Appendix J-3

Construction Plan and Cost Estimation

LIST OF CONTENTS

Construction Plan & Cost Estimation

August 25, 2010

J-POWER

Contents

Construction Plan

To complete the structure within the designated term keeping quality, cost, safety and environment

Items to be studied

1. Preparatory works and temporary facility plan
2. Construction Planning of Main Structures

1. Preparatory works and temporary facility plan

- Transportation Facilities
- Construction Road
- Construction Building
- Power and Communication Facilities
- Water Supply Facilities

Transportation Facilities

To be transported

- Construction Material and Equipment
- Explosive
- Cement
- Aggregate
- Structural Steel
- Heavy Construction Machinery
- Hydraulic Equipment (Gate, Steel Conduit etc.)
- Electrical Equipment (Turbine, Generator, Crane, Switchyard Gear, Control System etc.)

Transported by

- Truck (inland)
- Ship (marine and river)

Concrete Truck Mixer

Transporting Steel Penstock

Construction Road

- Width
- Alignment (minimum turning radius)
- Gradient
- Subbase (Asphalt, Gravel)

Construction Building

- Site office
- Labor and staff camp
- Motor pool for construction machinery
- Repair shop
- Fabricating yard for reinforcement bars
- Temporary assembly yard (hydraulic equipment etc.)
- Carpentry shop
- Laboratory (concrete test etc.)
- Explosive warehouse
- Material storage yard
- Others (Parking lots, First aid station, warehouse etc.)

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Site Office & Labor Camp

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Site Office

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Temporary Facility Area

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Storage Area

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Storage Area

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Power and Communication Facilities

- Various plants (Aggregate, Concrete plant etc.)
- Air supply equipment
- Water supply and drainage systems
- Lighting equipment
- Welding

※ The capacity (kVA) of power facilities shall meet the demand of maximum power consumption based on the monthly total power calculated from the construction schedule

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Concrete Plant

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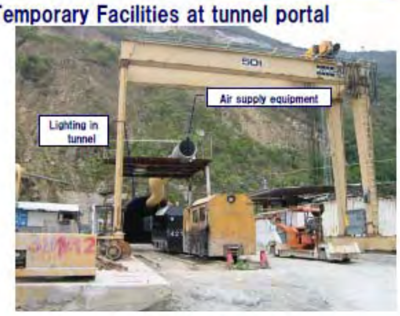
Temporary Facilities at tunnel portal



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Water Supply Facilities

- Cleaning
- Cooling water of machinery
- Sprinkling
- Camp
- Concrete production
- Tunnel excavation

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2. Construction Planning of Main Structures

- Dam
- Water Tunnel (Headrace, Tailrace)
- Penstock
- Powerhouse

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Dam

Diversion of River Flow
↓
Excavation of Foundation
↓
Fabrication of Form and Reinforcement
↓
Concrete Casting
↓
Installation of Gate and Hoisting Equipment

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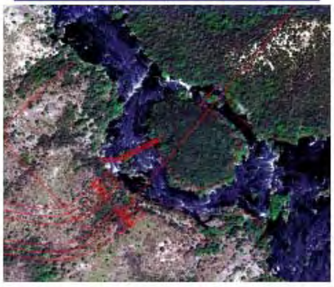
Diversion of River Flow (AYAGO)



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Diversion of River Flow

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Diversion of River Flow

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Diversion of River Flow

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Excavation of Foundation

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Fabrication of Form and Reinforcement

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Fabrication of Form and Reinforcement

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Fabrication of Form and Reinforcement

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Concrete Casting

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Concrete Casting

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Concrete Casting

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Installation of Gate and Hoisting Equipment

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Completion

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Water Tunnel (Headrace, Tailrace)

Reinforcement of Tunnel Portal
↓
Drill and Blasting
↓
Carry out muck from tunnel to outside
↓
Reinforce the excavated area by shotcrete and rockbolt
↓
Installation of sliding form
↓
Casting of Lining Concrete

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Reinforcement of Tunnel Portal

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Reinforcement of Tunnel Portal

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Drill and Blasting

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Drill and Blasting

38

Carry out muck from tunnel to outside

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Carry out muck from tunnel to outside

40

Reinforce the excavated area by shotcrete and rockbolt

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Reinforce the excavated area by shotcrete and rockbolt

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Installation of sliding form

φ8,210仕様

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Installation of sliding form

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Casting of Lining Concrete

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Small Tunnel Excavated Manually

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Entrance of Tunnel

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Temporary Facility Area

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Tunnel Boring Machine

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Tunnel Boring Machine

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Tunnel Boring Machine

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Penstock

Excavation of Tunnel

↓

Transport and Installation of Unit Penstock Conduit

↓

Weld and Connect Unit Conduit

↓

Casting of Lining Concrete

↓

(Re-Act)

↓

Transport and Installation of Unit Penstock Conduit

↓

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Transportation

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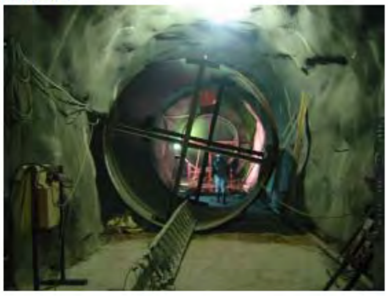
Installation



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Connection of Surge Tank

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Waterway Completion

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Powerhouse

Foundation excavation

↓

Foundation concrete placing and other civil works

↓

Installation of Draft tube

↓

Installation of the electrical equipment | Reinforcing bar and Concrete Casting

↓

The concrete placing for the civil works of the power plant will proceed in parallel

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Underground Powerhouse Excavation

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Draft Tube Installation

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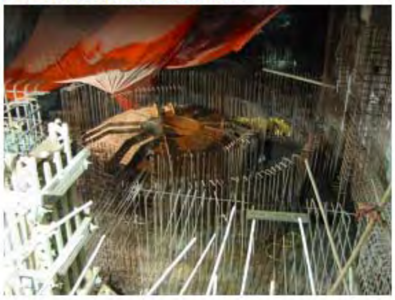
Civil Works (Reinforcement bars)



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Civil Works (Reinforcement bars & Concrete)

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Casing Installation

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Casing Installation

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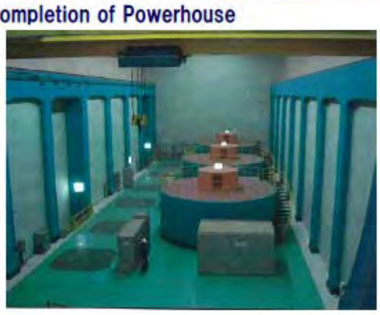
Completion of Powerhouse



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Portal of Underground Powerhouse

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3. Construction works in Okukiyotsu II

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4. Design and Salient Feature of AYAGO Project

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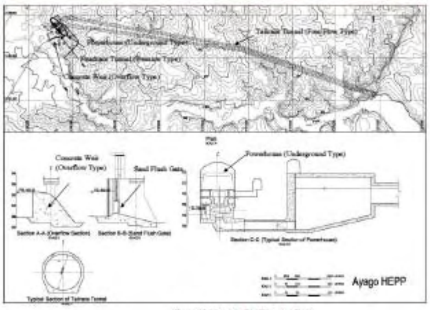

Figure 4.5.1-5 Ayago Site (Waterway Type)

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Salient Feature of Ayago Project

Items	Unit	Ayago
General		
Installed Capacity (Maximum Output)	MW	616
Gross Head	m	87.0
Effective Head	m	83.0
Maximum Discharge (For Installed Capacity)	m^3/s	840
Firm Discharge (90%)	m^3/s	467
Amenity Flow	m^3/s	50
Annual Firm Energy Production (90%)	GWh/Y	2,681
Annual Total Energy Production	GWh/Y	4,357

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Items	Unit	Ayago
Dam		
Type		Concrete
Height	m	20
Crest Length	m	480
Design Flood Discharge	m^3/s	4,000
Catchment Area	km^2	346,850
High Water Level	m	852.0
Rated Water Level	m	852.0
Tail Water level	m	765

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Items	Unit	Ayago
Waterway		
Headrace Tunnel Type		
Number of Tunnel	nos	6
Inner Diameter	m	8.40
Length	m	96
Penstock		
Number of Penstock	nos	12
Inner Diameter	m	3.80
Length	m	50
Tailrace		
Number of Tunnel	nos	6
Inner Diameter	m	8.40
Length	m	7,600

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Items	Unit	Ayago
Powerhouse		
Type		Underground
Numbers of Unit	nos	12
Type of Turbine		Francis
Turbine Efficiency	%	92.5
Generator Efficiency	%	97.5
Combined Efficiency	%	90.2
Maximum Discharge per One Unit	m^3/s	70.0
Capacity per One Unit	MW	51.4
Transmission Line		
Length	km	46
Voltage	kV	400

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5. Cost Estimation

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Breakdown of Construction Cost

(1) Preparatory Construction Cost	Land acquisition, Compensation for resettlement, Access road Existing road improvement, Office and camp facilities, power supply facilities etc.
(2) Environmental cost:	Cost for compensation, mitigation, monitoring, etc.
(3) Civil Works	Dam : Dam body, Care of river etc. Waterway : Intake, Headrace , penstock, Tailrace and Outlet etc. Powerhouse : Powerhouse foundation and structure
(4) Hydro-mechanical Equipment	Dam gate, Penstock, Intake and outlet gates etc.
(5) Electromechanical Equipment	Turbine, Generator, Transformer, Control equipment, Related auxiliary equipment etc.
(6) Transmission Line	Transmission line from the site to planned switchyard at Karuma
(7) Administrative and Engineering Costs	Administrative/management and engineering costs on detailed design and construction supervision (15% of the direct cost (total cost of preparatory works, environmental cost, civil works, hydro mechanical equipment, electromechanical equipment and transmission))
(8) Physical Contingency	10% of the direct cost (total cost of preparatory works, environmental cost, civil works, hydro mechanical equipment, electromechanical equipment and transmission)
(9) Interest during construction	8%
(10) Customs duties/VAT	Not considered

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Civil Work

- The construction costs of civil work are basically calculated in manner of multiplying the unit price by the quantity of each work item.
- The unit prices of civil work items are estimated by using those of similar hydropower projects, allowing for cost escalation.

