Forms	Prepared by:
Topographic map (Scale 1/50.000)	Shp	INSTITUTO GEOGRAFICO NACIONAL
Topographic map (Scale 1/100.000)	Shp,dxf	INSTITUTO GEOGRAFICO NACIONAL
Topographic map (Scale 1/250.000)	SHP	Geologic data systems
Topographic map (Scale 1/100.000)	Shock Wave	INGEMMET
30 m grid data	Text	NASA
River data	SHP	ANA
Watershed data	SHP	ANA
Erosion potential risk map	SHP	ANA
Soils map	SHP	INRENA
Vegetal coverage map	SHP2000 PDF1995	DGFFS
Rainfall data	Text	Senami

2) Preparation of basic data

The following data was prepared using the collected material. Details appear in Annex 6.

- Hydrographic watershed map
- Zoning by third order valleys map
- Geological and Hydrographic watershed Map
- 2000 Vegetation formation map
- 1995 Vegetation formation map
- Geological and slopes map
- Hydrographic and slopes watershed map
- Soil and watersheds map
- Isohyets map
- Population distribution map

(2) Analysis of the causes of soil erosion

1) Topographic characteristics

i) Surface pursuant to altitudes

Table 3.1.8-2 and Figure 3.1.8-1 show the percentage of surface according to each watershed's altitudes. In Cañete and Majes-Camana watersheds there is high percentage of areas with more than 4,000 m.a.s.l. Slopes in this area are light and are distributed on ice-capped and reservoirs areas. This part of Cañete and Majes-Camana rivers is big and has plenty and deep rivers in comparison to other watersheds. In Majes-Camana watershed, elevations between 4,500 and 5,000m.a.s.l are 53% of the total. On the other hand, in Chira River ,the greatest percentage is altitudes between 0 and 1,000m.a.s.l.

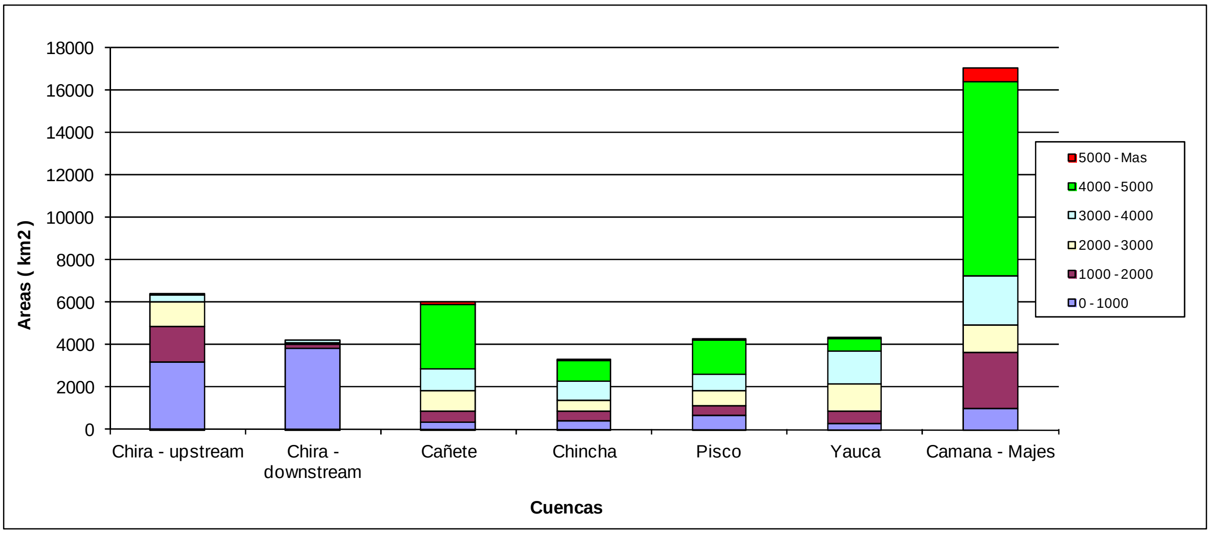


Figure 3.1.8-1 Surface according to altitude

Table 3.1.8-2 Surface according to altitudes

Altitude (m.a.s.l)	Surface (Km²)						
	Chira (upper watershed)	Chira (downstream watershed)	Cañete	Chincha	Pisco	Yauca	Majes'Camana
0 - 1000	3262,43	3861,54	381,95	435,6	694,58	332,79	1040,56
1000 - 2000	1629,48	207,62	478,2	431,33	476,7	575,82	2618,77
2000 - 3000	1153,61	43,24	1015,44	534,28	684,78	1302,58	1277,54
3000 - 4000	313,74	156,11	1012,58	882,39	760,47	1504,8	2305,64
4000 - 5000	0,22	0,00	3026,85	1019,62	1647,8	602	9171,56
5000 or more	0,00	0,00	108,95	0,67	6,19	0,55	635,44
Total	6359,48	4268,51	6023,97	3303,89	4270,52	4318,54	17049,51
Max Altitude		4110	5355	5005	5110	5060	5821

ii) Zoning according to slopes

Slope zoning maps were prepared fro each watershed. Figure 3.1.8-2 and Table 3.1.8-3 show the percentage distribution according to each watershed's slope. The accentuated topography of Cañete, Chincha, Pisco, Yauca, Majes-Camana and Chira, can be seen following this order. In Cañete and Chincha, slopes of more than 35% represent more than 50% of the total surface. The more pronounced topography, the more sediments production value. So, more sediment is produced.

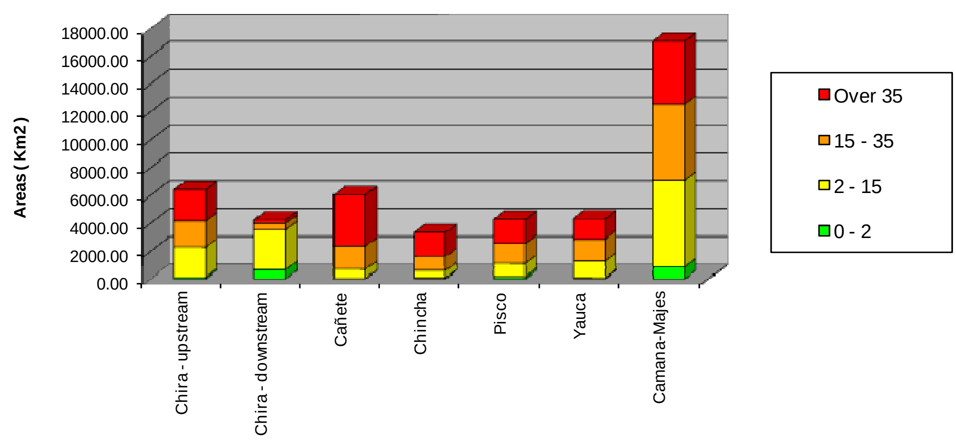


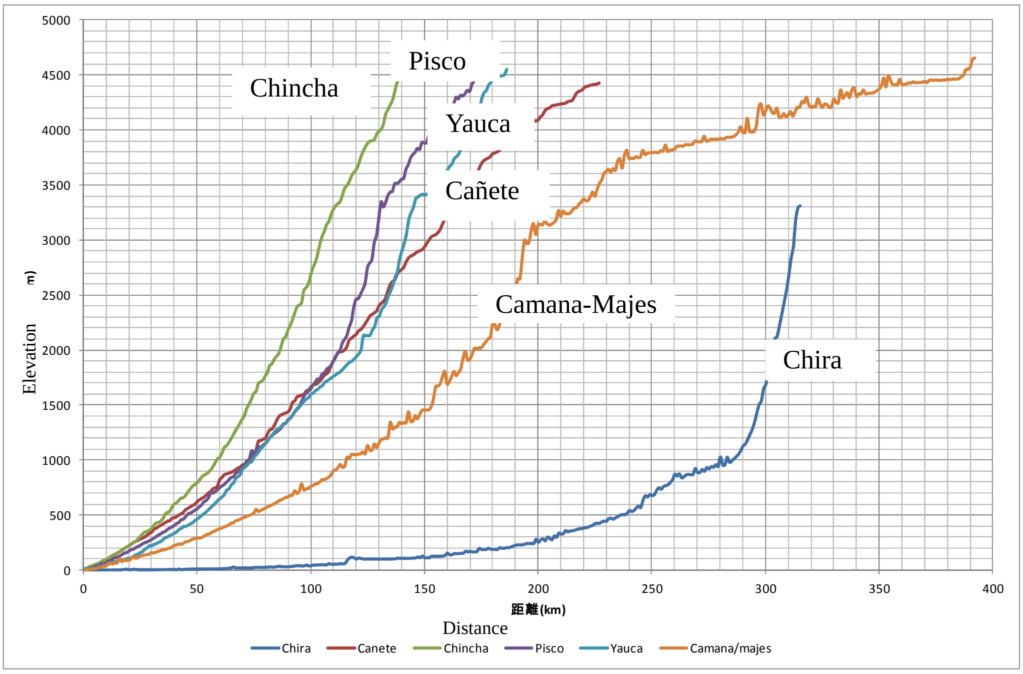
Figure 3.1.8-2 Percentage distribution according to slopes and surface

Table 3.1.8-3 Percentage distribution according to slopes and surface

	Chira (upper watershed)		Chira (lower watershed)		Cañete		Chincha	
Slope (%)	Area (km2)	%	Area (km2)	%	Area (km2)	%	Area (km2)	%
0 - 2	131,62	2%	651,28	15%	36,37	1%	90,62	3%
2 - 15	2167,69	34%	2859,35	67%	650,53	11%	499,68	15%
15 - 35	1852,79	29%	465,86	11%	1689,81	28%	1019,77	31%
35 or more	2237,64	35%	261,76	6%	3647,26	61%	1693,82	51%
TOTAL	6389,74	100%	4238,25	100%	6023,97	100%	3303,89	100%
	Pisco		Yauca		Majes-Camana			
Slope (%)	Area (km2)	%	Area (km2)	%	Area (km2)	%		
0 - 2	168,57	4%	79,01	2%	869,75	5%		
2 - 15	947,86	22%	1190,19	28%	6210,54	36%		
15 - 35	1426,18	33%	1591,21	37%	5452,97	32%		
35 or more	1727,91	40%	1458,13	34%	4516,25	26%		
TOTAL	4270,52	100%	4318,54	100%	17049,51	100%		

iii) River Longitudinal Profile

Figure 3.1.8-3 shows the longitudinal profile of the rivers. Cañete, Chincha, Pisco and Yauca have a similar profile. In case of Majes-Camana, the slope is deep from the mouth to km200, but from this point until km400, the slope is soft. Chira river has a soft slope up to km 300 and from this point up it turns into an accentuated slope.



Source: Elaborated by JICA Study Team based on 30m mesh

Figure 3.1.8-3 Longitudinal Profile of the 6 watersheds

iii) River-bed slope

As seen in Figure 3.1.8-5, ravines are divided into dragging and sediment flow sections. Table 3.1.8-3 and Figure 3.1.8-4 show the percentage bed slope. It is said that the sections where sediment flow is produced have a bed-slope between 1/30 and 1/6. It is seen that in general terms, the watersheds have a high regulation capacity.

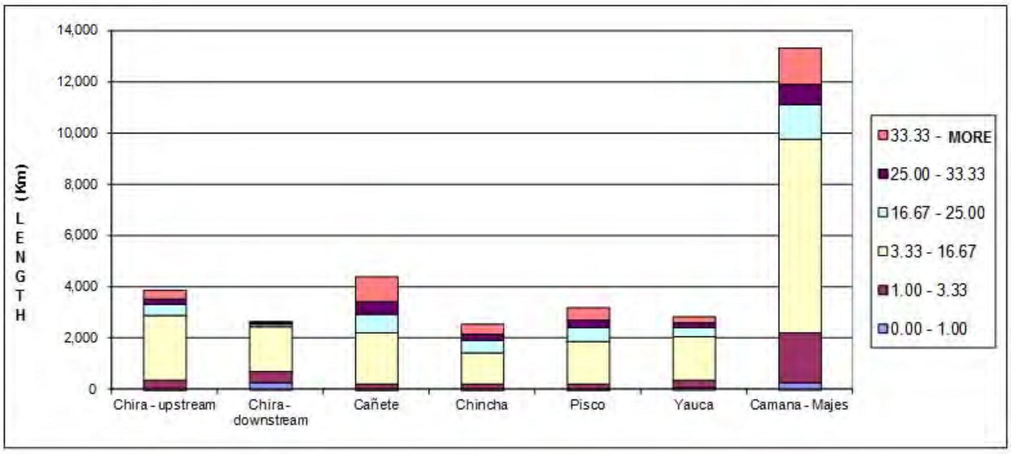


Figure 3.1.8-4 River-bed Slope and total length of streams

Table 3.1.8-3 River-bed Slope and total length of streams

Slope (%)	Chira - upstream	Chira - downstream	Cañete	Chincha	Pisco	Yauca	Majes-Camana
0,00 - 1,00	6,00	233,34	12,82	5,08	12,15	39,13	263,45
1,00 - 3,33	345,77	471,67	173,88	177,78	165,05	312,82	1953,19
3,33 - 16,67	2534,14	1751,16	1998,6	1250,82	1683,15	1687,19	7511,73
16,67 - 25,00	435,46	97,84	753,89	458,76	519,64	352,42	1383,17
25,00 - 33,33	201,72	37,51	467,78	255,98	291,84	185,78	761,15
33,33 - More	318,46	42,72	975,48	371,8	511,76	226,92	1425,65
TOTAL	3841,55	2634,24	4382,45	2520,22	3183,59	2804,26	13298,34

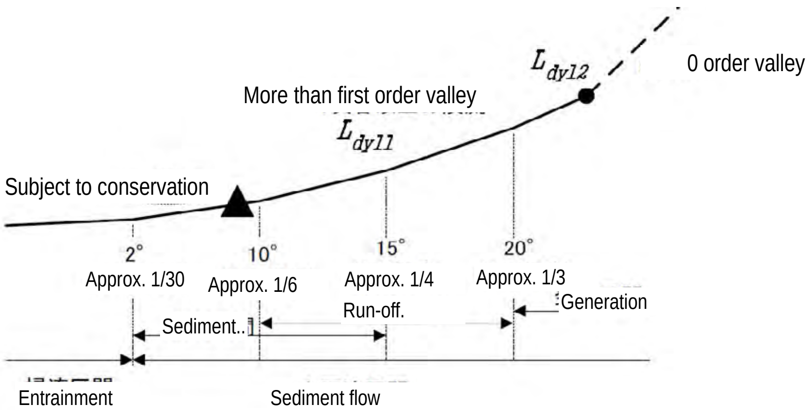


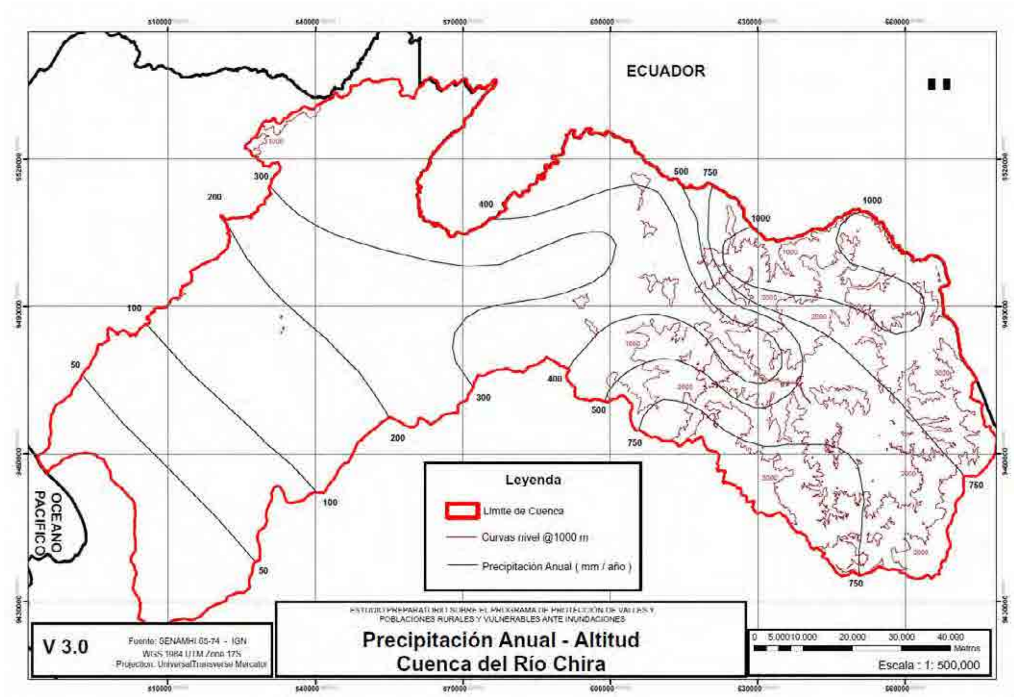
Figure 3.1.8-5 River-bed slope and sediment movement pattern

2) Rainfall

On the Pacific coast there is an arid area of 30 to 50km width and approx 3.000km long. This region belongs to a climate zone called Chala, where the middle annual temperature is about 20 ° C and almost it does not rain along the year.