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Civil Work Quantities :

Weir

Hd:	Weir Height	20 m
L:	Crest Length of Weir	480 m
Qf:	Design Flood Discharge	4000 m3/s

Ve: Excavation volume	$8.69 \times (Hd \times L)^{1.14}$	301,168 m3
Vc: Concrete volume	$16.1 \times (Hd^2 \times L)^{0.695}$	75,635 m3
Wr: Weight of reinforcement bars	$0.0274 \times Vc^{0.83}$	306.96 ton
Wg: Weight of gate	$0.145 \times Qf^{0.692}$	45 ton

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Civil Work Quantities :

Intake

Q:	Maximum Plant Discharge	840 m^3/s
ha:	Available drawdown	1 m
D:	Inner diameter of waterway	8.40 m
n:	Number of waterway channels	6
q:	Design discharge (Q/n)	140 m3/s

Ve: Excavation volume	$130 \times (((ha+D) \times Q)^{1/2} \times n^{1/3})^{1.27}$	82,829 m3
Vc: Concrete volume	$56.5 \times (((ha+D) \times Q)^{1/2} \times n^{1/3})^{1.23}$	29,374 m3
Wr: Weight of reinforcement bars	$0.04 \times Vc$	1,174.96 ton
Wg: Weight of gate	$0.9 \times (ha+D)^{1/9} \times Q$	970 ton
Ws: Weight of screen	$0.5 \times (ha+D)^{1/9} \times Q$	539 ton

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Civil Work Quantities :

Headrace

R:	Tunnel radius	4.2 m
t_0:	Lining concrete thickness	0.80 m
L:	Total length of waterway	96 m
n:	Number of waterway channels	6

Ve: Excavation volume	$3.2 \times (R+t_0)^2 \times L \times n$	46,080 m3
Vc: Concrete volume	$(3.2 \times (R+t_0)^2 - \pi R^2) \times L \times n$	14,176 m3
Wr: Weight of reinforcement bars	$0.04 \times Vc$	567.02 ton

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Civil Work Quantities :

Penstock

D_m:	Inner diameter of penstock	3.8 m
t:	Thickness of backfill concrete	0.5 m
L:	Total length of penstock	50 m
H:	Desigh Head	87 m
n:	Number of waterway channels	12

t_m: Thickness of steel penstock	$0.0313 \times H \times D_m + 2$	12.348 mm
Ve: Excavation volume	$\pi/4 \times (Dm+2t)^2 \times L \times n$	10,852 m3
Vc: Concrete volume	$\pi/4 \times ((Dm+2t)^2 - Dm^2) \times L \times n$	4,051 m3
Wr: Weight of reinforcement bars	$0.012 \times Vc$	48.61 ton
Wp: Weight of steel conduit	$7.85 \times \pi \times D_m \times t_m \times 1.1 \times L \times n$	763 ton

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Civil Work Quantities :

Powerhouse

Q:	Maximum Plant Discharge	840 m^3/s
He:	Effective head	83 m
d:	Height of powerhouse	32 m

A: Area of powerhouse	$20 \times Q^{1/2} \times He^{1/3}$	2,528 m2
Ve: Excavation volume	$27 \times A + 1.3 \times A \times d$	173,429 m3
Vc: Concrete volume	$15 \times A$	37,922 m3
Wr: Weight of reinforcement bars	$0.6 \times A$	1,516.87 ton

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Civil Work Quantities :

Transformer Hall

Q:	Maximum Plant Discharge	840 m^3/s
He:	Effective head	83 m
d:	Height of Hall	13 m

A: Area of powerhouse	$20 \times Q^{1/2} \times He^{1/3}$	2,528 m2
Ve: Excavation volume	$27 \times A + 1.3 \times A \times d$	109,341 m3
Vc: Concrete volume	$15 \times A$	37,922 m3
Wr: Weight of reinforcement bars	$0.6 \times A$	1,516.87 ton

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Civil Work Quantities :

Tailrace

R:	Tunnel radius	4.2 m
t_0	Lining concrete thickness	0.60 m
L:	Total length of waterway	7,600 m
n:	Number of waterway	6

Ve: Excavation volume	$3.2 \times (R+t_0)^2 \times L \times n$	3,361,997 m3
Vc: Concrete volume	$(3.2 \times (R+t_0)^2 - \pi R^2) \times L \times n$	836,231 m3
Wr: Weight of reinforcement bars	$0.04 \times Vc$	33,449 ton

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Civil Work Quantities :

Outlet

Q:	Maximum Plant Discharge	840 m^3/s
R:	Tunnel radius	4.2 m
n:	Number of waterway	6
q:	Design discharge (Q/n)	140 m3/s

Ve: Excavation volume	$395 \times (R \times Q)^{0.479}$	19,763 m3
Vc: Concrete volume	$40.4 \times (R \times Q)^{0.684}$	10,787 m3
Wr: Weight of reinforcement bars	$0.278 \times Vc^{0.610}$	80 ton

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Civil Work Quantities :

Access Tunnel for Underground Powerhouse

i:	Gradient of tunnel	0.1
He:	Over Burden	130 m

L: Length of access tunnel	He/i	1,300 m
Ve: Excavation volume	$45 \times L$	58,500 m3
Vc: Concrete volume	$10 \times L$	13,000 m3
Wr: Weight of reinforcement bars	$0.3 \times Vc$	3,900 ton

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Civil Work Cost **Ayago** **Run-of-River**

Item	Unit	Quantity	Unit cost (US $)	Cost (10^3US$)	Calculation method of construction cost
1. Dam				29,285	(1.1)+(1.2)
1.1. Care of river				5,857	(1.1)=(1.2)× 0.25
1.2. Weir				23,428	(1.2)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m^3	301,168	14	4,216	(i)
(ii) Concrete	m^3	75,635	178	13,463	(ii)
(iii) Reinforcement bar	ton	306.96	1,115	342	(iii)
(iv) Others	L.S.			5,406	(iv)=((i)+(ii)+(iii))× 0.3
2. Intake				d	(2)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m^3	a	16	e	(i)
(ii) Concrete	m^3	b	174	f	(ii)
(iii) Reinforcement bar	ton	c	1,135	g	(iii)
(iv) Others	L.S.			h	(iv)=((i)+(ii)+(iii))× 0.25

To be continued

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Civil Work Cost **Ayago** **Run-of-River**

Item	Unit	Quantity	Unit cost (US $)	Cost (10^3US$)	Calculation method of construction cost
3. Headrace				l	(3)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m^3	i	69	m	(i)
(ii) Concrete	m^3	j	163	n	(ii)
(iii) Reinforcement bar	ton	k	1,184	o	(iii)
(iv) Others	L.S.			p	(iv)=((i)+(ii)+(iii))× 0.15
4. Penstock				t	(4)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m^3	q	73	u	(i)
(ii) Concrete	m^3	r	119	v	(ii)
(iii) Reinforcement bar	ton	s	1,184	w	(iii)
(iv) Others	L.S.			x	(iv)=((i)+(ii)+(iii))× 0.2

To be continued

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Civil Work Cost **Ayago** **Run-of-River**

Item	Unit	Quantity	Unit cost (US $)	Cost (10^3US$)	Calculation method of construction cost
5. Powerhouse				ab	(5)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m^3	y	75	ac	(i)
(ii) Concrete	m^3	z	232	ad	(ii)
(iii) Reinforcement bar	ton	aa	1,182	ae	(iii)
(iv) Others	L.S.			af	(iv)=((i)+(ii)+(iii))× 0.5
6. Transformer Hall				aj	(5)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m^3	ag	75	ak	(i)
(ii) Concrete	m^3	ah	232	al	(ii)
(iii) Reinforcement bar	ton	ai	1,182	am	(iii)
(iv) Others	L.S.			an	(iv)=((i)+(ii)+(iii))× 0.5