Altitudes between 2,500 and 3,000 m.a.s.l. belong to the Quechua zone, where annual precipitation exist between 200 and 300mm. On altitudes from 3,500 and 4500m.a.s.l there is another region, called Suni, characterized by its sterility. Precipitations in this region occur annually with 700mm of rain

Figures 3.1.8-6 and 3.1.8-11 show the isohyets map (annual rainfall) of each watershed.



Source: Prepared by the JICA Study Team based on the SENAMHI data

Figure 3.1.8-6 Isohyet Map of the Chira river watershed

Annual precipitations in the flood analysis area fluctuate between 0 and 200mm. The average annual precipitation in the eastern area of 2,000m.a.s.l is between 750 and 1000 m.a.s.l.

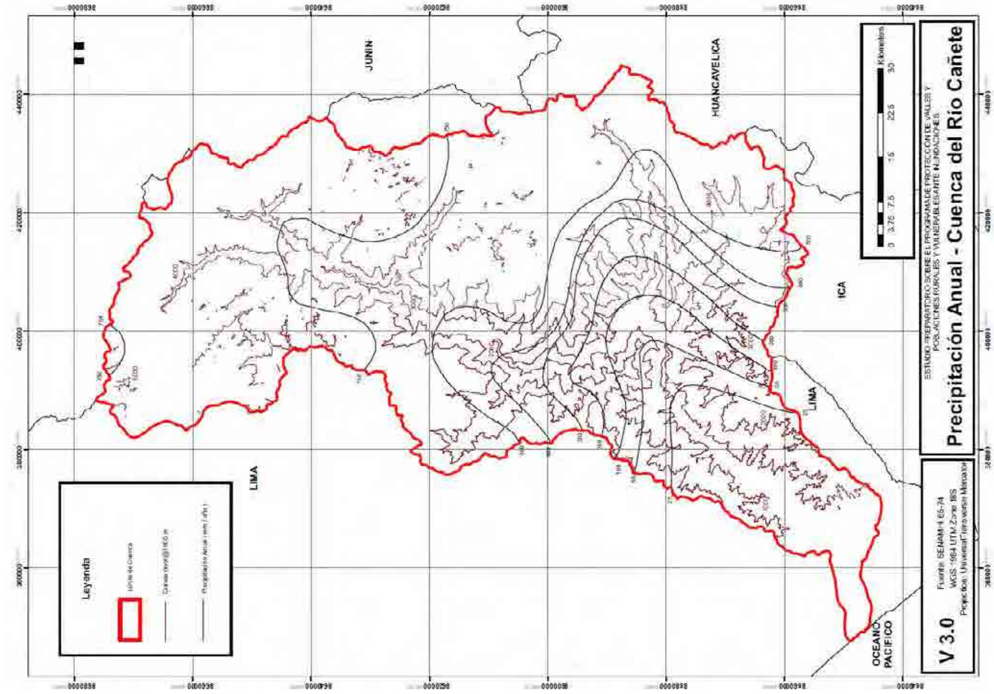


Figure 3.1.8-7 Isohyet Map of the Cañete river watershed

Annual precipitations in the flood analysis area fluctuate between 0 and 25mm. The average annual precipitation in the area of 4,000m.a.s.l is between 750 and 1,000 m.a.s.l.

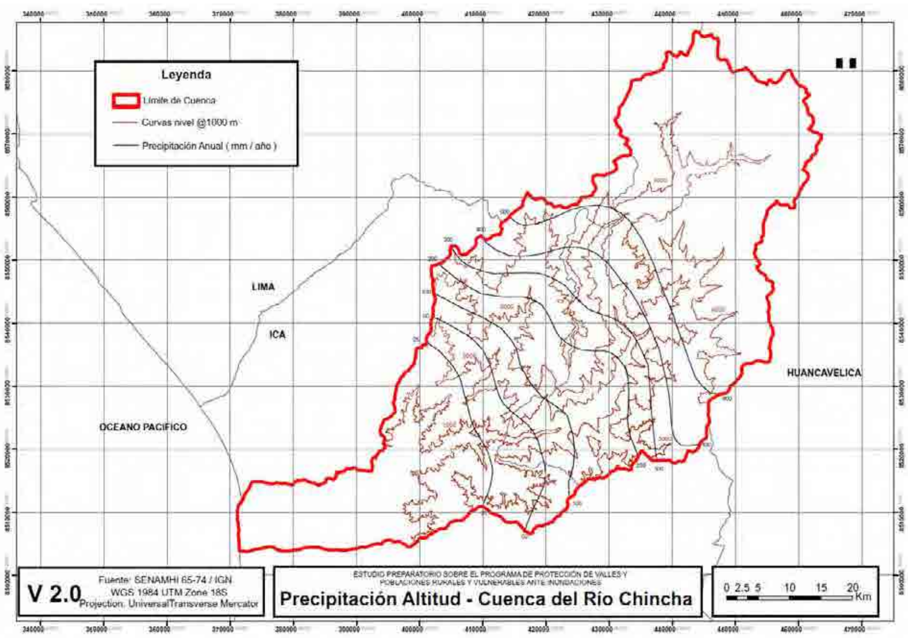


Figure 3.1.8-8 Isohyet Map of the Chincha river watershed

Annual precipitations in the flood analysis area fluctuate between 0 and 25mm. The average annual precipitation in the area of 4,000m.a.s.l is between 500 and 750 m.a.s.l.

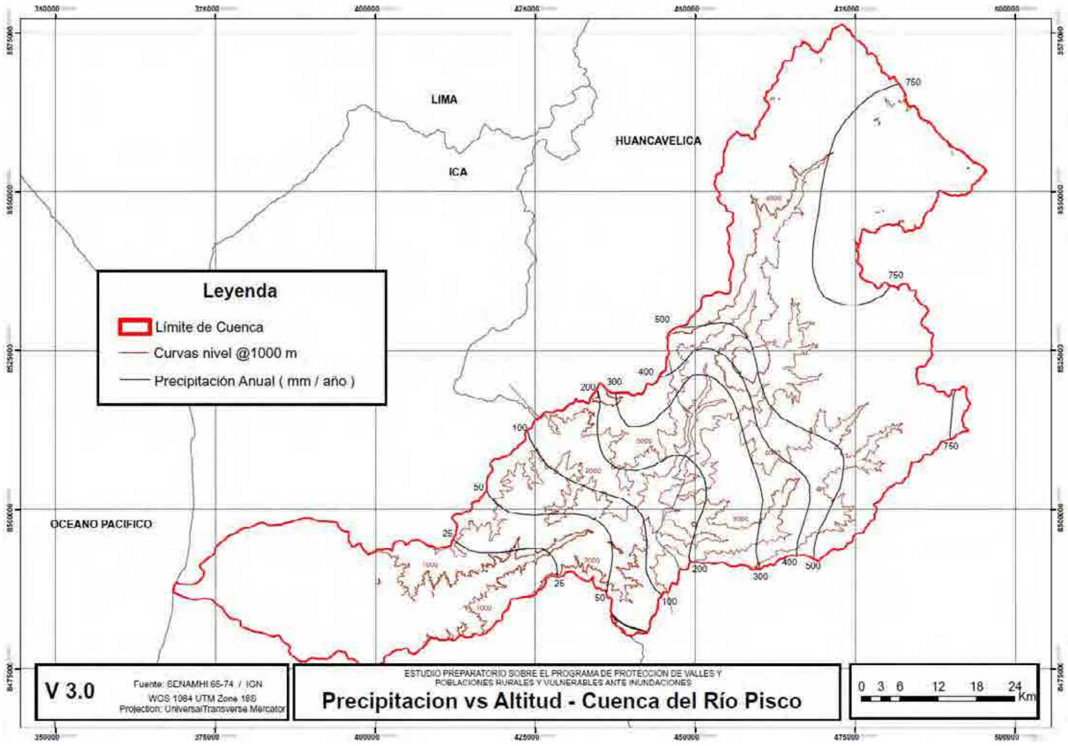


Figure 3.1.8-9 Isohyet Map of the Pisco river watershed

Annual precipitations in the flood analysis area fluctuate between 0 and 25mm. The average annual precipitation in the area of 4,000m.a.s.l is between 500 and 750 m.a.s.l.

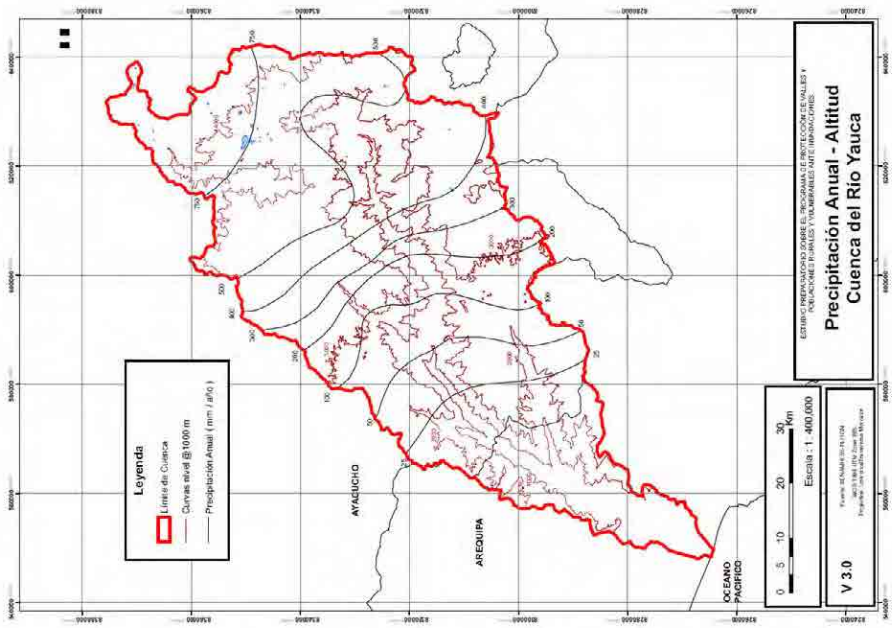


Figure 3.1.8-10 Isohyet Map of the Yauca river watershed

Annual precipitations in the flood analysis area fluctuate between 0 and 25mm. The average annual precipitation in the area of 3,000 to 4,000m.a.s.l is between 500 and 750 m.a.s.l.

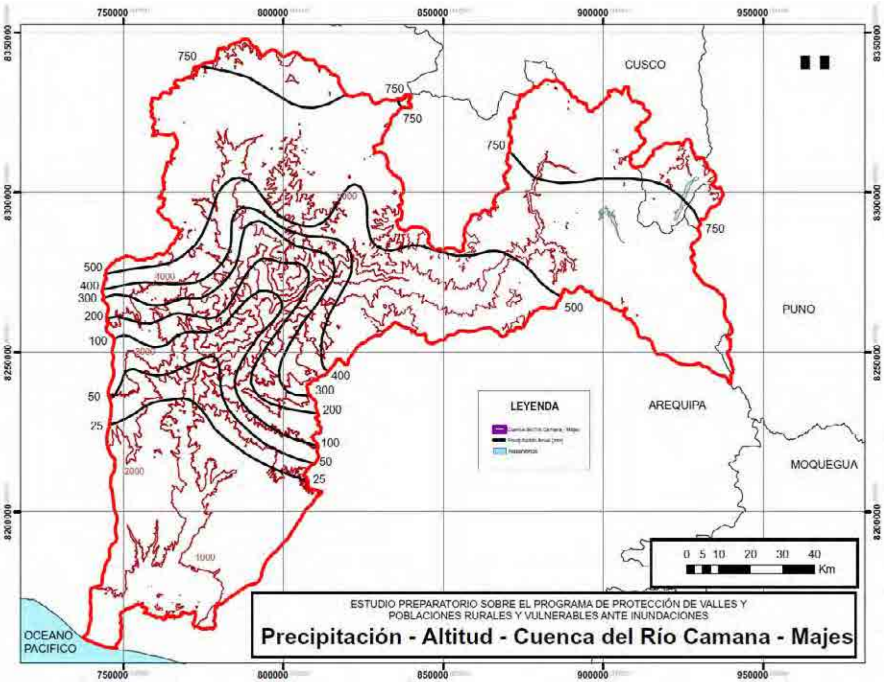


Figure 3.1.8-11 Isohyet Map of the Majes-Camana river watershed

Annual precipitations in the flood analysis area fluctuate between 0 and 50mm. The average annual precipitation in the area of 4,000 to 5,000m.a.s.l is between 500 and 750 m.a.s.l.

3) Slope and hillside altitude

In Figure 3.1.8-12 and Table 3.1.8-4 the relation of the slope and the hillsides altitude is shown.

In Chira river upper watershed, slopes with more than 35% between 1,000 and 3,000m.a.s.l are mostly found, and in the lower watershed the slopes between 2 and 15% which represent 67% of the total are found.

In Cañete river watershed, slopes with more than 35% represent 60% of slopes. Slopes with more than 35% are found mainly in heights between 4,000 and 6,000m.a.s.l.

In Chincha river watershed, slopes with more than 35% are between 2,000 and 4,000m.a.s.l.

In Pisco river watershed, slopes with more than 35% are between 1,000 and 4,000m.a.s.l. Over 4,000m.a.s.l, soft slopes with less than 35%l are distributed.

In Yauca river watershed, slopes with more than 35% are between 1,000 and 3,000m.a.s.l. Over 3,000m.a.s.l, soft slopes with less than 35% are distributed.

In Majes-Camana river watershed, the topography is very variable between 1,000 and 4,000m.a.s.l. Colca Canyon, considered as one of the deepest in the world is located in this area.

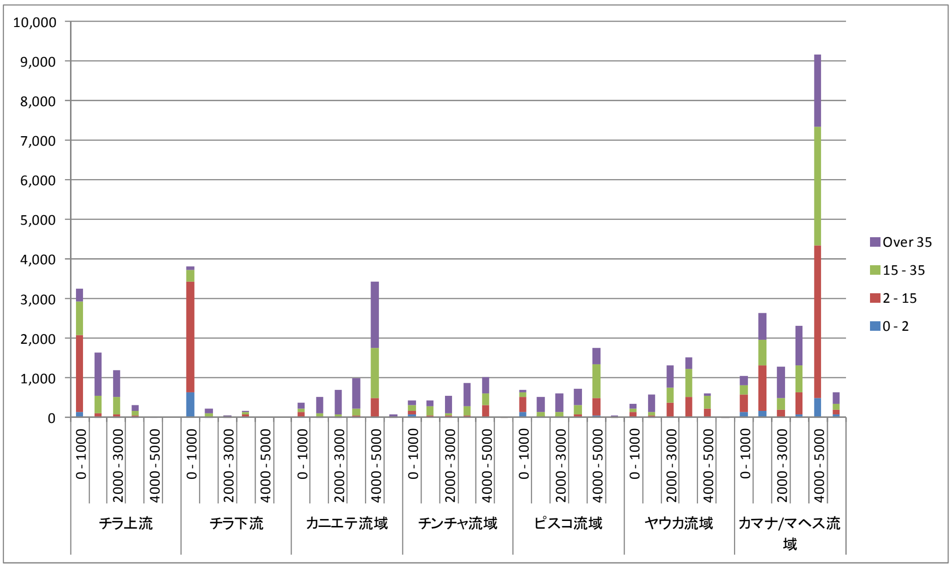


Figure 3.1.8-12 Relation between slopes and altitude in each watershed

Table-3.1.8-4 Relation between slopes and altitude in each watershed

Watershed	Slope	Altitude (m.a.s.l) 0 - 1000		1000 - 2000		2000 - 3000		3000 - 4000		4000 - 5000		5000 - More		Total
Upper Chira	0 - 2	129,06	98%	1,34	1%	0,83	1%	0,39	0%	0,00	0%	0,00	0%	131,62
	2 - 15	1934,27	89%	99,74	5%	84,46	4%	49,22	2%	0,00	0%	0,00	0%	2167,69
	15 - 35	859,87	46%	443,18	24%	432,88	23%	116,86	6%	0,00	0%	0,00	0%	1852,79
	35 or more	319,67	14%	1084,79	48%	677,65	30%	155,31	7%	0,22	0%	0,00	0%	2237,64
Lower Chira	0 - 2	647,61	99%	0,21	0%	0,13	0%	3,33	1%	0,00	0%	0,00	0%	651,28
	2 - 15	2777,68	97%	12,58	0%	6,70	0%	62,39	2%	0,00	0%	0,00	0%	2859,35
	15 - 35	300,77	65%	87,38	19%	10,34	2%	67,37	14%	0,00	0%	0,00	0%	465,86
	35 or more	100,13	38%	108,92	42%	31,86	12%	20,85	8%	0,00	0%	0,00	0%	261,76
Cañete	0 - 2	15,51	60%	0,56	2%	0,15	1%	0,52	2%	8,88	35%	0,05	0%	25,67
	2 - 15	111,54	17%	18,13	3%	11,10	2%	35,27	5%	490,68	73%	3,26	0%	669,98
	15 - 35	101,99	6%	75,00	4%	64,27	4%	193,48	11%	1252,70	73%	21,88	1%	1709,32
	35 or more	141,11	4%	435,02	12%	604,91	17%	751,43	21%	1668,31	46%	59,99	2%	3660,77
Chincha	0 - 2	78,15	86%	0,00	0%	0,00	0%	0,00	0%	12,47	14%	0,00	0%	90,62
	2 - 15	80,09	16%	50,00	10%	47,83	10%	32,12	6%	289,52	58%	0,12	0%	499,68
	15 - 35	148,11	15%	234,91	23%	64,87	6%	256,02	25%	315,65	31%	0,21	0%	1019,77
	35 or more	129,25	8%	146,42	9%	421,58	25%	594,25	35%	401,98	24%	0,34	0%	1693,82
Pisco	0 - 2	132,09	76%	1,79	1%	2,08	1%	3,58	2%	33,74	19%	0,02	0%	173,30
	2 - 15	371,35	39%	25,01	3%	23,33	2%	67,75	7%	459,43	48%	1,51	0%	948,38
	15 - 35	118,98	8%	107,69	8%	101,38	7%	230,25	16%	856,43	60%	4,06	0%	1418,79
	35 or more	60,92	4%	373,82	22%	479,29	28%	415,34	24%	398,45	23%	3,8	0%	1731,62
Yauca	0 - 2	21,13	27%	1,48	2%	14,72	19%	25,07	32%	16,56	21%	0,05	0%	79,01
	2 - 15	106,81	9%	40,14	3%	350,89	29%	498,75	42%	193,38	16%	0,22	0%	1190,19
	15 - 35	86,07	5%	94,66	6%	399,92	25%	685,64	43%	324,82	20%	0,10	0%	1591,21
	35 or more	118,78	8%	439,54	30%	537,05	37%	295,34	20%	67,24	5%	0,18	0%	1458,13
Majes-Camana	0 - 2	140,95	15%	158,22	17%	14,72	2%	78,54	8%	480,22	51%	61,23	7%	140,95
	2 - 15	446,73	7%	1164,54	18%	350,89	5%	560,22	9%	3850,12	59%	128,91	2%	446,73
	15 - 35	222,03	4%	622,51	12%	399,92	8%	673,63	13%	3014,22	59%	154,69	3%	222,03
	35 or more	230,75	5%	677,32	15%	537,05	12%	993,25	22%	1823,81	40%	290,08	6%	230,75

4) Erosion Characteristics

In Figure 3.1.8-13 the characteristics of the watersheds are summarized, except for Chira. Characteristics lower than 1,000m.a.s.l with scarce vegetation and rain corresponds to "Area A." Here, little erosion is made. Areas between 1,000 and 4,000m.a.s.l with accentuated slope, scarce vegetation and no vegetation in some others correspond to "Area B." Here, more erosion happens despite the almost lack of rain. Finally, areas above 4,000m.a.s.l with low temperature correspond to "Area C". Here, land is covered by wetlands adapted to cold weather, and the slope is soft, due to which erosion occurs. Table 3.1.8-5 shows the corresponding relation between area and altitudes.

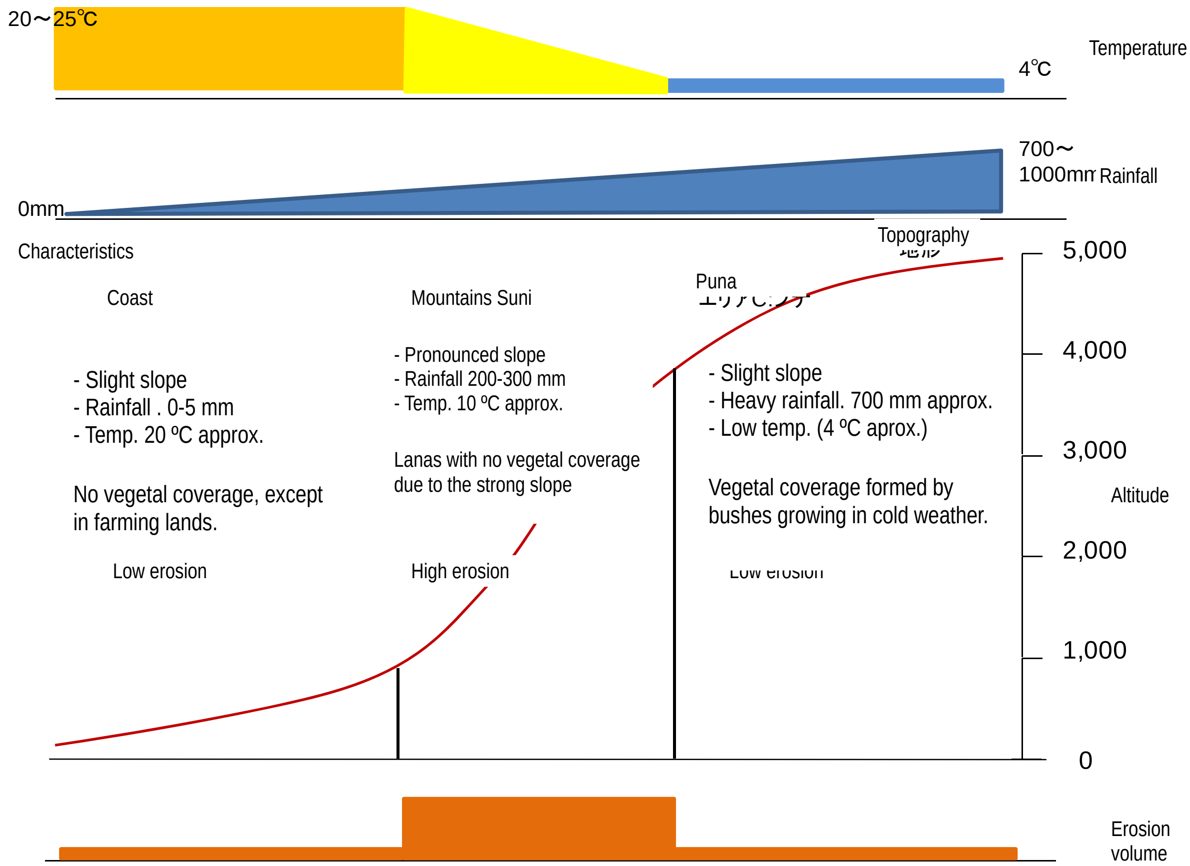


Figure 3.1.8-13 Relation between the altitudes and area

Table 3.1.8-5 Relation between the areas and altitude

Area	Cañete	Chincha	Pisco	Yauca	Majes-Camana
A	0-1.000	0-1.000	0-1.000	0-1.000	0-1.000
B	1.000-3.500	1.000-3.500	1.000-3.500	1.000-3.500	1.000-3.000
C	3.500-5.000	3.500-5.000	3.500-5.000	3.500-5.000	3.000-5.000

(3) Production of sediments

1) Results of the geological study

It is considered that in the 4 watersheds, without including Chira and Majes-Camana, similar conditions are presented because they are geographically near. In Chira River watershed, there is Poechos dam which retains sediments. So, there is no discharge to the lower watershed. Next, the results of the filed study on Pisco, Cañete and Majes-Camana are shown.

(a) Pisco and Cañete Watersheds

Next, the study results are described:

- On mountain slopes there are formations of clastic deposits leaved by collapses or wind erosion
- Production patterns are differentiated according to the foundation rock geology. If this foundation is andesitic or basaltic, the mechanisms consists mainly in great gravel falling (see Figure 3.1.8-14 and 3.1.8-15)
- There is no rooted vegetation (Figure 3.1.8-16) due to the sediment in ordinary time. On the joints of the andesitic rock layer where few sediment movements occur, algae and cactus have developed
- In almost every stream lower terrace formation was observed. In these places, sediments dragged from slopes do not enter directly to the stream, but they stay as deposits on the terraces. Due to this, most of the sediments that enter the river probably are part of the deposits of the erosion terraces or accumulated sediments due to the bed's alteration (see Figure 3.1.8-17)
- On the upper watershed there are less terraces and the dragged sediments of slopes enter directly to the river, even though its amount is very little
- In ravines, terraces are developed (of more than 10m height in Cañete and Pisco watersheds). The base of these terraces has direct contact with channels and from this spot sediments are dragged again and carried-out in ordinary flows (including small and medium overflows in rainy season)

Figure 3.1.8-14 Andesitic and balsitic soil collapsed

Figure 3.1.8-15 Sediment production of sedimentary rocks

Figura 3.1.8-16 Invasión de cactus

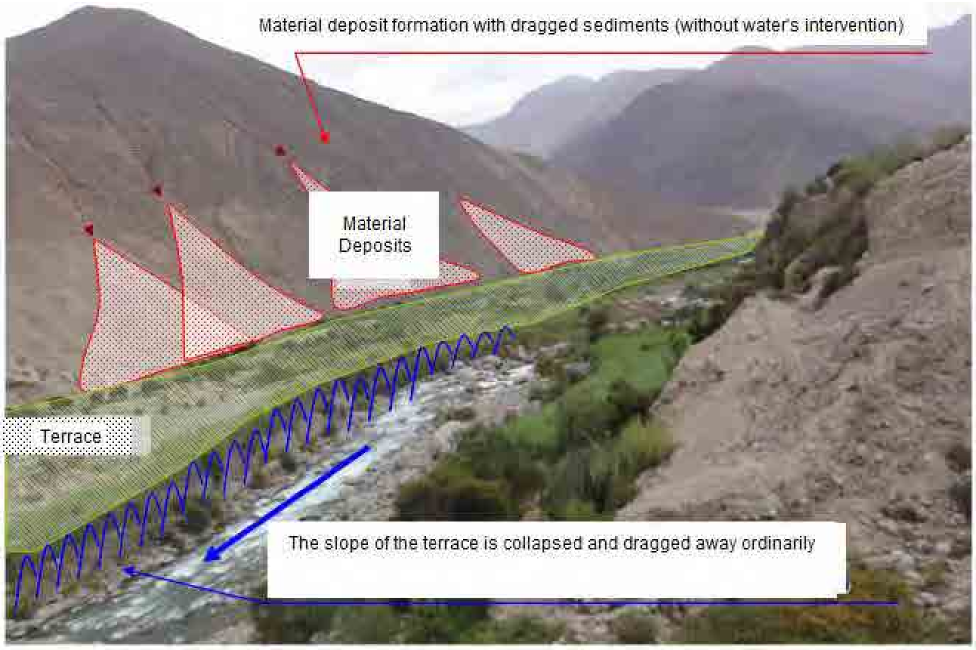


Figure 3.1.8-17 Stream sediment movement

(b) Majes-Camana Watershed

The study results are described below.

- A canyon of approximately 800 m from the soil has been formed, the river flows in the middle. The valley width is 4.2km, the river width is 400m (see Figure 3.1.8-20). It has the characteristics of a terrain setting similar that of Yauca Watershed; however, the depth and the width of Camana-Majes Watershed is larger
- In the mountain surface there is no vegetation, the formation of clastic material deposits is observed, which are detached due to collapse or eolic erosion (See Figure 3.1.8-26)
- The Mesozoic sedimentary rock is the main one in the production patterns, mainly due to the mechanism of fall of large amounts of gravel and eolic fracture and erosion. (see Figure 3.1.8-26)
- In the case of the section subject of this study, the valley base width is broad (111km from the river mouth, in the intersection of Andamayo), the formation of low lands were observed in the beds. IN these places, the sediments dragged from the hillsides do not enter directly to the stream, but are deposited on the terrace. Thus, the most of sediments entering the river are probably produced by the

eroded terraces deposits or accumulated sediments due to the alteration of bed (see Figure 3.1.8-26)

- In the higher watershed, fewer terraces were observed and dragged sediments to the hillsides directly enter to the river, although in a reduced amount (see Figure 3.1.8-16)
- According to the interviews, the situation of the sediment generation of the study section sub-watersheds is showed below. On the other hand, it was said that there was sediment entrainment from upstream silting to the flow, however, this fact was not observed
- In the canyon, terraces have been developed; terrace bottoms are in contact with the flow channel in several points. It may be considered that the ordinary water current (including small and medium floods during rainy season) brings sediments

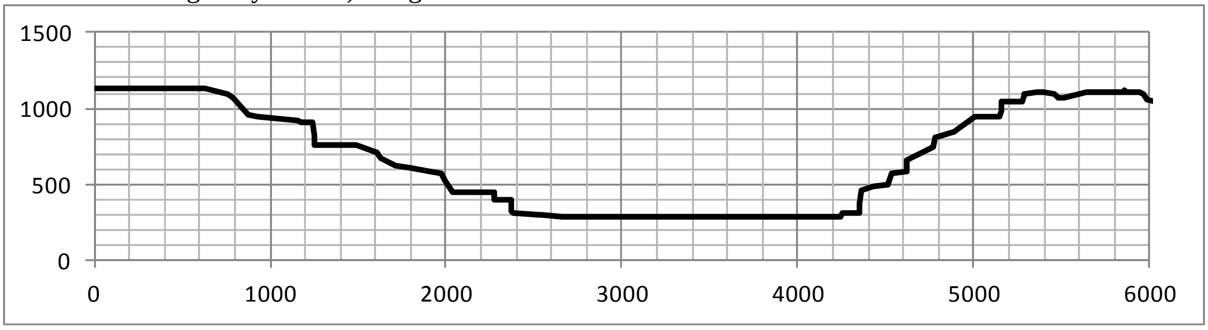


Figure 3.1.8-18 Cross-section of Majes watershed (50km approx. from the mouth)

Table 3.1.8-6 Generation of the water alluvium upstream Majes river

No	River name	Distance	Situation
1	Cosos Figure 3.1.8-11 Figure 3.1.8-12	88km approx.	In rainy season, once per month, alluvium are generated which, due to the sediment entrainment, obstruct rural (=local) highways. The situation may be restored in a day. Sometimes it affects the water pipelines.
2	Ongoro Figure 3.1.8-13	103km approx.	In 1998, an alluvium was generated, 2 persons died due to the sediment entrainment. It took one month to recover the damages in the irrigation channels. 30 minutes before, approximately 8 families listened from the mountain a sound anticipating the alluvium, which helped them to evacuate. These 8 families currently live in the same place of the disaster. The main river of the Majes river is very large and the bed has not been silted. An NGO supported the restoration of the irrigation channels.
3	San Francisco Figure 3.1.8-14	106km approx.	In 1998, an alluvium was generated, producing damages in the irrigation channels. It took one month to temporary restore it and 4 years for restoration. The amount of the alluvium with sand sediment has been 10m. high approximately.
4	Jorón Figure 3.1.8-15	106km approx.	The alluvium was generated and the sediments were entrained to the main river. The sand sediment alluvium was 10m high. It is thought it entrained 100.000 to 1.000.000 m^3 of sediments.