To be continued

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Item	Unit	Quantity	Unit cost (US $)	Cost (10³US$)	Calculation method of construction cost
7. Tailrace Tunnel				ar	(7)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m³	ao	69	as	(i)
(ii) Concrete	m³	ap	163	at	(ii)
(iii) Reinforcement bar	ton	aq	1,184	au	(iii)
(iv) Others	L.S.			av	(iv)=((i)+(ii)+(iii)) × 0.3
8. Outlet				az	(8)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m³	aw	16	ba	(i)
(ii) Concrete	m³	ax	174	bb	(ii)
(iii) Reinforcement bar	ton	ay	1,135	bc	(iii)
(iv) Others	L.S.			bd	(iv)=((i)+(ii)+(iii)) × 0.25
9. Access Tunnel				bh	(9)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m³	be	64	bi	(i)
(ii) Concrete	m³	bf	212	bj	(ii)
(iii) Reinforcement bar	ton	bg	1,068	bk	(iii)
(iv) Others	L.S.			bl	(iv)=((i)+(ii)+(iii)) × 0.2
10. Miscellaneous	L.S.			bm	(10)=Σ((1)-(9)) × 0.05
Sub Total				bn	Σ(1)-(10)

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Hydro mechanical Works

- The construction costs of hydro mechanical works are basically calculated in manner of multiplying the unit price by the quantity of each work item.
- The unit prices of civil work items are estimated by using those of similar hydropower projects undertaken by the Consultant, and allowing for cost escalation.

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Hydromechanical Equipment Cost

Item	Unit	Quantity	Unit cost (US$)	Cost (10³US$)
1. Intake Dam				446
Regulating Radial Gate	ton	45	9,900	446
2. Intake				10,365
Gate	ton	970	8,300	8,049
Screen	ton	539	4,300	2,317
3. Penstock (steel pipe)	ton	763	4,700	3,588
4. Tailrace gate	ton	970	8,300	8,049
5. Others	L.S.	20%		4,490
Subtotal				26,937

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Total Construction Cost

【Conditions】

- Compensation cost of 5 MUS$ is appropriated for Ayago where the resettlement is not needed.
- Environmental cost is estimated at 5% for the projects inside of national park (Ayago).
- Transmission from each project site to the planned switchyard at Karuma is evaluated for the cost estimation by considering the international market price.
- Administration and engineering costs are assumed at 15% of the direct cost (total cost of preparatory works, environmental cost, civil works, hydro mechanical equipment, electromechanical equipment and transmission).
- Contingency is assumed at 10% of the direct cost.
- Interest rate during construction period is estimated at 8%.
- Unit prices and construction costs do not include VAT and customs duties for imported materials or equipment.

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Item	Cost (x10³US$)	Note
1. Preparation and Land acquisition	63,811	
(1) Access road	4,500	100x10³US$/km × 45 km
(2) Compensation & Resettlement	5,000	
(3) Camp & Facilities	13,811	(3. Civil work) × 2%
2. Environmental mitigation cost	A	(3. Civil work) × 5%
3. Civil work	B	
4. Hydraulic equipment	C	
5. Electro-mechanical equipment	245,200	Installed Capacity 616 MW
6. Transmission line	17,940	Ayago-Karuma 46 km
Direct cost	1,078,978	
7. Administration and Engineering service	D	Direct cost × 15%
8. Contingency	E	Direct cost × 10%
9. Interest during construction	215,796	Interest Rate 8% 5years
Total cost	F	

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Generation Cost

Generation Cost per kWh (US cent/kWh) = Construction Cost (US$) × Annual cost factor / Annual Generation (kWh)

Where

- Construction Cost = 1,564,519,000 USD
- Annual cost factor = Capital recovery factor: $= \frac{i(1+i)^{t}}{(1+i)^{t}-1}$ + Operation and maintenance cost: 1% = 0.09

  where: i = Interest rate 8% t = Life time 50 years
- Annual Generation (kWh) = 4,357,000,000 kWh

Generation Cost		cent/kWh

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6. Construction Plan For Environmental and Social Considerations

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Social Background

JCOLD

- Rapid Growth of Economy
- Change in Sense of Values
  - Fulfilling Economical Satisfaction
  - → Raising Quality of Life
- Headwind to Dam Projects
  - Severe Conflict between Dam Project Owners and Local Community People
- Taking Public Opinion into Account
- Consideration to Social and Environmental Impacts

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Amendment of River Law in 1997

Purpose of Dam Project is defined as follows

①Disaster Prevention from Flood etc.
②Suitable Utilization of River Water
③Maintenance of Original River Flow
④Preservation of Natural Environment

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Environmental elements		Environmental factors	Examples of environmental conservation (Items to be considered, technical tasks)
Atmosphere	Dust, etc.	Operation of construction machines	Avoidance of simultaneous operation of plural construction machines and full load operation of machines
			Avoidance of operation under strong wind
			Separation of plural operation routes
			Watering of the construction area and access road
			Separation of construction machines from conservation objectives
			Temporary pavement
			Cleaning of the construction vehicles

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Environmental elements		Environmental factors	Examples of environmental conservation (Items to be considered, technical tasks)
Noise	Noise	Transportation of construction materials, etc.	Separation of plural operation routes
			Noise prevention wall etc.
			Change of method and time of works
		Operation of construction machines	Minimization of operation in nighttime
			Adoption of low-noise construction machines
			Adoption of low-noise construction methods
			Separation of construction machines from conservation objectives
			Change of method and time of works
			Speed limit and prohibition of overload

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Environmental elements		Environmental factors	Examples of environmental conservation (Items to be considered, technical tasks)
Vibration	Vibration	Transportation of construction materials, etc.	Separation of plural operation routes
			Change of method and time of works
		Operation of construction machines	Minimization of transportation in nighttime
			Adoption of low-vibration construction machines
			Adoption of low-vibration construction methods
			Separation of construction machines from conservation objectives
			Change of method and time of works
			Speed limit and prohibition of overload

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Environmental elements		Environmental factors	Examples of environmental conservation (Items to be considered, technical tasks)
Water quality	Water pollution	Existence of reservoir	Selective intake equipment
			Bypass channel of inflow water
			Aeration equipment
		Intake of river water	Discharge of river maintenance flow
	Eutrophication	Existence of reservoir	Selective intake equipment
			Bypass channel of inflow water
			Aeration equipment
	Water turbidity	Temporary impact due to land reclamation, etc.	Prevention of rain water inflow to the construction area by discharge channel
			Turbid water sedimentation pool
			Turbid water disposal plant
		Existence of reservoir	Selective intake equipment
			Bypass channel of inflow water
	Dissolved oxygen concentration	Existence of reservoir	Selective intake equipment
			Bypass channel of inflow water
			Aeration equipment
	Hydrogen ion concentration	Temporary impact due to land reclamation, etc.	Neutralization by acid or base
	Water temperature	Existence of reservoir	Selective intake equipment
			Bypass channel of inflow water

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Environmental elements		Environmental factors	Examples of environmental conservation (Items to be considered, technical tasks)
Topography and geology	Important topography and geology	Terrain shape changes and existence of structures	Change of location
			Minimization of structure and underground structure
			Minimization of terrain shape change
		Existence of reservoir	Change of location
Fauna	Important species and remarkable habitats	Existence of structures or occupation of land	Change of location
			Restriction of illumination in nighttime
			Prohibition of entering into land except for the reclaimed area
			Prohibition of capturing and threatening animals
			Minimization of structure and underground structure
			Reduction of ground surface road by adoption of tunnel and bridge
			Underground discharge channel (box culvert, etc.)
			Minimization of terrain shape change
			Disposal of leftover
			Slopes enabling animals to escape
			Recovery of vegetation in the reclaimed area
			Construction of artificial wetland, etc.
			Capture and transfer of animals from the reclaimed area

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Environmental elements		Environmental factors	Examples of environmental conservation (Items to be considered, technical tasks)
Flora	Important species and important community	Existence of structures or occupation of land	Change of location
			Prohibition of entering into land except for the reclaimed area
			Protection of vegetation from erosion by rainfall
			Prohibition of collection of plants
			Protection of important species
			Prohibition of entering into wetland
			Minimization of structure and underground structure
			Reduction of ground surface road by adoption of tunnel and bridge
			Minimization of terrain shape change
			Modification of shape of the reclaimed area
			Construction of artificial wetland, etc.
			Transplantation from the reclaimed area
			Greening of the reclaimed area (especially in early stage)
Ecosystem	Ecosystem characterizing the project area	Existence of structures or occupation of land	Same as the measures for "Fauna" and "Flora".