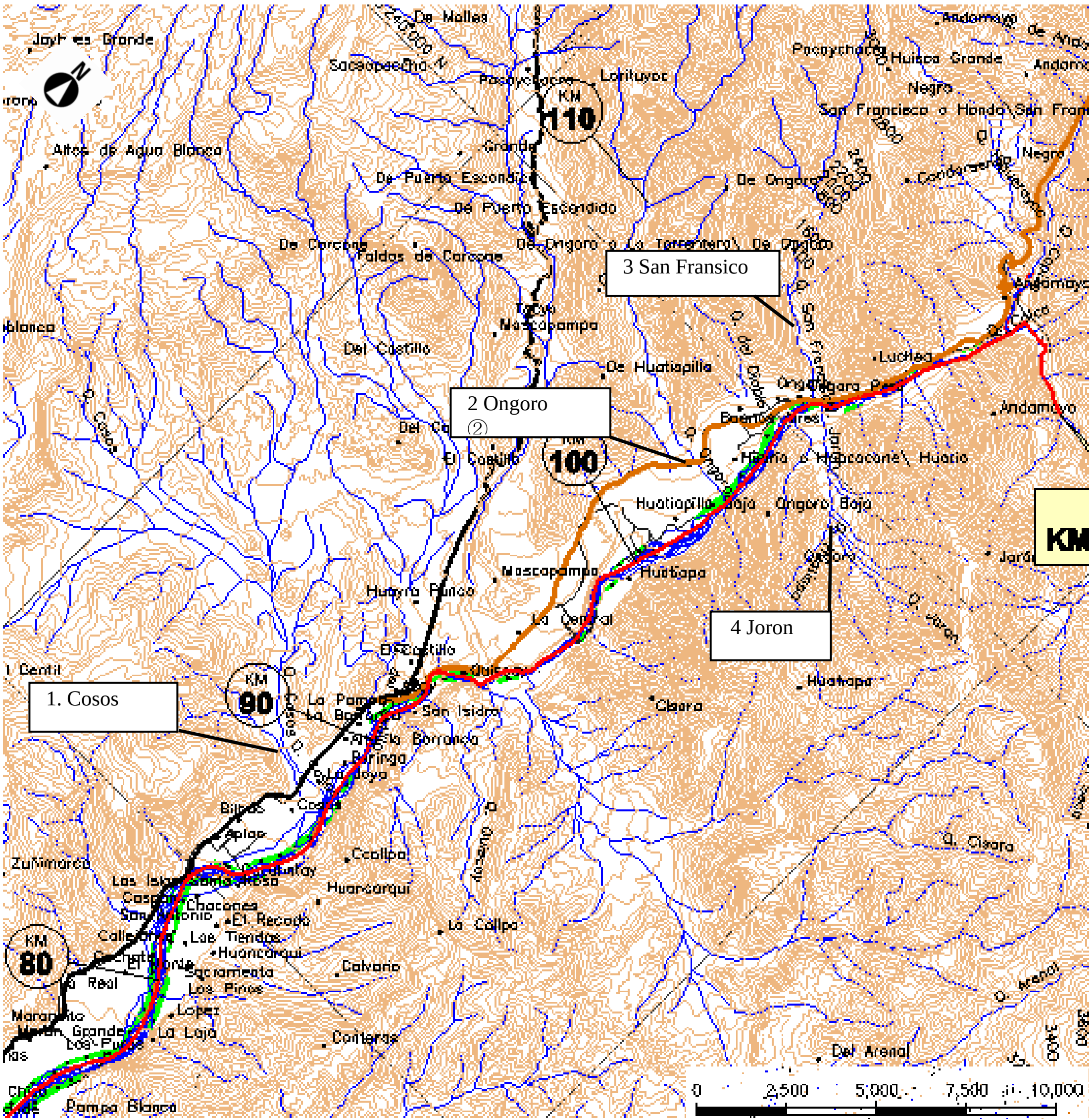


Figure 3.1.8-9 Location of the alluvium generation

Figure 3.1.8-10 Situation around Km 60
(formation of the valley approximately 5km width)
Figure 3.1.8-11 Situation of the sediment silting in Cosos river(Approx. 900m width)


Figure 3.1.8-12 Rural (=local) highway crossing the Cosos river (in rainy season the sediments cover the rural highway, however, it is restored in a day)

Figure 3.1.8-13 Situation of Ongoro (in 1998, 2 persons died due to the alluvium)


Figure 3.1.8-14 Situation of the sediment deposition in the San Francisco river (obstruction of irrigation channels due to the disaster. The walls of the highway are the soil and sand sediments at that time)

Figure 3.1.8-15 Situation of Jorón river (alluvium sediments arrived up to the main river in 1998)


Figure 3.1.8-16 Situation around the Km110 mouth (It may be deduced that there is low affluence of sediments from hillsides to the river channel)

Figure 3.1.8-17 Intersection of the Camana river and Andamayo river (Andamayo river is an overflow channel)

2） Relation of the damages by sediment and rainfall

In 1998, several damages were produced due to sediments in the Camana-Majes watershed. Due to that, a rainfall study was made on 1998. The rainfall data is obtained by the hydrographic analysis of Annex 1 of the Support Report. The pluviometric stations closest to the where the sediments were identified were verified (Table 3.1.8-7), thus obtaining the information of years with probability of higher rainfall and the larger amount of rain days on 1998, as shown in Table 3.1.8-8. In Chuquibamba 15 year rainfall precipitation data have been observed, in Pampacola, 25 years, in Aplao and Huambo only 2 years.

In general, during the powerful El Niño Phenomenon of 1982-1983 and 1998, has occurred almost every 50 years[2], it considered 50 year rainfall; therefore, it was determined that the sediment damages were due to these rainfall.

Table 3.1.8-7 List of Pluviometric Station to check rainfall

Station	Coordinates		
	Latitude	Length	Altitude (m.a.s.l)
Aplao	16%l 04'10	72%l 29'26	625
Chuquibamba	15%l 50'17	72%l 38'55	2839
Huambo	15%l 44'1	72%l 06'1	3500
Pampacolca	15%l 42'51	72%l 34'3	2895

Table 3.1.8-8 Probability of rainfall in every Pluviometric Station and the larger amount of rainfall per day in 1998

Station	Rainfall for T (years)							Rainfall in 1998
	2	5	10	25	50	100	200	
Aplao	1,71	5,03	7,26	9,51	10,71	11,56	12,14	1,20
Chuquibamba	21,65	36,96	47,09	59,89	69,39	78,82	88,21	82,00
Huambo	22,87	30,14	34,96	41,05	45,57	50,05	54,52	25,30
Pampacolca	21,13	29,11	34,40	41,08	46,04	50,95	55,86	42,40

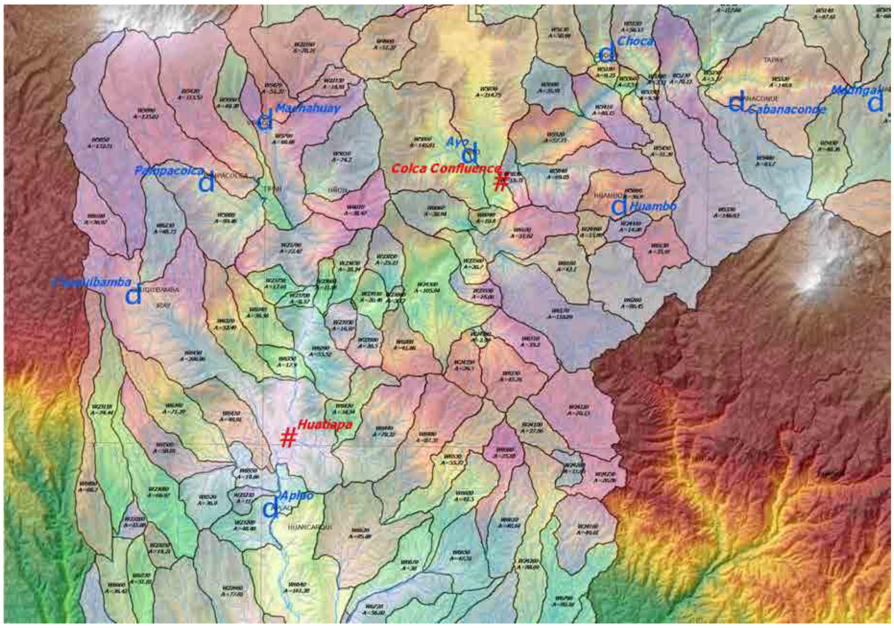


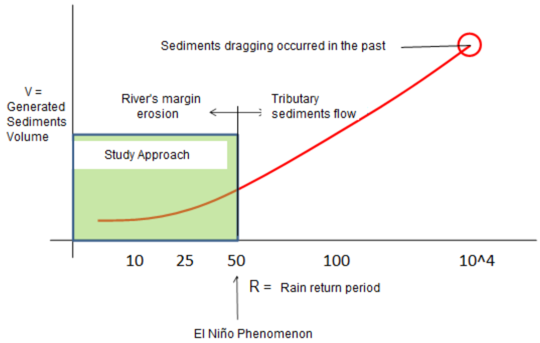
Figure 3.1.8-28 Location of the Pluviometric Station

[2] (Source) Lorenzo Huertas DILUVIOS ANDINOS A TRAVÉS DE LAS FUENTES DOCUMENTALES - COLECCIÓN CLÁSICOS PERUANOS 05/2003

4) Production forecast and sediments entrainment

It is expected that the amount of sediment production and entrainment will vary depending of the dimension of factors such as rainfall, volume of flow, etc.

Since a quantitative sequential survey has not been performed, nor a comparative study, here we show some qualitative observations for an ordinary year, a year with a rainfall similar to that of El Niño and one year with extraordinary overflow. The scope of this Study is focused on a rainfall with 50 year return period, as indicated in the Figure below, which is equivalent to the rainfall producing the sediment flow from the tributaries.



(i) An ordinary year

Figure 3.1.8-29 presents production and discharge sediment data in ordinary time:

- Almost no sediments are produced from the hillsides
- Sediments are produced by the encounter of water current with the sediment deposit detached from the hillsides and deposited at the bottom of terraces
- It is considered that the entrainment is produced by this mechanism: the sediments accumulated in the sand banks within the bed are pushed and transported downstream by the bed change during low overflows

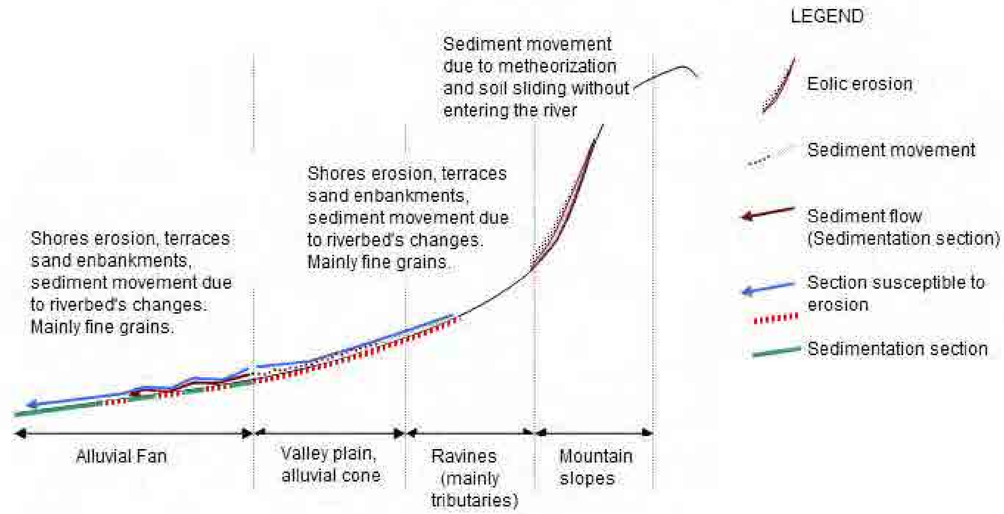


Figure 3.1.8-29 Production and entrainment of sediments in an ordinary year

(ii) When torrential rains with a 50 year return period occur

Pursuant to the interviews performed in the locality, every time El Niño phenomenon occurs the tributary sediment flow occurs. However, since the bed has enough capacity to regulate sediments, the influence on the lower watershed is reduced.

- The amount of sediments entrained varies depending on the amount of water running by the hillsides
- The sediment flow from the tributaries reaches to enter to the main river
- Since the bed has enough capacity to regulate the sediments, the influence in the watershed is reduced

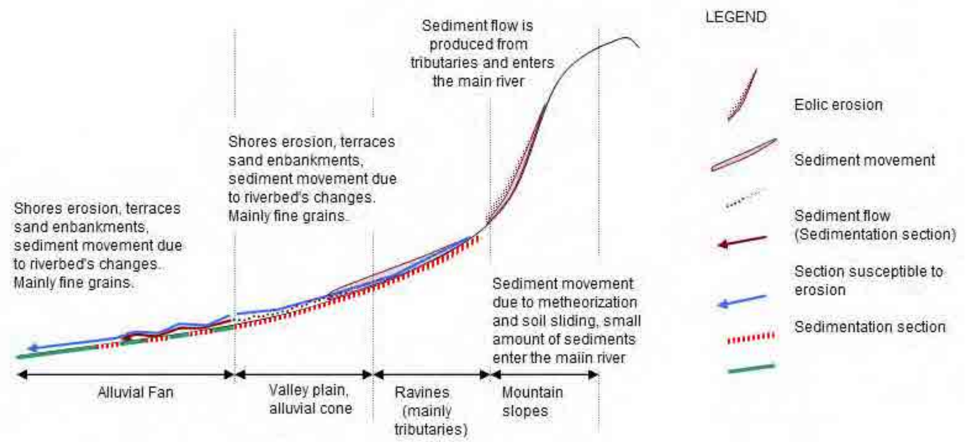


Figure 3.1.8-30 Production and entrainment of sediments during torrential rainfall with a 50 year return period

(iii) Large magnitude overflows (which may cause the formation of terraces similar to those existing now), with a 1:10.000 year return period

In the coast, daily rainfall with 100 years of probability are approximately 50 mm, so land slides entrained by water scarcely occur currently. However, precisely since there are few rains, when torrential rainfall occurs, there is a high potential of water sediment entrainment.

If we suppose that rainfall occurs with extremely low possibilities, for example, 1:10.000 years, we estimate that the following situation would happen (see Figure 3.1.8-23).

- Sediment entrainment from hillsides, by the amount congruent with water amount
- Exceeding sediment entrainment from the bank and bottom of hillsides by the amount congruent with the water amount, provoking landslides which may close streams or beds
- Destruction of the natural embankments of beds closed by the sediments, sediment flow by the destruction of sand banks
- Formation of terraces and increase of sediments in the beds of lower watershed due to the large amount of sediments
- Overflowing in section between alluvial cone and critical sections, which may change the bed.

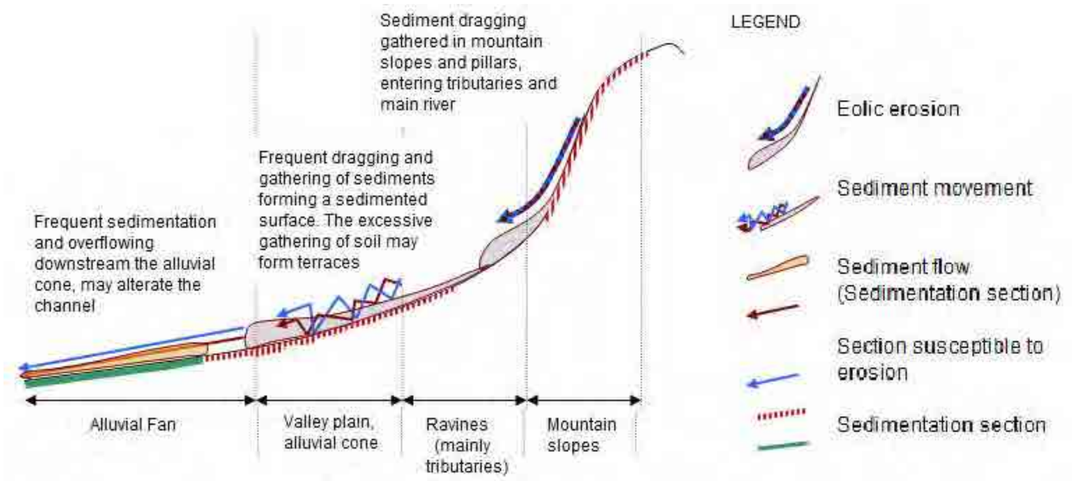


Figure 3.1.8-31 Production of sediments in large overflowing (once a few thousands years)

(5) Approach of this Study

The approach of this Study is focused in rain with 50 year return periods, as indicated in the next Figure, which is equivalent to the precipitations that produce sediment flow from tributaries.

3.1.9 Run off analysis

(1) Rainfall data

1) Current rainfall monitoring system

The current rainfall data collection system used for the run off analysis was reviewed; besides, the necessary rainfall data was collected and processed for such analysis. Rainfall data was obtained from SENAMHI and ELECT.PERU.

① Chira River Watershed

Tables 3.1.9-1~2 and Figure 3.1.9-1 indicate the rainfall monitoring points and the data collected according to the period.

In Chira river watershed rainfall monitoring is performed in 14 stations (including those currently non-operative), for a maximum period of 47 years since 1964 until 2010.

Table 3.1.9-1 List of rainfall monitoring stations (Chira river watershed)

CODIGO	ESTACION	DEPARTAMENTO	LONGITUD	LATITUD
152202	ARDILLA (SOLANA BAJA)	PIURA	80° 26'1	04° 31'1
150003	EL CIRUELO	PIURA	80° 09'1	04° 18'1
152108	FRIAS	PIURA	79° 51'1	04° 56'1
230	LA ESPERANZA	PIURA	81° 04'4	04° 55'55
152125	LAGUNA SECA	PIURA	79° 29'1	04° 53'1
152104	LAS LOMAS 1	PIURA	80° 15'1	04° 38'1
140	LAS LOMAS 2	PIURA	80° 15'1	04° 38'1
208	MALLARES	PIURA	80° 44'44	04° 51'51
152144	MONTERO	PIURA	79° 50'1	04° 38'1
152101	PANANGA	PIURA	80° 53'53	04° 33'33
152135	SAN JUAN DE LOS ALISOS	PIURA	79° 32'1	04° 58'1
203	SALALA	PIURA	79° 27'27	05° 06'6
152110	SANTO DOMINGO	PIURA	79° 53'1	05° 02'1

Table 3.1.9-2 Period of rainfall data collection (Chira river watershed)

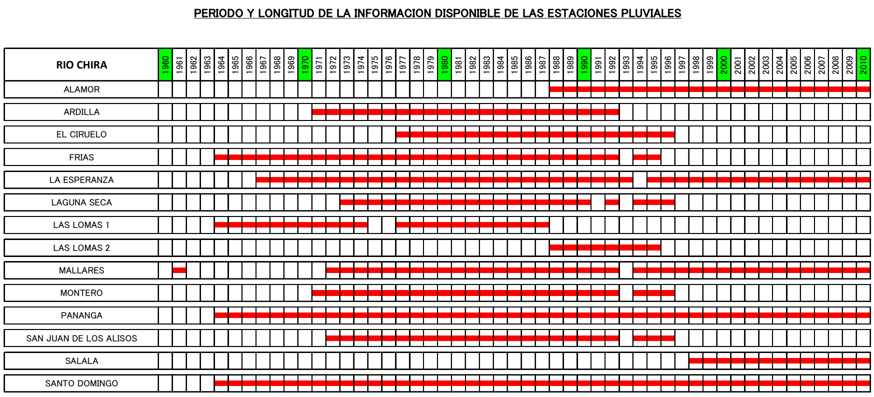


Figure 3.1.9-1 Monitoring stations location map (Chira River watershed)

② Cañete River Watershed

Tables 3.1.9-1~4 and Figure 3.1.9-2 indicate the rainfall monitoring points and the data collected according to the period in Cañete River watershed.

In Cañete river watershed rainfall monitoring is performed in 13 stations (including those currently non-operative), for a maximum period of 47 years since 1964 until 2010.

Table 3.1.9-3 List of rainfall monitoring stations (Cañete river watershed)

CODIGO	ESTACION	DEPARTAMENTO	LONGITUD	LATITUD
636	YAUYOS	LIMA	75° 54'38.2	12° 29'31.4
155450	YAURICOCHA	LIMA	75° 43'22.5	12° 19'0
155169	TOMAS	LIMA	75° 45'1	12° 14'1
156106	TANTA	LIMA	76° 01'1	12° 07'1
6230	SOCSI CAÑETE	LIMA	76° 11'40	13° 01'42
638	PACARAN	LIMA	76° 03'18.3	12° 51'43.4
6641	NICOLAS FRANCO SILVERA	LIMA	76° 05'17	12° 53'57
156112	HUANTAN	LIMA	75° 49'1	12° 27'1
156110	HUANGASCAR	LIMA	75° 50'2.2	12° 53'55.8
156107	COLONIA	LIMA	75° 53'1	12° 38'1
156109	CARANIA	LIMA	75° 52'20.7	12° 20'40.8
156104	AYAVIRI	LIMA	76° 08'1	12° 23'1
489	COSMOS	JUNIN	75° 34'1	12° 09'1

Table 3.1.9-4 Period of rainfall data collection (Cañete river watershed)

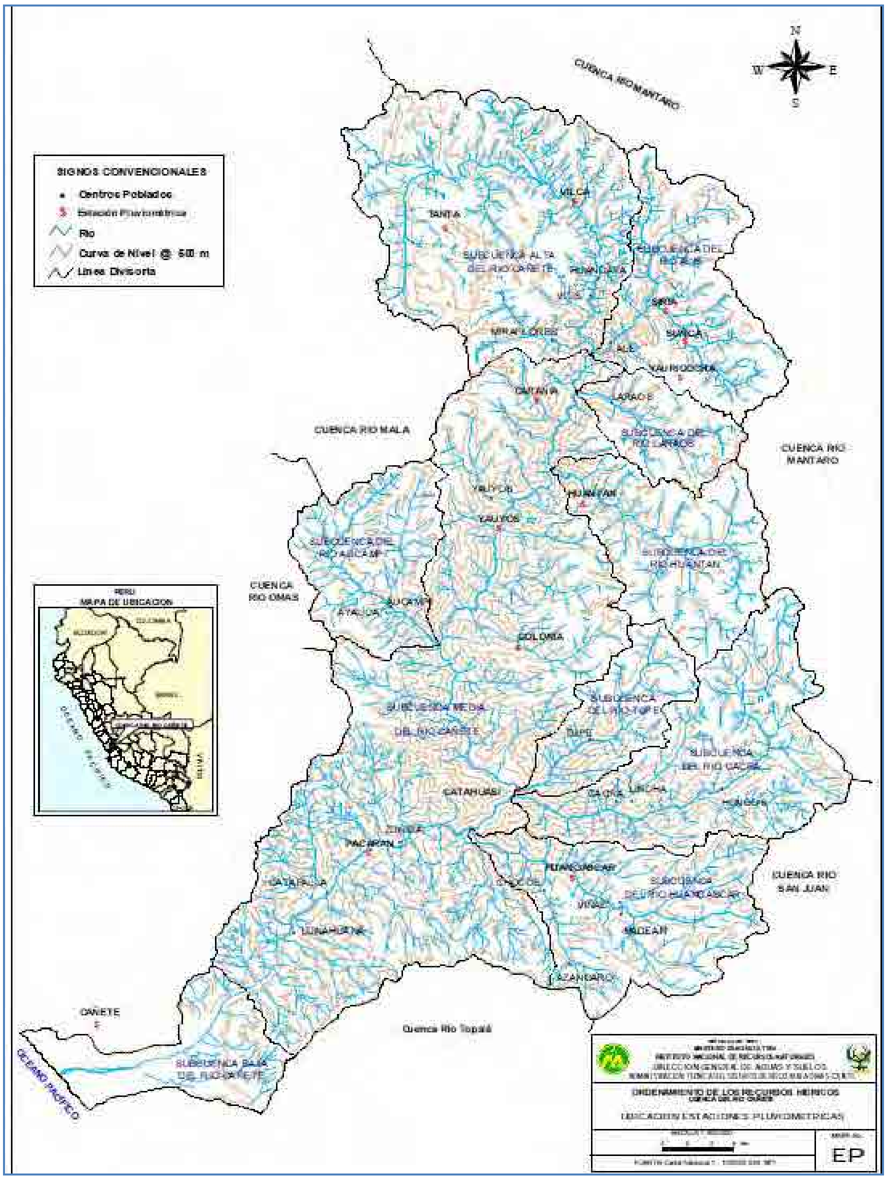


Figure 3.1.9-2 Monitoring stations location map
(Cañete River watershed)

③ Chincha River Watershed

Tables 3.1.9-5~6 and Figure 3.1.9-3 indicate the rainfall monitoring points and the data collected according to the period in Chincha River watershed.

In Chincha river watershed rainfall monitoring is performed in 14stations (including those currently non-operative), for a maximum period of 31 years since 1980 until 2010.

Table 3.1.9-5 List of rainfall monitoring stations (Chincha river watershed)

NOMBRE DE ESTACION	CODIGO ESTACION	Cuenca	Tipo Estac.	Inicio Func.	Años de Observ.	UBICACION POLITICA			UBIC. GEOGRAFICA			Instituc. Responsable	OBSERVACION
						Dpto	Prov	Dist	Lat	Long	Alt		
CONTA	203501	San Juan	H-Lm	1922	80	Ica	Chincha	Chincha Alta	13°27'	75°58'	320	JUNTA USUARIOS	OPERATIVA
FONAGRO	130791	San Juan	MAP	1986	17	Ica	Chincha	Chincha Baja	13°28'	76°08'	50	SENAMHI	OPERATIVA
SAN JUAN DE CASTROVIRREYNA	156114	San Juan	PLU	1966	37	Huancavelica	Castrovirreyna	San Juan	13°12´	75°38´	2150	SENAMHI	OPERATIVA
SAN JUAN DE YANAC	156113	San Juan	PLU	1964	37	Ica	Chincha	Chavín	13°13´	75°47´	2400	SENAMHI	OPERATIVA
HUACHOS	151503	San Juan	PLU	1980	23	Huancavelica	Castrovirreyna	Huachos	13°14´	75°32´	2680	SENAMHI	OPERATIVA
VILLA DE ARMAS	110641	San Juan	CO	1964	27	Huancavelica	Castrovirreyna	Arma	13°08´	75°32´	3500	SENAMHI	OPERATIVA
SAN PEDRO DE HUACARPANA	156115	San Juan	CO	1964	34	Ica	Chincha	S.P.Huacarpana	13°03´	75°39´	3680	SENAMHI	OPERATIVA
LAGUNA HUICHINGA	110632	San Juan	PLU	1980	18	Huancavelica	Castrovirreyna	Aurahua	13°02"	75°34"	3480	SENAMHI	PARALIZADA
TANTARA	110633	San Juan	PLU	1980	18	Huancavelica	Castrovirreyna	Tantará	13°14"	75°37"	2890	SENAMHI	PARALIZADA
CHUNCHO	110631	Mantaro	PLU	1945	23	Lima	Yauyos	Tupe	12°45'	75°31'	4695	IRRIG-SAN JNUAN	PARALIZADA
BERNALES	110650	Pisco	CO	1964	39	Ica	Pisco	Humay	13°45´	75°57´	250	SENAMHI	OPERATIVA
HUANCANO	110639	Pisco	CO	1964	39	Ica	Pisco	Huancano	13°36´	75°37´	1006	SENAMHI	OPERATIVA
TICRAPO	110643	Pisco	PLU	1964	39	Huancavelica	Castrovirreyna	Ticrapo	13°23´	75°26´	2174	SENAMHI	PARALIZADA
TOTORA	110644	Pisco	PLU	1964	39	Huancavelica	Castrovirreyna	Castrovirreyna	13°08'	75°19´	3900	SENAMHI	PARALIZADA

Table 3.1.9-6 Period of rainfall data collection (Chincha river watershed)

CHINCHA	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
HUACHOS																					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
VILLA DE ARMAS								■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■												
CONTA																																												■	■	■	■	■	■	■	■
FONAGRO (CHINCHA)																											■	■	■	■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SAN JUAN DE YANAC																														■	■					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SAN PEDRO DE HUACARPANA																																						■	■	■	■	■	■	■	■	■	■	■	■	■	■
SAN PEDRO DE HUACARPANA 2						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				■		■	■	■	■			■	■	■														
TOTORA							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																						
TICRAPO					■	■	■	■	■	■	■	■	■	■	■	■		■	■	■		■	■	■	■		■	■	■	■																					
COCAS					■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■																													

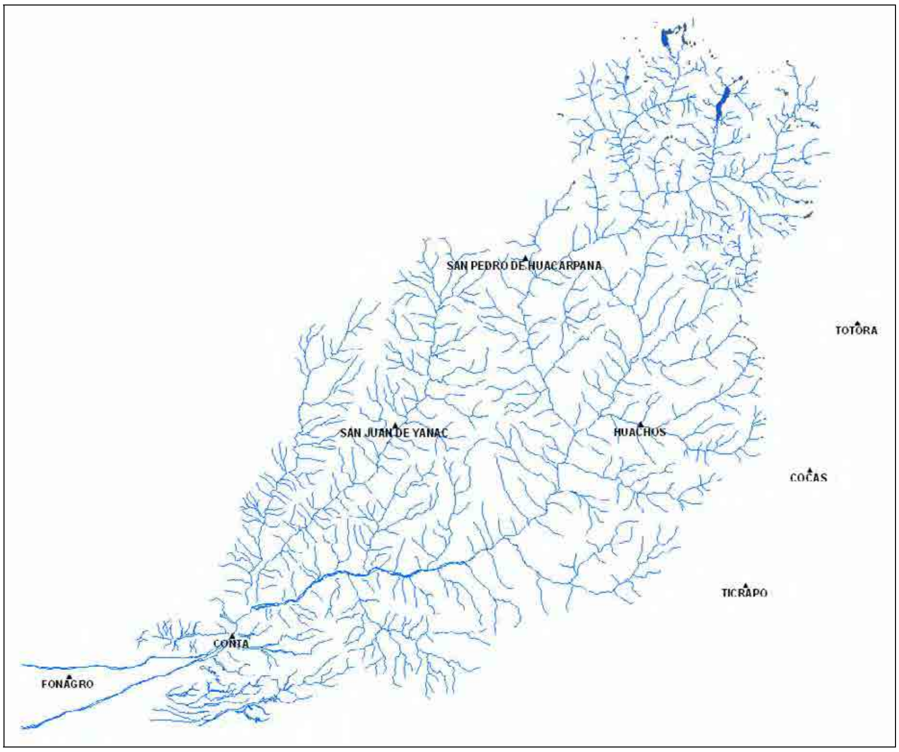


Figure 3.1.9-3 Monitoring stations location map
(Chincha River watershed)

④ Pisco River Watershed

Tables 3.1.9-7~8 and Figure 3.1.9-4 indicate the rainfall monitoring points and the data collected according to the period.