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Environmental elements		Environmental factors	Examples of environmental conservation (Items to be considered, technical tasks)
Landscape	Main view points, landscape resources, and main view	Terrain shape changes and existence of structures	Change of location
			Minimization of structure and underground structure
			Minimization of terrain shape change
		Existence of reservoir	Change of location
Places for interaction activities between humans and nature	Main places for interaction activities between humans and nature	Transportation of construction materials, etc.	Change of transportation route
			Reduction of ground surface road by adoption of tunnel and bridge
		Terrain shape changes and existence of structures	Change of location
			Minimization of structure and underground structure
			Minimization of terrain shape change
		Existence of reservoir	Selective intake equipment
			Bypass channel of inflow water
			Aeration equipment
		Intake of river water	Discharge of river maintenance flow
Industrial waste		Temporary impact due to land reclamation, etc.	Reuse and recycling

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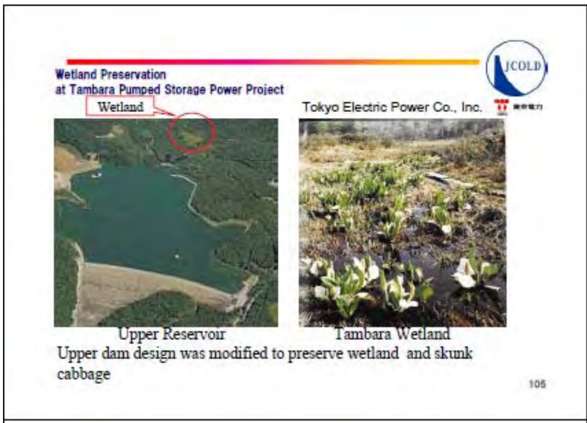
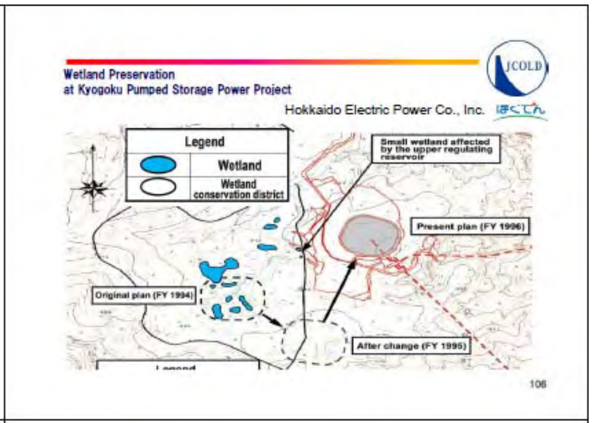
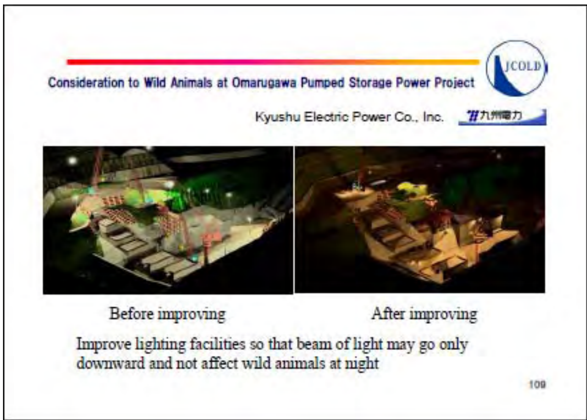
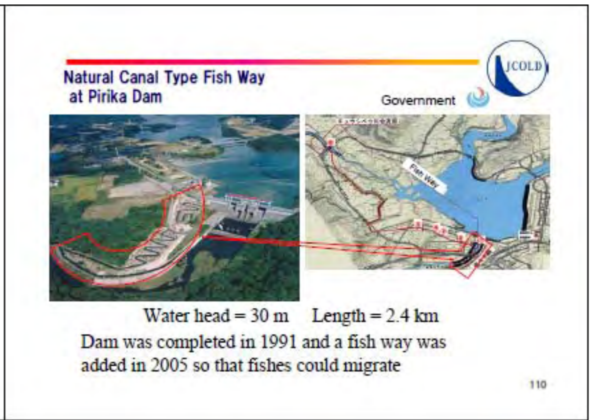

Wetland Preservation
at Tambara Pumped Storage Power Project
Wetland
Tokyo Electric Power Co., Inc.
Upper Reservoir
Tambara Wetland
Upper dam design was modified to preserve wetland and skunk cabbage
105


Wetland Preservation
at Kyogoku Pumped Storage Power Project
Hokkaido Electric Power Co., Inc.
Legend
Wetland
Wetland conservation district
Small wetland affected by the upper regulating reservoir
Present plan (FY 1996)
Original plan (FY 1994)
After change (FY 1995)
106


Preservation of Natural Environment at Okinawa Seawater Pumped Storage Power Project
Electric Power Development Co., Ltd.
Tortoise crawling up gutter
POWER
Road side gutter with mild slope
Biotope at disposal area
107


Planting at Omarugawa Pumped Storage Power Project
Kyushu Electric Power Co., Inc.
Sowing at disposal area only with original plants
Right after sowing
After 6 months
108


Consideration to Wild Animals at Omarugawa Pumped Storage Power Project
Kyushu Electric Power Co., Inc.
Before improving
After improving
Improve lighting facilities so that beam of light may go only downward and not affect wild animals at night
109


Natural Canal Type Fish Way
at Pirika Dam
Government
Fish Way
Water head = 30 m Length = 2.4 km
Dam was completed in 1991 and a fish way was added in 2005 so that fishes could migrate
110


Recovery of Original River Flow at Koshibu Dam
Government
実施前
実施後
Before discharging maintenance flow
After discharging maintenance flow
• Install hydropower plant just downstream dam
• Discharge maintenance flow and generate electricity
111


Sediment Dredging
at Sakuma Reservoir
Electric Power Development Co., Ltd.
POWER
Dredging sediment deposit by sand pump
112

Sediment Flushing Facilities of Dashidaira Dam

Kansai Electric Power Co., Inc. 関西電力

Coordinated Sediment Discharge (1/2)

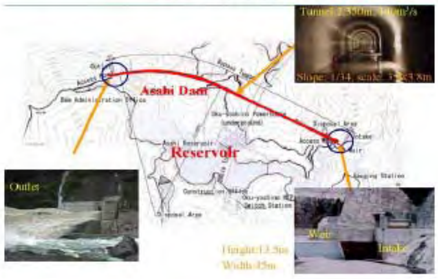
Kansai Electric Power Co., Inc. 関西電力 Government

Dashidaira Dam Unazuki Dam

Discharge sediment deposited in reservoirs and let flood water flow through reservoirs by coordinated flushing and sluicing operation

Bypass System of Asahi Dam

Kansai Electric Power Co., Inc. 関西電力



Sediment Discharge System in Miwa Dam

Government

Thank you for your Attention

5. Cost Estimation (Answer)

Civil Work Cost **Ayago** **Run-of-River**

Item	Unit	Quantity	Unit cost (US $)	Cost (10³US$)	Calculation method of construction cost
1. Dam				29,285	(1.1)+(1.2)
1.1. Care of river				5,857	(1.1)=(1.2)× 0.25
1.2. Weir				23,428	(1.2)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m³	301,168	14	4,216	(i)
(ii) Concrete	m³	75,635	178	13,463	(ii)
(iii) Reinforcement bar	ton	306.96	1,115	342	(iii)
(iv) Others	L.S.			5,406	(iv)=((i)+(ii)+(iii))× 0.3
2. Intake				9,712	(2)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m³	82,829	16	1,325	(i)
(ii) Concrete	m³	29,374	174	5,111	(ii)
(iii) Reinforcement bar	ton	1,174.96	1,135	1,334	(iii)
(iv) Others	L.S.			1,942	(iv)=((i)+(ii)+(iii))× 0.25

To be continued

Civil Work Cost **Ayago** **Run-of-River**

Item	Unit	Quantity	Unit cost (US $)	Cost (10³US$)	Calculation method of construction cost
3. Headrace				7,086	(3)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m³	46,080	69	3,180	(i)
(ii) Concrete	m³	14,176	163	2,311	(ii)
(iii) Reinforcement bar	ton	567.02	1,184	671	(iii)
(iv) Others	L.S.			924	(iv)=((i)+(ii)+(iii))× 0.15
4. Penstock				1,596	(4)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m³	10,852	73	790	(i)
(ii) Concrete	m³	4,051	119	483	(ii)
(iii) Reinforcement bar	ton	48.61	1,184	58	(iii)
(iv) Others	L.S.			266	(iv)=((i)+(ii)+(iii))× 0.2

To be continued

Civil Work Cost **Ayago** **Run-of-River**

Item	Unit	Quantity	Unit cost (US $)	Cost (10^3US$)	Calculation method of construction cost
5. Powerhouse				35,498	(5)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m^3	173,429	75	13,090	(i)
(ii) Concrete	m^3	37,922	232	8,783	(ii)
(iii) Reinforcement bar	ton	1,516.87	1,182	1,793	(iii)
(iv) Others	L.S.			11,833	(iv)=((i)+(ii)+(iii)) × 0.5
6. Transformer Hall				28,243	(5)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m^3	109,341	75	8,253	(i)
(ii) Concrete	m^3	37,922	232	8,783	(ii)
(iii) Reinforcement bar	ton	1,516.87	1,182	1,793	(iii)
(iv) Others	L.S.			9,414	(iv)=((i)+(ii)+(iii)) × 0.5