In Pisco river watershed monitoring is performed in 20 stations (including those currently non-operative), for a maximum period of 39 years from 1964 to 2002.

Table 3.1.9-7 List of rainfall monitoring stations (Pisco river watershed)

Estación	Codigo de Estación	Categoria	Ubicación Politica			Ubicación Geográfica			Periodo de Información
			Departamento	Provincia	Distrito	Latitud	Longitud	Altitud	
Agnococha	156141	CO	Huancavelica	Castrovirreyna	Pilpichaca	13º 08'	75º 09'	4650	1964 -1989
Astobamba	155495	PLU	Huancavelica	Huancavelica	Huancavelica	12º 57'	75º 06'	4500	1964 -1984
Bernales	157105	CO	Ica	Pisco	Humay	13º 45'	75º 57	250	1972 - 1981, 1984 - 1987, 1989 - 1991, 1993, 1994, 1999 - 2002
Castrovirreyna	156145	CO	Huancavelica	Castrovirreyna	Castrovirreyna	13º 17'	75º 19'	3956	1964 - 1980
Choclococha	156130	PLU	Huancavelica	Castrovirreyna	Santa Ana	13º 09'	75º 04'	4550	1964 - 1983, 1985 - 2001
Chuncho	155269	PLU	Huancavelica	Castrovirreyna	Chuncho	12º 45'	75º 22'	3800	1945 - 1968
Cocas	156143	CO	Huancavelica	Castrovirreyna	Cocas	13º 16'	75º 22'	3246	1964 - 1979
Cusicancha	156121	PLU	Huancavelica	Castrovirreyna	S.A. Cusicancha	13º 29'	75º 18'	3550	1964 - 1986, 1988 - 2002
Fonagro	130791	MAP	Ica	Chincha	Chincha Baja	13º 28'	76º 08'	50	1986 - 1990, 1995 - 2002
San Genaro	156129	PLU	Huancavelica	Castrovirreyna	Santa Ana	13º 12'	75º 06'	4570	1964 - 1975
Huamani	157107	CO	Ica	Ica	Los Molinos	13º 50'	75º 35'	800	1970 - 1984, 1987 - 1991, 1993, 1994, 1999
Huancano	157103	CO	Ica	Pisco	Huancano	13º 36'	75º 37'	1006	1964, 1966 - 1976, 1978 - 1982, 1988, 1994, 1999 -2002
Pariona	156131	PLU	Huancavelica	Castrovirreyna	Tambo	13º 32'	75º 04'	4240	1970 - 1982
Pisco	157106	S	Ica	Pisco	Pisco	13º 45'	76º 13'	7	1948 - 1969
San Juan	156114	PLU	Huancavelica	Castrovirreyna	Castrovirreyna	13º 12'	75º 37'	2200	1966 - 2002
Tambo	156122	PLU	Huancavelica	Castrovirreyna	Tambo	13º 41'	75º 16'	3080	1964 - 2002
Ticrapo	156117	PLU	Huancavelica	Castrovirreyna	Ticrapo	13º 23'	75º 26'	2174	1964 - 1988
Totora	156119	PLU	Huancavelica	Castrovirreyna	Castrovirreyna	13º 08'	75º 19'	3900	1964 - 1984, 1986 - 1988
Tunel Cero	156142	CO	Huancavelica	Castrovirreyna	Pilpichaca	13º 15'	75º 05'	4425	1964 - 2002
Pampa de Villacuri	157108	CO	Ica	Pisco	Pisco	13º 57'	75º 48'	430	1971, 1972, 1975, 1984 - 1986, 1991

CO: Climatológicas Ordinarias *S: Sinoptica* *PLU: Pluviométricas* *MAP: Meterorologica - Agrologica - Priuncipal*

Table 3.1.9-8 Period of rainfall data collection (Pisco river watershed)

RIO PISCO	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGNOCOCHA											■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
CHOCLOCOCHA																■	■	■	■	■	■	■	■	■	■	■
COCAS					■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■				
CUSICANCHA							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
PARIONA												■	■	■	■	■	■	■	■	■	■	■	■			■
SAN JUAN DE CASTROVIRREYNA								■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
TAMBO						■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
TICRAPO					■	■	■	■	■	■	■	■	■	■	■	■		■	■	■		■	■	■	■	
TOTORA							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
TUNEL CERO												■	■	■	■	■	■	■	■	■	■	■	■		■	■
HACIENDA BERNALES													■	■	■	■	■	■	■	■	■	■	■	■	■	■
HUAMANI								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

RIO PISCO	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGNOCOCHA	■	■	■	■																					
CHOCLOCOCHA	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
COCAS																									
CUSICANCHA	■	■				■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
PARIONA		■	■	■																					
SAN JUAN DE CASTROVIRREYNA	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
TAMBO	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
TICRAPO	■	■	■	■																					
TOTORA	■	■	■																						
TUNEL CERO	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
HACIENDA BERNALES	■	■	■	■	■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■
HUAMANI	■	■	■			■	■		■	■						■	■	■	■	■	■	■	■	■	■

Figure 3.1.9-4 Monitoring stations location map (Pisco River watershed)

⑤ Yauca River Watershed

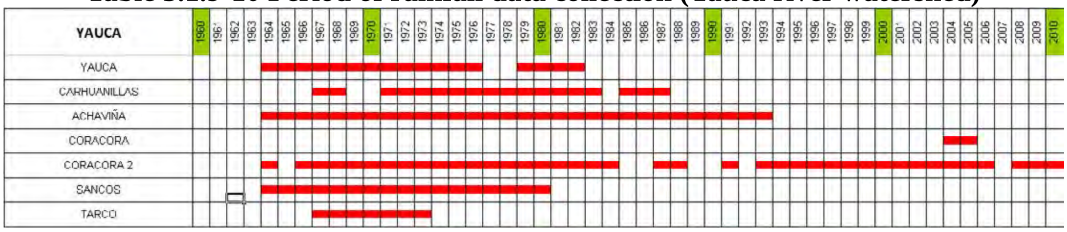
Tables 3.1.9-9~10 and Figure 3.1.9-5 indicate the rainfall monitoring points and the data collected according to the period.

In Yauca river watershed rainfall monitoring is performed in 7 stations (including those currently non-operative), for a maximum period of 47 years since 1964 until 2010.

Table 3.1.9-9 List of rainfall monitoring stations (Yauca river watershed)

NAME	CODE of STATION	LONGITUD [º ' "]	LATITUD [º ' "]	HEIGHT [m.a.s.l]	PERIOD
YAUCA	000743	74 % l31'01.0"	15 % l40'01.0"		1964-1976,1979-1982
CARHUANILLAS	157220	73 % l44'01.0"	15 % l08'01.0"	3,000	1967-1968,1971-1987
CHAVIÑA	000742	73 % l50'01.0"	14 % l59'01.0"	3,310	1964-1982
CORA CORA	000743	73 % l47'01.0"	15 % l01'01.0"	3,172	1964, 1966-1984, 1987-1988,1991, 1993-2010
SANCOS	000740	73 % l57'01.0"	15 % l04'01.0"	2,800	1964-1980
TARCO	157216	73 % l45'01.0"	15 % l18'01.0"	3,300	1967-1969, 1971-1973

Table 3.1.9-10 Period of rainfall data collection (Yauca river watershed)



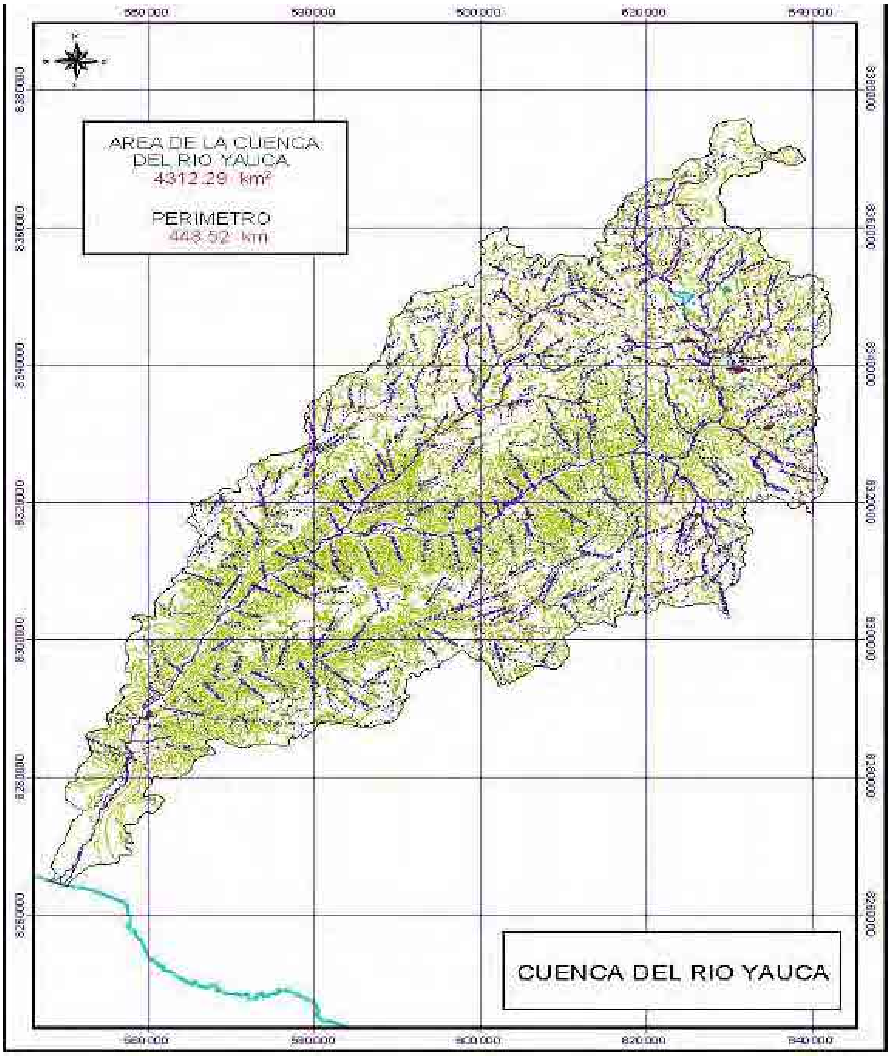


Figure 3.1.9-5 Monitoring stations location map
(Yauca River watershed)

⑥ Majes-Camana River Watershed

Tables 3.1.9-11~12 and Figure 3.1.9-6 indicate the rainfall monitoring points and the data collected according to the period in Majes-Camana River watershed.

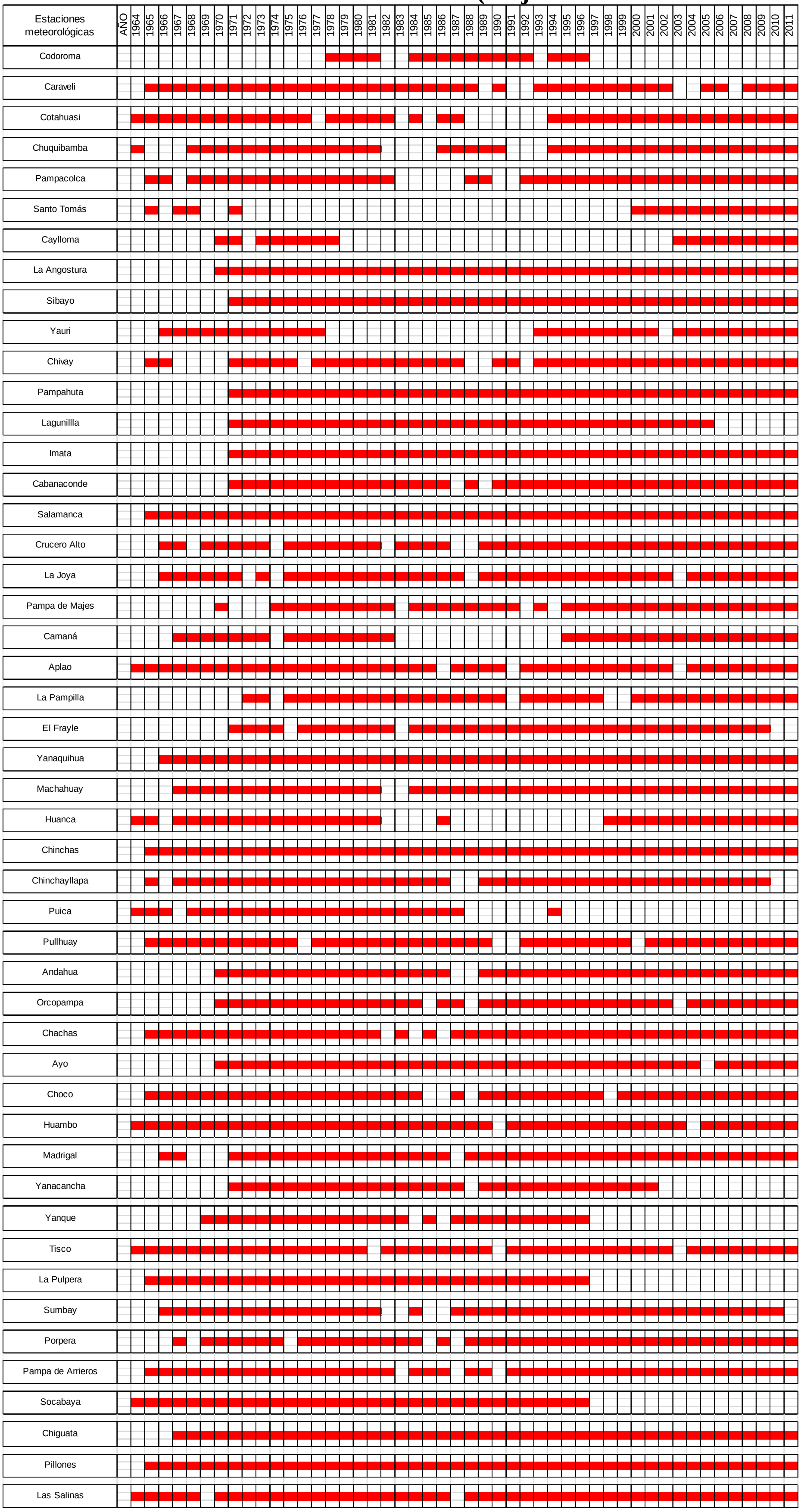
In Majes-Camana river watershed rainfall monitoring is performed in 48 stations (including those currently non-operative), since 1964.

However, it should be mentioned that in some points it was not possible to obtain the accurate data, due to a prolonged lapse where the data collection was stopped in some stations or for any other reasons. Thus, the discharge analysis was carried out using data from 38 stations which registered data relatively accurate. These stations are those indicated in Table 3.1.9-11.

Table 3.1.9-11 List of rainfall monitoring stations (Majes-Camana river watershed)

Estación meteorológica	Coordenadas		
	Latitud	Longitud	Altitud (msnm)
Andahua	15° 29'37	72° 20'57	3528
Aplao	16° 04'10	72° 29'26	645
Ayo	15° 40'45	72° 16'13	1956
Cabanaconde	15° 37'7	71° 58'7	3379
Camaná	16° 36'24	72° 41'49	15
Caravelí	15° 46'17	73° 21'42	1779
Chachas	15° 29'56	72° 16'2	3130
Chichas	15° 32'41	72° 54'59.7	2120
Chiguata	16° 24'1	71° 24'1	2943
Chinchayllapa	14° 55'1	72° 44'1	4497
Chivay	15° 38'17	71° 35'49	3661
Choco	15° 34'1	72° 07'1	3192
Chuquibamba	15° 50'17	72° 38'55	2832
Cotahuasi	15° 22'29	72° 53'28	5088
Crucero Alto	15° 46'1	70° 55'1	4470
El Frayle	16° 05'5	71° 11'14	4267
Huambo	15° 44'1	72° 06'1	3500
Imata	15° 50'12	71° 05'16	4445
La Angostura	15° 10'47	71° 38'58	4256
La Joya	16°35'33	71°55'9	1292
La Pampilla	16° 24'12.2	71° 31'.6	2400
Lagunillas	15° 46'46	70° 39'38	4250
Las Salinas	16° 19'5	71° 08'54	4322
Machahuay	15° 38'43	72° 30'8	3150
Madrigal	15° 36'59.7	71° 48'42	3262
Orcopampa	15° 15'39	72° 20'20	3801
Pampa de Arrieros	16° 03'48	71° 35'21	3715
Pampa de Majes	16° 19'40	72° 12'39	1434
Pampacolca	15° 42'51	72° 34'3	2950
Pampahuta	15° 29'1	70° 40'33.3	4320
Pillones	15° 58'44	71° 12'49	4455
Porpera	15° 21'1	71° 19'1	4152
Pullhuay	15° 09'1	72° 46'1	3113
Salamanca	15° 30'1	72° 50'1	3303
Sibayo	15° 29'8	71° 27'11	3827
Sumbay	15° 59'1	71° 22'1	4294
Tisco	15° 21'1	71° 27'1	4175
Yanaquihua	15° 46'59.8	72° 52'57	2815

Table 3.1.9-12 Period of rainfall data collection (Majes-Camana river watershed)



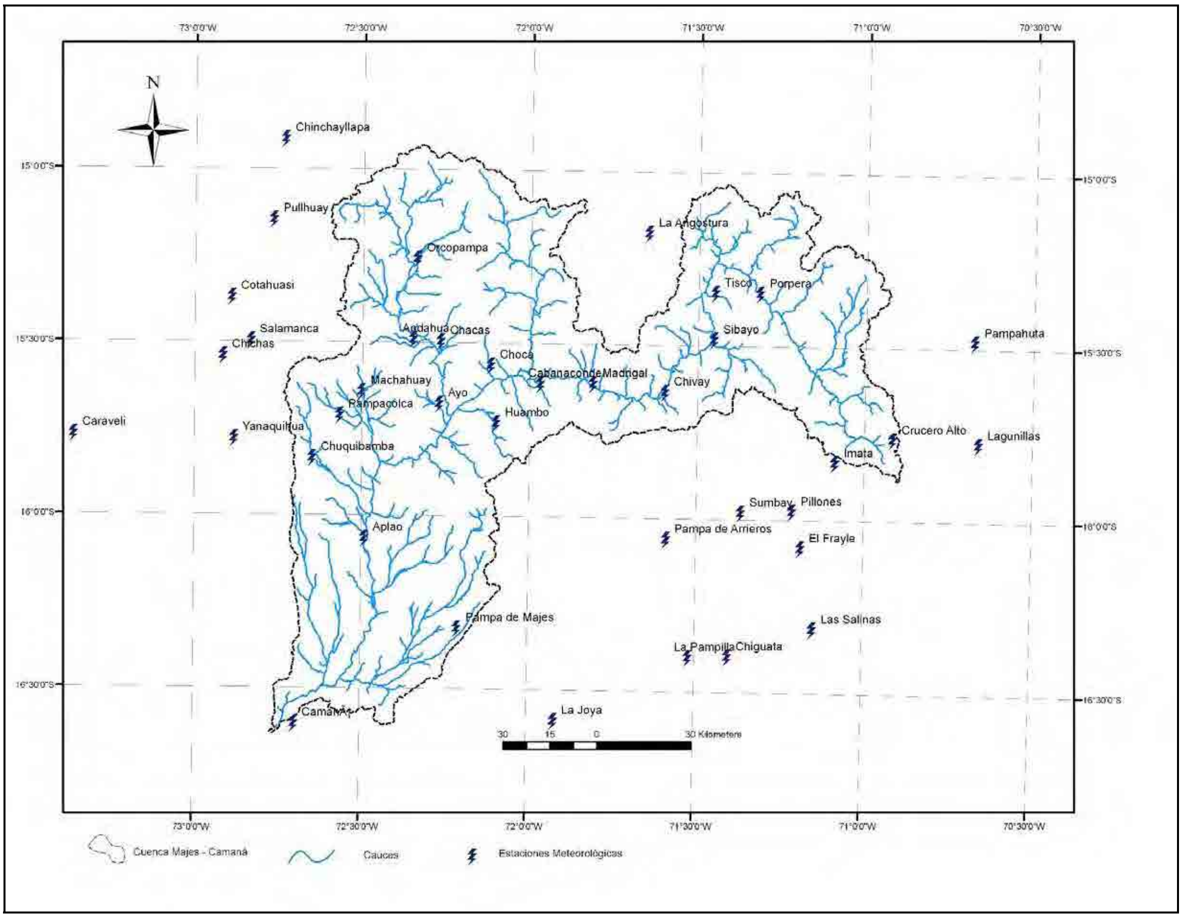


**Figure 3.1.9-6 Monitoring stations location map
(Majes-Camana River watershed)**

2) Isohyet map

Annual rain isohyets maps are described next (average of 10 years) elaborated by SENAMHI using data recovered in the period 1965-1974.

① Chira River Watershed

Figure 3.1.9-7 shows a isohyet map of Chira River watershed.

In the Chira River Watershed is observed that the considerable variation of the annual rainfall depending on the zones, with a minimum of 50mm and a maximum of 1000 mm approximately. The rainfall is lower on the lower watershed and it increases as the altitudes gets near the upper watershed, increasing the altitudes.

The annual rainfall in the lower watershed, subject to the control of floods, is not so intense, with a variation of 50 to 200mm. However, it is the watershed with the lowest watershed rainfall among the 5 selected watersheds.

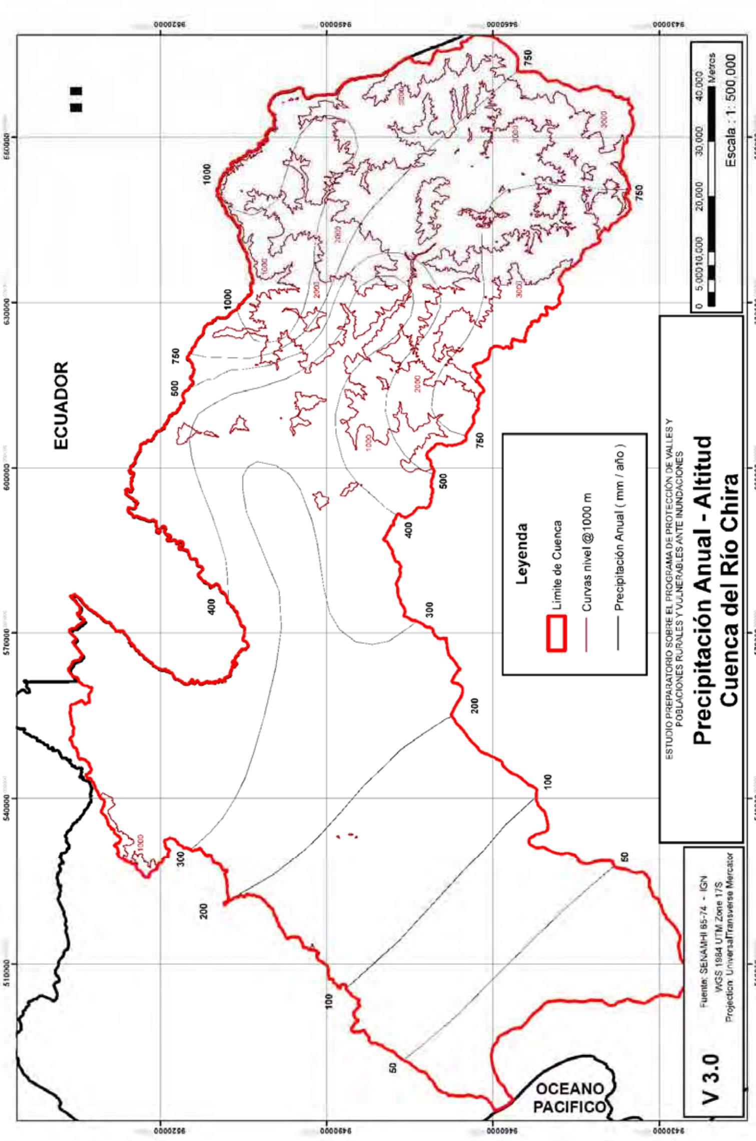


Figure 3.1.9-7 Isohyet Map (Chira River watershed)

② Cañete River Watershed

Figure 3.1.9-8 shows a map of the isohyet of Cañete River watershed.

In the Cañete River Watershed is observed that the considerable variation of the annual rainfall depending on the zones, with a minimum of 25mm and a maximum of 750 mm approximately. The rainfall is lower on the lower watershed and it increases as the altitudes get near the upper watershed, increasing the altitudes.

The annual rainfall in the low watershed, subject to the control of floods, is reduced ranging from 25 to 50 mm.

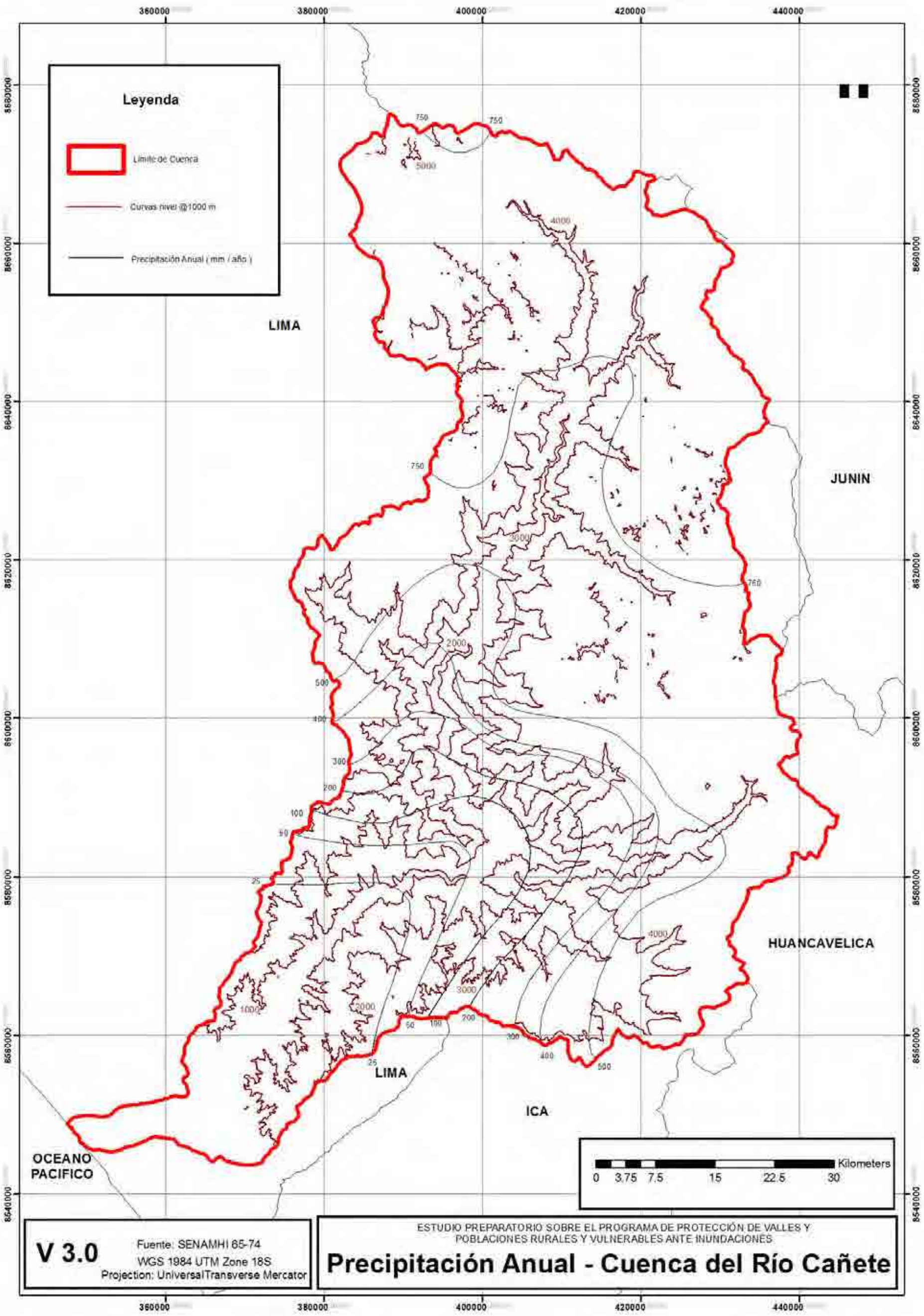


Figure 3.1.9-8 Isohyet Map (Cañete River watershed)

③ Chincha River Watershed

Figure 3.1.9-9 shows a map of the isohyet of Chincha River watershed.

In the Chincha River Watershed is observed that the considerable variation of the annual rainfall depending on the zones, with a minimum of 25mm and a maximum of 900 mm approximately. The rainfall is lower on the lower watershed and it increases as the altitudes get near the upper watershed, increasing the altitudes.

The annual rainfall in the low watershed, subject to the control of floods, is almost null, ranging 25mm.

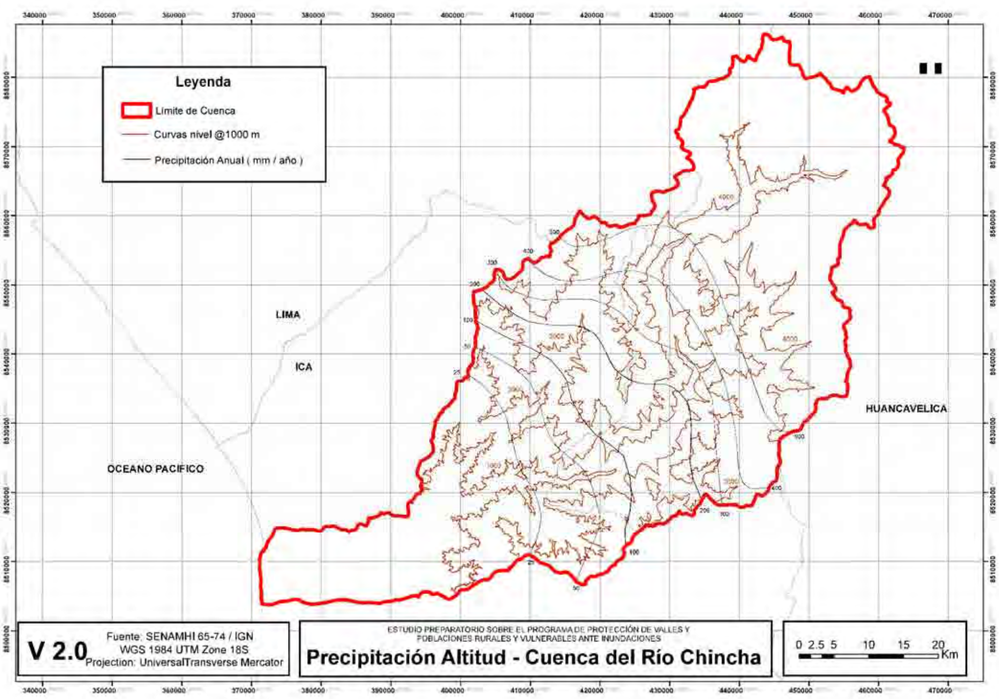


Figure 3.1.9-9 Isohyet Map (Chincha River watershed)

④ Pisco River Watershed

Figure 3.1.9-10 shows the isohyets map of the Rio Pisco.
The Pisco River basin shows that the annual rainfall varies considerably depending on the area, with a minimum of 50 mm and maximum 750 mm. Rainfall is low in the lower basin and increases as it approaches the upper basin, increasing altitudes.The annual rainfall in the low watershed, subject to the control of floods, is reduced ranging from 25 to 50 mm.