To be continued

Item	Unit	Quantity	Unit cost (US $)	Cost (10^3US$)	Calculation method of construction cost
7. Tailrace Tunnel				531,928	(7)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m^3	3,361,997	69	233,199	(i)
(ii) Concrete	m^3	836,231	163	136,380	(ii)
(iii) Reinforcement bar	ton	33,449	1,184	39,596	(iii)
(iv) Others	L.S.			122,753	(iv)=((i)+(ii)+(iii)) × 0.3
8. Outlet				2,873	(7)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m^3	19,763	16	325	(i)
(ii) Concrete	m^3	10,787	174	1,882	(ii)
(iii) Reinforcement bar	ton	80	1,135	91	(iii)
(iv) Others	L.S.			575	(iv)=((i)+(ii)+(iii)) × 0.25
9. Access Tunnel				12,802	(8)=(i)+(ii)+(iii)+(iv)
(i) Excavation	m^3	58,500	64	3,750	(i)
(ii) Concrete	m^3	13,000	212	2,755	(ii)
(iii) Reinforcement bar	ton	3,900	1,068	4,164	(iii)
(iv) Others	L.S.			2,134	(iv)=((i)+(ii)+(iii)) × 0.2
10. Miscellaneous	L.S.			31,539	(9)=Σ(1)~(8)) × 0.05
Sub Total				690,562	

Hydromechanical Equipment Cost

Item	Unit	Quantity	Unit cost (US$)	Cost (10^3US$)
1. Intake Dam				446
Regulating Radial Gate	ton	45	9,900	446
2. Intake				10,365
Gate	ton	970	8,300	8,049
Screen	ton	539	4,300	2,317
3. Penstock (steel pipe)	ton	763	4,700	3,588
4. Tailrace gate	ton	970	8,300	8,049
5. Others	L.S.	20%		4,490
Subtotal				26,937

Item	Cost ($x10^3$US$)	Note
1. Preparation and Land acquision	63,811	
(1) Access road	4,500	$100x10^3$US$/km × 45 km
(2) Compensation & Resettlement	5,000	
(3) Camp & Facilities	13,811	(3. Civil work) × 2%
2. Environmental mitigation cost	*34,528*	(3. Civil work) × 5%
3. Civil work	*690,562*	
4. Hydraulic euipment	*26,937*	
5. Electro-mechanical equipment	245,200	Installed Capacity 616 MW
6. Transmission line	17,940	Ayago-Karuma 46 km
Direct cost	1,078,978	
7. Administration and Engineering service	*161,847*	Direct cost × 15%
8. Contingency	*107,898*	Direct cost × 10%
9. Interest during construction	215,796	Interest Rate 8% 5years
Total cost	*1,564,519*	

Generation Cost

Generation Cost per kWh（US cent/kWh）=Construction Cost（US$）×Annual cost factor / Annual Generation（kWh）

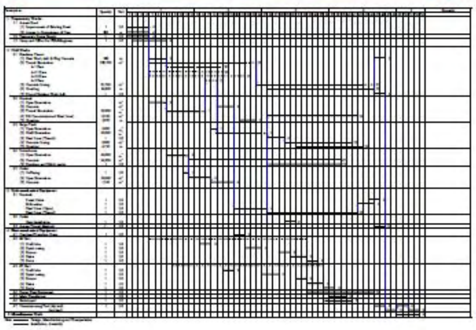
Where

- ➢Construction Cost = 1,564,519,000 USD
- ➢Annual cost factor = Capital recovery factor: $=\frac{i(1+i)^{50}}{(1+i)^{50}-1}$
  + Operation and maintenance cost: 1% = 0.09

  i = Interest rate 8%　t = Life time 50 years
- ➢Annual Generation（kWh）=4,357,000,000 kWh

Generation Cost	3.23	cent/kWh

7. Construction Schedule



8. Current Situation of Geological Investigation

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Appendix J-4

Investment Risk Management

LIST OF CONTENTS

Investment Risk Management

for

Hydropower Project

26 August 2010

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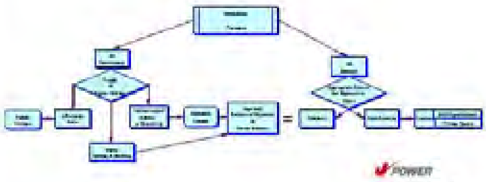
CONTENT

2

I. Investment Purposes

Two standpoints on investment

- As Government: supply of public utilities
- As Investor : return on investment



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(cont'd) I. Investment Purposes

- Hydropower could replace costly thermal power to reduce imported fuel resulting in saving of foreign exchange.
- Hydropower could be exported to neighboring countries because of competitive cost resulting in earning of foreign exchange.
- Hydropower could lower domestic power rates to contribute to public welfare and make domestic industries more competitive.

↓

Dividend to private investor equals to public welfare and economic growth toward improved balance of payments and fiscal balance for the government

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II. Mode of Investment

➢ Project-financed IPP including PPP with public equity participation

- ✓ Private companies set up a special purpose company (SPC) as an independent power producer (IPP)
- ✓ The government could participate in the SPC as Public-Private Partnership (PPP)
- ✓ The SPC is obligated to make repayments to banks and other financial institutions
- ✓ Dependent on project cashflow without recourse to the investors

➢ Government-and/or aid-financed public works including PPP with operation concession to the private sector

- ✓ The government or its executing agency engages in hydropower development as public works
- ✓ The government is obligated to make repayment to aid organizations/private banks
- ✓ Dependent on creditworthiness of the government like corporate finance
- ✓ The government could grant a business concession to the private sector for operation and maintenance as PPP

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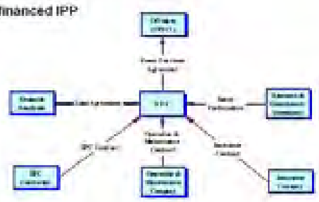
(cont'd) II. Mode of Investment

Basic Project Scheme

Project-financed IPP



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(cont'd) II. Mode of Investment

Merits and Demerits

Project-financed IPP

Merits for SPONSOR
- ✓ Reduced exposure to investment risks by risk sharing
- ✓ Off balance transaction to keep fund raising capacity
- ✓ Higher leverage

Demerits for SPONSOR
- ✓ Complicated scheme
- ✓ Higher financial costs
- ✓ Time consuming till financial close

Merits for LENDER
- ✓ Higher margin (interest & commission fee)

Demerits for LENDER
- ✓ Complicated scheme
- ✓ Higher risk exposure
- ✓ Time consuming till financial close

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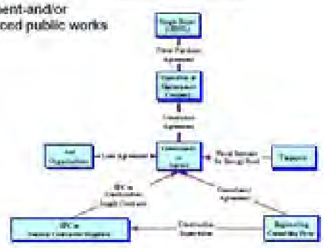
(cont'd) II. Mode of Investment

Basic Project Scheme

Government-and/or aid-financed public works



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(cont'd) II. Mode of Investment

Merits and Demerits

Government-and/or
aid-financed public works

Merits	Demerits
✓ Simple scheme ✓ Time saving till construction start ✓ Lower financial costs ✓ Human resources development of the government/executing agency ✓ Transparency of transactions and costs	✓ Higher exposure to risks of the government ✓ Increased external sovereign debt ✓ Larger involvement of government/executing agency requiring input of human resources

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III. Exposure to Risks

Definition of Risk

Two standpoints on perception of risk

- for Government:

  Any factor affecting the project in terms of construction within the budget and schedule and to the specifications and uninterrupted delivery of services of electricity at reasonable prices

- for Investor & Lender:

  Any factor affecting the cashflow to be generated by the project

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(cont'd) III. Exposure to Risks

Risk Categories

✓ Natural force majeure: natural calamity (earthquake, storm, flood, epidemic, etc.)

✓ Political force majeure (country risk): war, SRCC (strike・riot・civil commotion), expropriation, policy change, restriction on overseas remittanae, etc.

✓ Sponsor risk: management capability, credit capability

✓ Commercial risk: completion risk, operation risk, market risk, macroeconomic risk

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(cont'd) III. Exposure to Risks

Principles of Risk Management (1)

Who should take risks?

The person who can control the risk

Or, if the risk is not controllable,

The person who is in such a position as deemed to be appropriate to take the risk.

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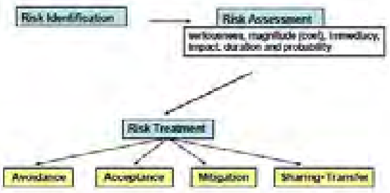
(cont'd) III. Exposure to Risks

Principles of Risk Management (2)



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(cont'd) III. Exposure to Risks

Principles of Risk Management (3)

Avoidance →	*Withdraw or do not get involved*
Acceptance →	*Budget the possible costs and monitor factors of the accepted risk*
Mitigation →	*Work out countermeasures to reduce possible damage from the risk*
Sharing・Transfer →	*Share the risk between the parties concerned including insurance, which is a way for partial risk transfer*

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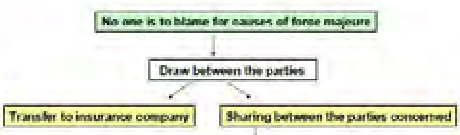
IV-1. Risk Management (Natural Force Majeure)

Natural Force Majeure = Natural Calamity: earthquake, storm, flood, epidemic, etc



The contract must provide for sharing of costs incurred from force majeure: extra costs, recovery costs, compensation, etc.