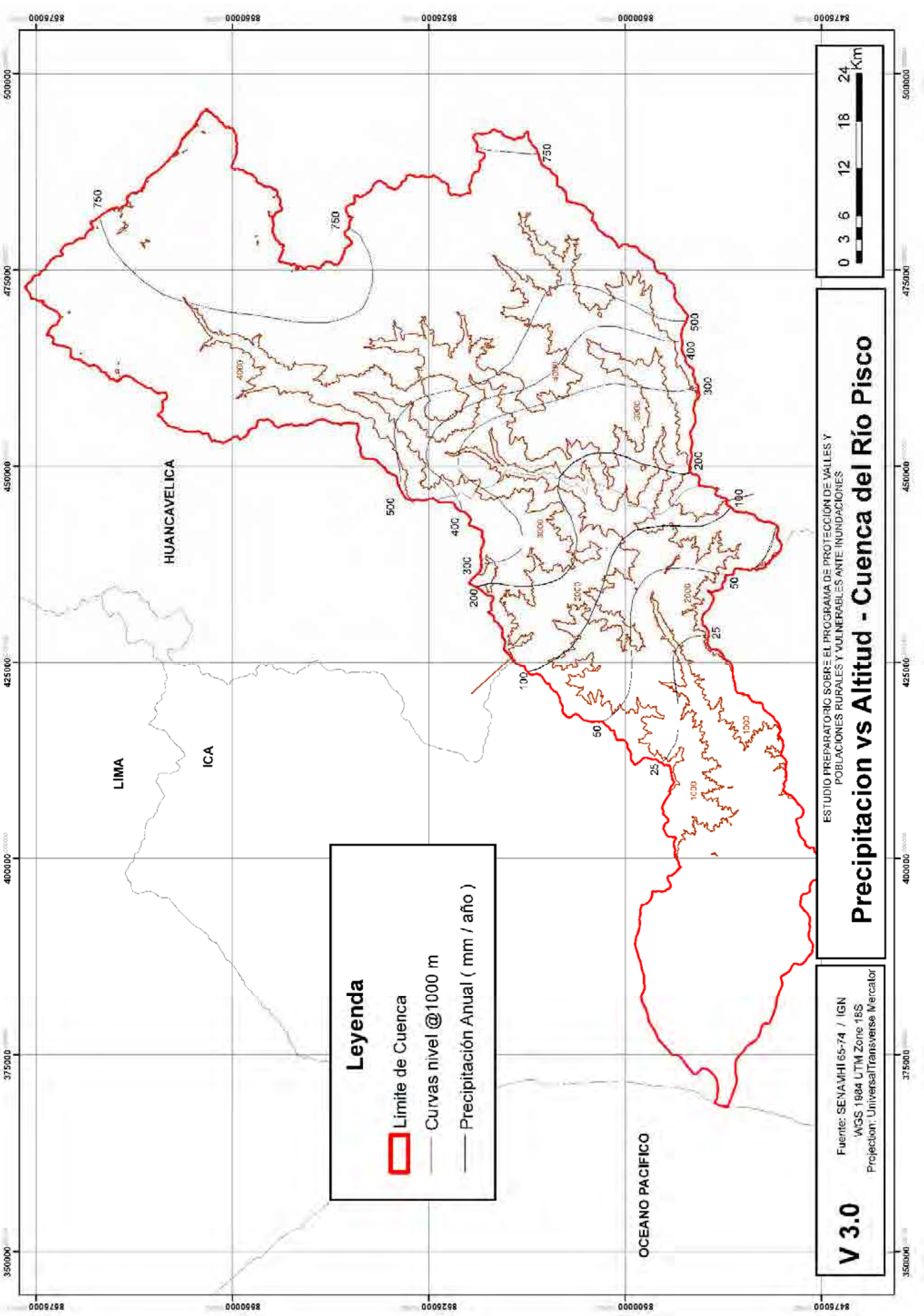


Figure 3.1.9-10 Isohyet Map (Pisco River watershed)

⑤ Yauca River Watershed

Figure 3.1.9-11 shows a map of the isohyet of Yauca River watershed.

In the Yauca River Watershed is observed that the considerable variation of the annual rainfall depending on the zones, with a minimum of 25mm and a maximum of 750 mm approximately. The rainfall is lower on the lower watershed and it increases as the altitudes gets near the upper watershed, increasing the altitudes.

The annual rainfall in the low watershed, subject to the control of floods, is reduced ranging from 25 to 50 mm.

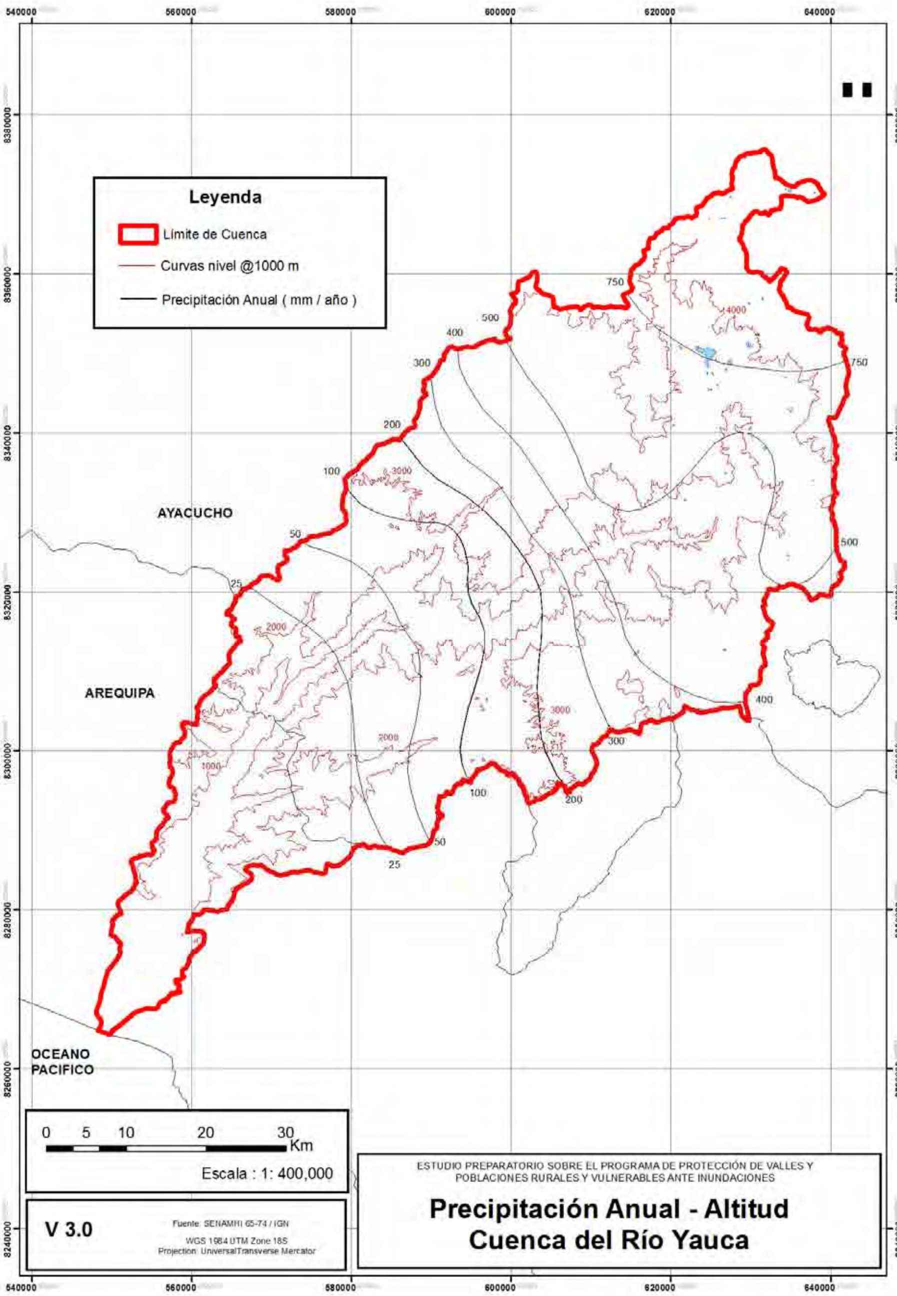


Figure 3.1.9-11 Isohyet Map (Yauca River watershed)

⑥ Majes-Camana River Watershed

Figure 3.1.9-12 shows a map of the isohyet of Majes-Camana River watershed. This watershed is characterized by the considerable variation of the annual rainfall depending on the zones, with a minimum of 50mm and a maximum of 750 mm approximately. The rainfall is lower when it is closer to the Pacific coast (low watershed), and it increases as the altitudes increase (high watershed).

The annual rainfall in the low watershed, subject to the control of floods, is reduced ranging from 50 to 200 mm.

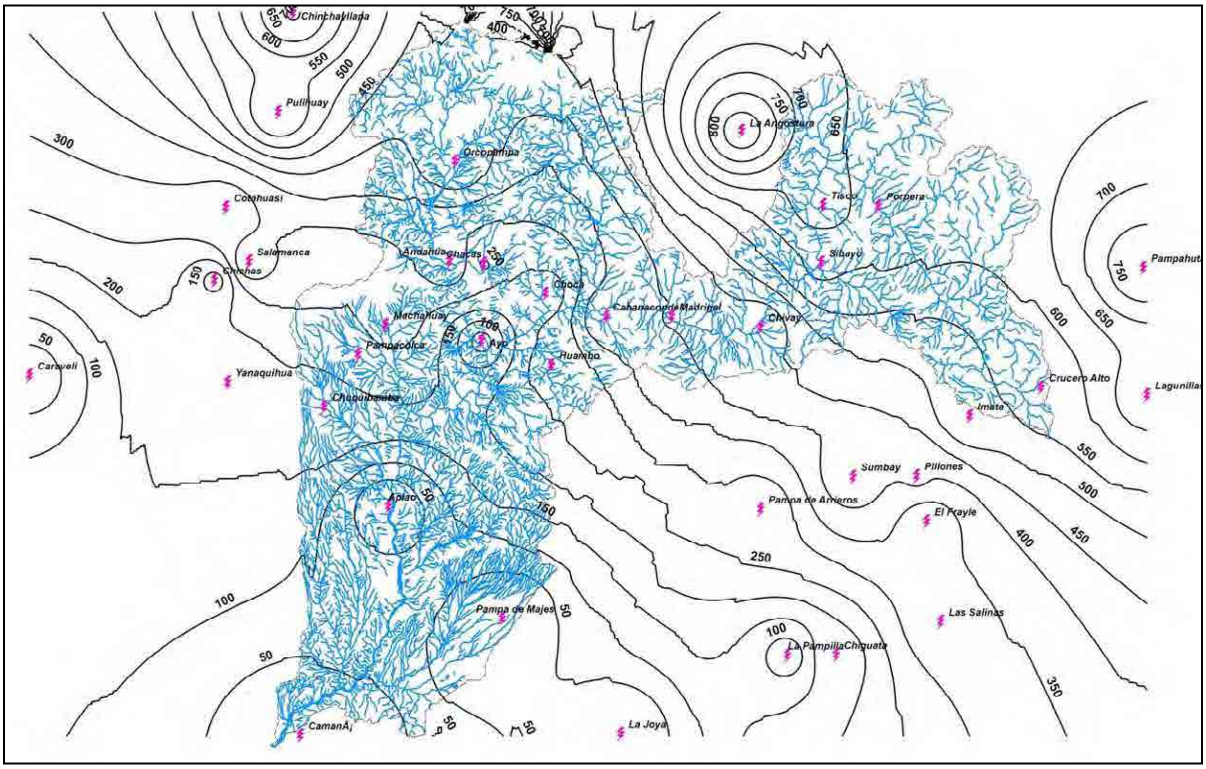


Figure 3.1.9-2 Isohyet Map (Majes-Camana River watershed)

(2) Rainfall analysis

1) Methodology

The statistic hydrologic calculation was made using the rainfall data collected from several stations, to determine the rainfall with 24 hour return period in every station.

Several models of distribution of return periods were tested and the most adequate one was adopted. Thus, the precipitation with 24 hours return period was determined with this model.
The statistic hydrologic models were.

- Normal distribution or Gaussian
- Log-Normal distribution of 3 parameters
- Log-Normal distribution of 2-parameters
- Log-Normal distribution of 2 or 3 parameters
- Log Pearson Type III distribution
- Gumbel distribution
- General distribution of extreme value

2) Results of the rainfall analysis of return period– t

The rainfall of several stations are shown below and the reference point of each watershed, according to return periods.

Comparing precipitations with a 50 years return period of each watershed it is obtained that in 5 watersheds (Except Chira), this vary only in millimetres, which means less than 100mm. Chira River is an specific case, rain with 50 year return period surpasses 100mm with a max of 339mm. This trend can also be seen in the isohyets map.

① Chira River Watershed

Table 3.1.9-13 shows the monitoring points and the rainfall with 24 hour return period in each station. Figure 3.1.9-13 shows the map of isohyets of rainfall with 50 year return period.

Table 3.1.9-13 Rainfall with 24 hour return period (Chira river watershed)

Nº	Station	Elevation (m.a.s.l.)	No. of Records	Return period (in years) 25	50	100	500	Registered	Assumed Distribution
1	Morropón	172	10	134,81	158,52	178,27	228,53	90,40 (*)	Gumbel
2	Malacasi	128	9	287,08	339,22	390,99	510,83	251,20	Gumbel
3	Virrey	230	27	231,55	290,51	347,08	484,48	230,70	Log Pearson III
4	Chignia	360	19	148,24	170,47	194,53	250,12	184,40	Gumbel
5	Barrios	310	19	135,34	153,85	172,23	214,89	119,70	Gumbel
6	Huarmaca	2180	43	112,54	128,58	140,48	172,84	111,40	Gumbel
7	Canchaque	1200	19	184,58	189,45	214,18	271,24	137,30	Gumbel

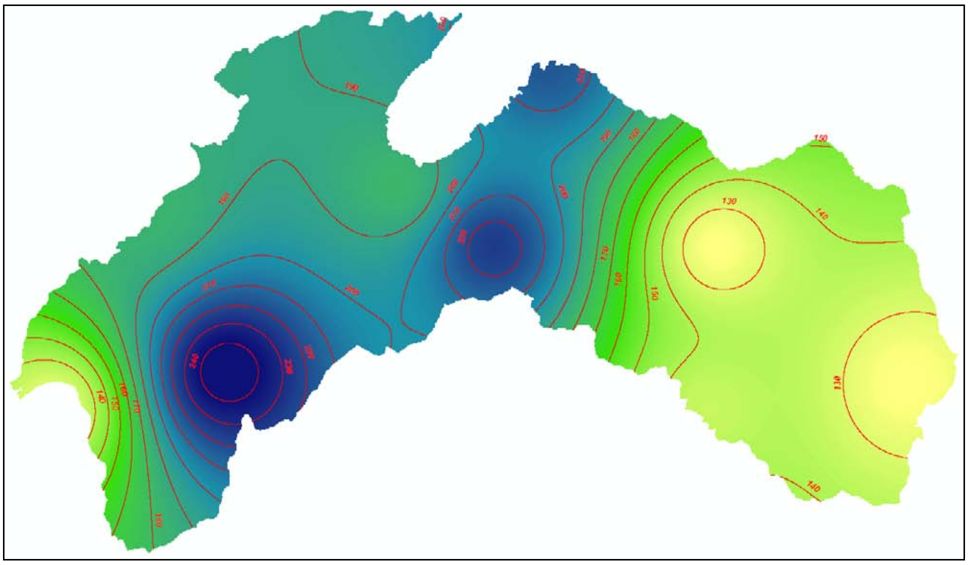


Figure 3.1.9-13 Map of isohyets of a 50 years period rainfall (Chira river watershed)

② Cañete River Watershed

Table 3.1.9-14, -15 shows the monitoring points and the rainfall with 24 hour return period in the reference point (Socsi Station). Figure 3.1.9-14 shows the map of isohyets of rainfall with 50 year return period.