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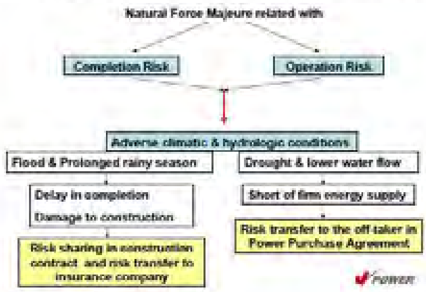
(cont'd) IV-1. Risk Management (Natural Force Majeure)



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IV-2. Risk Management (Country Risk)

Country risk = Political Force Majeure:
war, SRCC (strike・riot・civil commotion), expropriation, policy change, restriction on overseas remittance, etc.

No one is to blame for causes of force majeure

BUT
Only for IPP
Because this is sovereign risk.

For IPP	For Public Works
Same treatment as natural force majeure	*The Government must take all risks*

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(cont'd) IV-2. Risk Management (Country Risk)

For IPP
↓
Same treatment as natural force majeure
+
Government guarantee in Implementation Agreement
+
Guarantee by international financial institution

For Public Works
↓
The government must take all country risks
+
Government guarantee to the parties concerned:
- ✓Contractor
- ✓Supplier
- ✓Operator

+
Insurance by Export Credit Agency

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IV-3. Risk Management (Sponsor risk)

The Sponsor (s) is the key to project success whether IPP (investor) or Public Works (government)

For IPP
↓
Lenders rely on:
- ✓management capability
- ✓financial capacity

For Public Works
↓
Lenders rely on:
- ✓macroeconomic and fiscal management capability of the government
- ✓project management capability of the government or its executing agency

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(cont'd) IV-3. Risk Management (Sponsor risk)

For IPP
- Firm commitment by the Sponsor(s) → Joint and several responsibility if the Sponsors are plural; The Sponsor's guarantee for financial support and for project completion if SPC fails
- Prohibited exit from the project of the Sponsor → No transfer of the Sponsor's share

For Public Works
- Firm commitment by the Government → Budget appropriation & competent staff assignment
- Policy continuity → Government guarantee for compensation

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IV-4. Risk Management (Commercial Risk)

Completion Risk (1)

3 major control points for project completion (construction): quality, time and cost
↓
Contracts for construction and supply must provide for reasonable risk sharing between the parties

Various contract types for risk sharing in construction

- Quality / Time → Scope of works
  - EPC (full turn-key)
  - Design-build + Supply & installation
  - Construction + Supply & installation
- Cost → Payment basis
  - Lump sum (fixed)
  - Unit price
  - Cost plus

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(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (2)

EPC (full turn-key) (Completion risk is transferred to EPC contractor & fast tracking)
(1 contract package)
Scope of works: design, equipment supply & installation and construction

	Risk for the Sponsor/Government	Risk for the Contractor
Quality	✓failure of the Contractor	✓responsibility for design ✓interface of civil works and equipment installation ✓overall performance of hydropower plant
Time	✓delay in completion	✓adverse climatic conditions: flood, prolonged rainy season ✓adverse geological conditions

Mitigation: monetary compensation such as liquidated damage in the EPC contract
EPC contractor's participation in O&M as one of the parties for a certain period of time as quality assurance

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(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (3)

Design-build + Supply & installation (possible cost reduction & fast tracking)
(more than 1 contract package)
Scope of works: design and construction of civil works + equipment supply & installation

	Risk for the Sponsor/Government	Risk for the Contractor/Supplier
Quality	✓interface of civil works and equipment installation ✓overall performance of hydropower plant	✓responsibility for design ✓respective performance of civil works, hydromechanical equipment and electromechanical equipment
Time	✓delay in completion ✓coordination for construction schedule between different contracts	✓adverse climatic conditions: flood, prolonged rainy season ✓adverse geological conditions

Mitigation: employment of competent engineering consulting firm for construction supervision
or
Risk transfer: to Construction Management firm

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(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (4)

Construction + Supply & installation
(more than 1 contract package)

Scope of works: construction of civil works + equipment supply & installation

	Risk for the Sponsor/Government	Risk for the Contractor/Supplier
Quality	✓ responsibility for design ✓ interface of civil works and equipment installation ✓ overall performance of hydropower plant	✓ respective performance of civil works, hydromechanical equipment and electromechanical equipment
Time	✓ delay in completion ✓ coordination for construction schedule between different contracts	✓ adverse climatic conditions: flood, prolonged rainy season ✓ adverse geological conditions

Mitigation: employment of competent engineering consulting firm for construction supervision
or
Risk transfer: to Construction Management firm

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(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (5)

Lump sum (fixed)

EPC contract usually adopts lump-sum basis and must be on a fixed price to transfer cost overrun risk to EPC contractor.

	Risk for the Sponsor/Government	Risk for the Contractor
Cost	✓ higher contingency included in the contract amount ✓ abandonment of the Contractor due to cost overrun	✓ adverse geological conditions ✓ adverse climatic conditions ✓ interface of civil works and equipment installation

Mitigation: Against higher margin, cost plus basis may be adopted for structure foundation and underground works.
Against abandonment, monetary compensation for substitute contractor included in the contract.

The margin may be reduced but there remains cost overrun risk for the Sponsor/Government depending on geological conditions

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(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (6)

Unit price (including fee for the contractor in unit prices)

Civil works contract usually adopts unit-price basis.

	Risk for the Sponsor/Government	Risk for the Contractor
Cost	✓ cost overrun	✓ adverse geological conditions ✓ adverse climatic conditions ✓ interface of civil works and equipment installation

Mitigation: employment of competent engineering consulting firm for construction supervision
Risk transfer: to Construction Management firm

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(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (7)

Cost plus (reimbursable costs plus fee)

Fee can be defined in various forms such as fixed fee and fee proportional to costs.

	Risk for the Sponsor/Government	Risk for the Contractor
Cost	✓ cost overrun	✓ adverse geological conditions ✓ adverse climatic conditions ✓ interface of civil works and equipment installation

Mitigation: employment of competent engineering consulting firm for construction supervision
Risk transfer: to Construction Management firm

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(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (8)

Risks inherent in contract of hydropower construction (1)

Contract risk | Climatic & hydrologic risk | Geological risk | Environmental risk

- Contract risk → Employer's risk; Contractor's risk
- Climatic & hydrologic risk (e.g.: flood) → Employer's risk
- Climatic & hydrologic risk (e.g.: groundwater level) → Adverse physical conditions
- Geological risk → Adverse physical conditions

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(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (9)

Risks inherent in contract of hydropower construction (2)

Contract risk viewed from the Employer

Employer's risk
- ✓ Natural & political force majeure
- ✓ Design and works performed by the Employer or its agents
- ✓ Use or occupation of part of the works by the Employer
- ✓ Unforeseeable adverse conditions including climatic & hydrologic risks

Payment amount
- ✓ Higher contingency included in EPC contract
- ✓ Measurements of works performed for unit price contract
- ✓ Addition of new work items to the priced bill of quantities in the case of unforeseeable geological conditions for unit-price contract
- ✓ Variation order & additional/extra works required (caution needed in EPC contract)

Risk transfer by EPC contract (but not all)

Other risks
- ✓ Errors & discrepancies in contract documents
- ✓ Inadequate surveys and design mistakes
- ✓ Mistakes in instructions during construction
- ✓ Delay in instructions required and approval of drawings
- ✓ Delay in payment

Negligence or failure of duty of care of the Employer

Risk mitigation/transfer by employment of CS or CM firm

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(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (10)

Risks inherent in contract of hydropower construction (3)

Contract risk viewed from the Contractor
- ✓ Ambiguous scope of works (inferred works)
- ✓ Variation order
- ✓ Interface between various contractors & suppliers
- ✓ Delay in others' works
- ✓ Delay in permits (e.g.: use of land, right-of-way, customs clearance)
- ✓ Delay in approvals or disapprovals by the Engineer
- ✓ Approval of subcontractors
- ✓ Liquidated damages & limit to total liability
- ✓ Unforeseeable site conditions (e.g.: geology)
- ✓ Cost increase due to force majeure & price escalation
- ✓ Taking-over & substantial completion
- ✓ Defects liability period & statute of limitation to latent defects
- ✓ Tax (corporate & personal income tax, VAT, customs duties, etc.)

→ Claims to the Employer
- ✓ Claim mechanism to be built in the contract
- ✓ Claim strategy
- ✓ Claim contractual grounds and data & evidences
- ✓ Claim amount & time extension

→ Dispute Adjudication Board and Arbitration
- DAB-arbitration mechanism to be built in the contract

→ Litigation

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(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (11)

Risks inherent in contract of hydropower construction (4)

Geological risk
- ✓ Insufficient site investigations
- ✓ Less accurate basic design & detail design

Caution needed in EPC contract or Design-build contract

Disputes
(unforeseeable degree by the experienced contractor)
- ✓ Accuracy of geological information in the tender documents provided by the Employer
- ✓ Interpretation of the geological information by the Contractor
- ✓ Sufficiency of the tender submitted by the Contractor
- ✓ Ambiguous scope of works & inferred works
- ✓ Addition of new work items
- ✓ Measurement for payment

→
- ✓ Modification to scope of works
- ✓ Variation order
- ✓ New rate for new work items

Risk mitigation: employment of engineering consulting firm for detail design of civil works and tendering based on that detail design
or
Risk transfer to CM firm

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(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (12)

Risks inherent in contract of hydropower construction (5)

Environmental risk

- ✓ compliance with law, environmental & social management plan
- ✓ limitation to construction activities
- ✓ NGOs' increased activities
- ✓ cost overrun and/or delay in completion due to environmental reasons
- ✓ construction discontinued due to environmental reasons

- ✓ Risk acceptance: budget environmental & social management plan
- ✓ Risk mitigation: prepare construction plan with environmental considerations
- ✓ Risk mitigation: good relationship & communications with neighboring communities, relevant authorities and NGOs
- ✓ Risk transfer: force majeure in the case of discontinued construction

POWER 33

(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (13)

Employment of engineering consulting firm for construction supervision or construction management firm as risk mitigation or transfer

Scope of services

- ✓ Definite design & tender documents preparation
- ✓ Tendering & contract negotiations
- ✓ Approval of drawings & site supervision
- ✓ Approval of statement of performance & invoice
- ✓ Contract management & claim management

increasing ← responsibility → decreasing

(responsible for quality, time and cost in CM at risk)

(impartial engineering judgment for reasonable risk sharing in quality, time and cost)

Construction Management (CM at risk ← → pure CM)

Construction Supervision (Through the Engineer ← → Advisory)

increasing ← cost of services → decreasing

POWER 34

(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (14)

Various contract types for consulting services and construction management

(These contract types can be applied to construction contract)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

POWER 35

(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (15)

Insurance as risk transfer of completion risk

- ✓ Cargo insurance: equipment & materials under transport
- ✓ Contractor's (Erection) all risks insurance: works, materials and equipment under construction/erection
- ✓ Movables comprehensible insurance: construction machinery
- ✓ Third party liability insurance: damage/loss of property or human body of third party
- ✓ Worker's compensation insurance & Employer's liability insurance: own employees and other construction staff
- ✓ Automobile insurance: vehicles for construction
- ✓ Professional indemnity insurance: design work

BUT
Not all risks can be transferred to insurance company (deductibles, exclusions)

→ Risk sharing between the parties in the contract

POWER 36

(cont'd) IV-4. Risk Management (Commercial Risk)

Completion Risk (15)

Typical Models of Conditions of Contract for Construction

- ➢ FIDIC (Fédération Internationale des Ingénieurs-Conseils)
  - ✓ Red Book (civil engineering construction)
  - ✓ Yellow Book (electrical & mechanical works)
  - ✓ Orange Book (design-build & turnkey)
  - ✓ Silver Book (EPC turnkey project)
  - ✓ White Book (consulting services)
- ➢ ICE (Institution of Civil Engineers, UK)
  - ✓ ICE Conditions of Contract Measurement Version
  - ✓ ICE Design and Construct Conditions of Contract
- ➢ ICC (International Chamber of Commerce)
  - ✓ ICC Model Turnkey Contract for Major Projects

POWER 37

(cont'd) IV-4. Risk Management (Commercial Risk)

Operation Risk (1)

If PPA provides for take-or-pay or capacity charge as payment basis, plant availability is a vital factor, regardless of actual delivery of electricity.

- → Force majeure risk
- → Management risk
- → Maintenance risk
- → Hydrologic risk
- → Environmental risk

POWER 38

(cont'd) IV-4. Risk Management (Commercial Risk)

Operation Risk (2)

Force majeure risk (natural and political)

↓

Risk transfer to the insurance company

- ✓ Property insurance: physical damage to plant & equipment (exclusion: war, civil war, gross negligence & willful misconduct)
- ✓ Business interruption insurance: financial damage from plant shutdown due to accident or damage
- ✓ Third-party liability insurance: property damage and bodily injury or loss of third party

BUT
Not all risks can be transferred to insurance company (deductibles, exclusions)

POWER 39

(cont'd) IV-4. Risk Management (Commercial Risk)

Operation Risk (3)

Management risk

- ✓ management capacity of the operator
- ✓ skill level of operation staff
- ✓ corporate culture of the operator

Maintenance risk

- ✓ routine checkup and long-term maintenance plan
- ✓ skill level of maintenance staff
- ✓ troubleshooting
- ✓ availability of spare parts

to keep plant availability

IPP: Involvement of the Sponsor and/or EPC contractor

Public Works: competitive tender for the operator

capacity and experience of hydropower plant operation

POWER 40

(cont'd) IV-4. Risk Management (Commercial Risk)

Operation Risk (4)

Hydrologic risk

Less than the firm energy due to decrease in water flow

↓

Risk transfer to the off-taker as force majeure in PPA

BUT

↓

Plant availability must be kept.

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(cont'd) IV-4. Risk Management (Commercial Risk)

Operation Risk (8)

Environmental risk

- ✓ compliance with law, environmental & social management plan
- ✓ limitation to operation
- ✓ NGOs' increased activities
- ✓ increase in operation cost due to environmental reasons
- ✓ operation discontinued due to environmental reasons

↓

- ✓ Risk acceptance: budget environmental & social management plan
- ✓ Risk mitigation: prepare O&M plan with environmental considerations
- ✓ Risk mitigation: good relationship & communications with neighboring communities, relevant authorities and NGOs
- ✓ Risk transfer: force majeure in the case of discontinued operation

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(cont'd) IV-4. Risk Management (Commercial Risk)

Market Risk (1)

Revenue = Price x Quantity

Price	Quantity
Power tariff setting to be approved by ERA	Decrease in power demand
↓	↓
Fixed tariff in long term PPA with the off-taker	Take-or-pay basis in long-term PPA with the off-taker

(cost overrun of the construction may be passed on to the off-taker through some formula for setting the tariff provided for in PPA instead of the predetermined tariff.)

43

(cont'd) IV-4. Risk Management (Commercial Risk)

Market Risk (2)

Availability of transmission lines for power evacuation

(Transmission lines are means of transport to the power market)

- ✓ Who is to construct the transmission lines?
- ✓ When are the transmission lines available for power evacuation?
- ✓ Where is the delivery point to the off-taker?
- ✓ What is the Grid Code?
- ✓ Who is responsible for operation & maintenance of the transmission lines?
- ✓ Who is in charge of national power system and power dispatch?
- ✓ How much is the wheeling charge?
- ✓ What is the metering mechanism?

↓

PPA must provide for all the above considerations for risk transfer to the off-taker

44

(cont'd) IV-4. Risk Management (Commercial Risk)

Macroeconomic Risk

- ✓ Inflation: Increase in cost of construction and operation/maintenance due to price fluctuation
- ✓ Interest rate: Increase in interest payment to lenders due to fluctuation of market interest rate
- ✓ Exchange rate: Increase in payment to construction contractors if currency is different between borrowings and payments to contractors

  or

  Increase in payment for debt service or other O&M expenses if currency is different between revenues and payments

↓

Risk mitigation

- ✓ Inflation: fixed lump sum contract for construction or pass through to the off-taker in PPA
- ✓ Interest: fixed interest rate for borrowing or interest swap to convert to fixed interest rate
- ✓ Exchange rate: hedge by forward exchange contract or negotiation to make the same currency as much as possible

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Appendix J-5

Environment

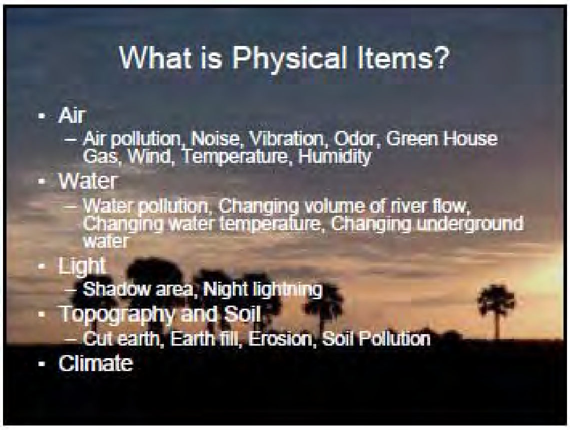
LIST OF CONTENTS

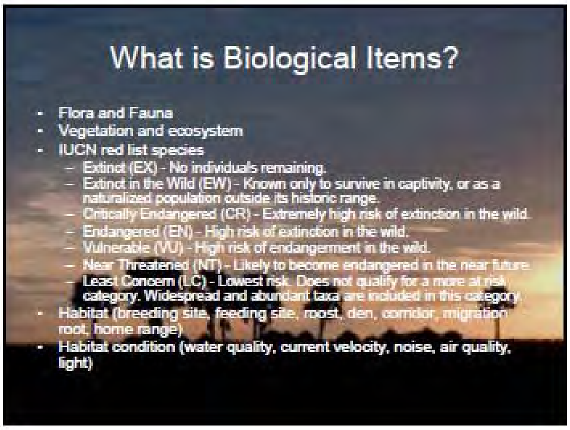

Environment and Impact Assessment
Akiko Urago


Agenda
1. Environment (10:00-10:50)
2. Environmental Impact (11:00-11:50)
3. Environmental Impact Assessment (13:00-13:50)
4. Strategic Environmental Assessment (14:00-14:50)
5. Project Environmental Impact Assessment (15:00- 15:50)


1. Environment

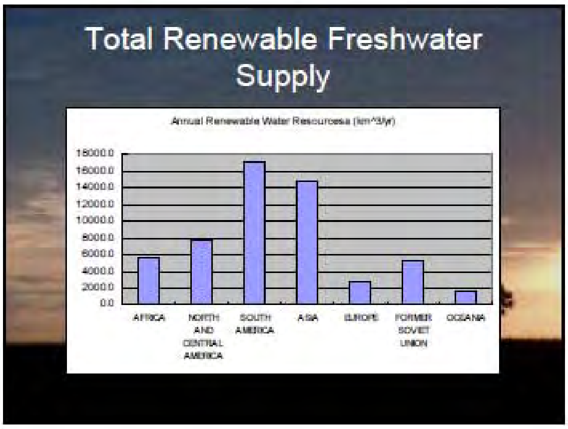

What is Environment?
• Physical items
– Air, Noise, Water, Light, Topography, Soil, Climate
• Biological items
– Plants (Flowering plants, Ferns, Bryophytes), Fungi, Animals (Mammals, birds, reptiles, amphibians, fish, insects, and other invertebrates such as spiders, crabs, squid, earthworms, etc.)
• Social items
– People, Land use, Infrastructure, Social service, Economic activities, Culture, Risk,

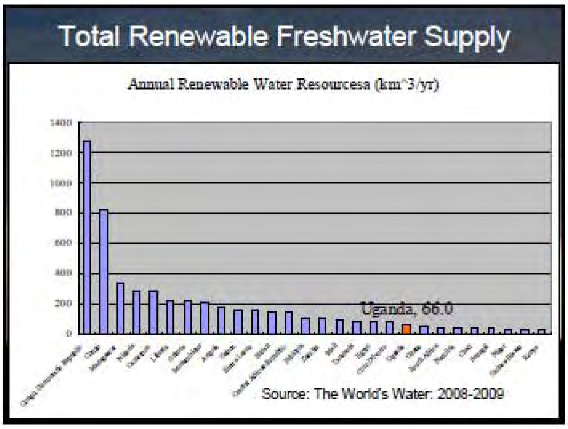

What is Physical Items?
• Air
– Air pollution, Noise, Vibration, Odor, Green House Gas, Wind, Temperature, Humidity
• Water
– Water pollution, Changing volume of river flow, Changing water temperature, Changing underground water
• Light
– Shadow area, Night lightning
• Topography and Soil
– Cut earth, Earth fill, Erosion, Soil Pollution
• Climate

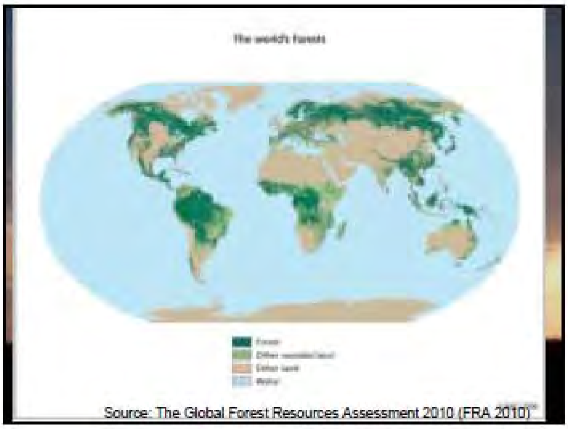

What is Biological Items?
• Flora and Fauna
• Vegetation and ecosystem
• IUCN red list species
– Extinct (EX) - No individuals remaining.
– Extinct in the Wild (EW) - Known only to survive in captivity, or as a naturalized population outside its historic range.
– Critically Endangered (CR) - Extremely high risk of extinction in the wild.
– Endangered (EN) - High risk of extinction in the wild.
– Vulnerable (VU) - High risk of endangerment in the wild.
– Near Threatened (NT) - Likely to become endangered in the near future.
– Least Concern (LC) - Lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category.
• Habitat (breeding site, feeding site, roost, den, corridor, migration root, home range)
• Habitat condition (water quality, current velocity, noise, air quality, light)

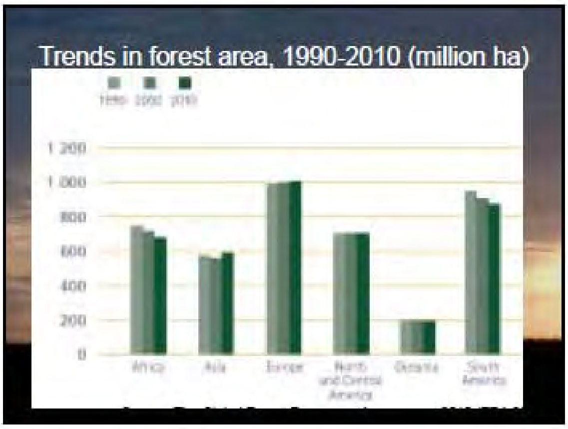

What is social items?
• People
– Population, Administration, Ethnic Group
• Land use & Infrastructure
– Houses, Buildings, Transportation, Water supply, Electricity Supply, Sanitation
• Social service and Risk
– Education, Human health, Waste, Accident, Disastor
• Economic Activities
– Agriculture, Fishery, Industry, Retailing, Tourism, Transport industry, etc.
• Culture
– Language, Religion, tradition, cultural property, recreation, landscape

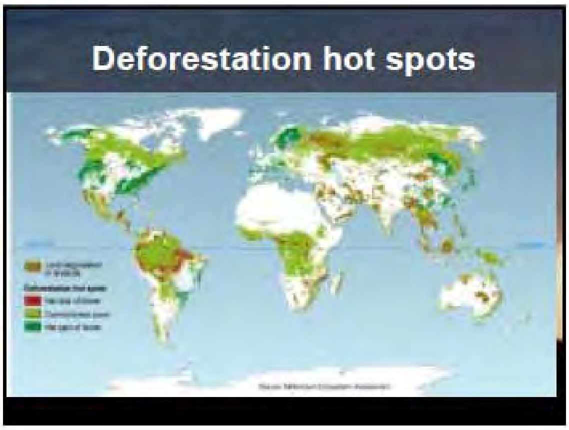

People's and Wildlife's Environment
People
Wildlife
Air
Water
Noise/ Vibration
Land use
Social things
Economic things
Air
Water
Noise/ Vibration
Forest
Grass land
Water edge
Soil

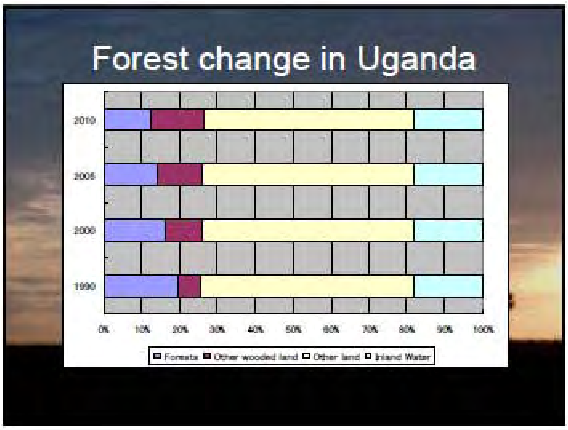

Total Renewable Freshwater Supply
Annual Renewable Water Resourcesa (km^3/yr)
18000.0
16000.0
14000.0
12000.0
10000.0
8000.0
6000.0
4000.0
2000.0
0.0
AFRICA
NORTH AND CENTRAL AMERICA
SOUTH AMERICA
ASIA
EUROPE
FORMER SOVIET UNION
OCEANIA

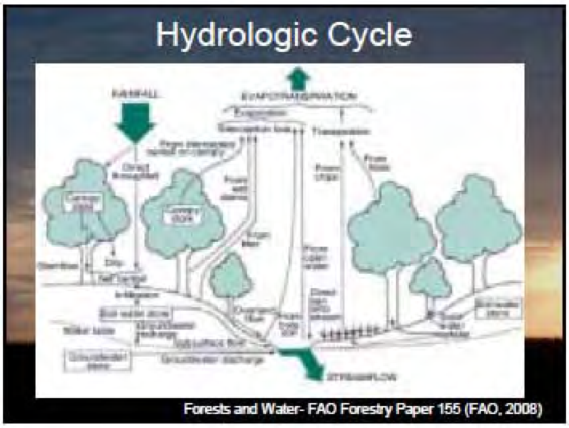

Total Renewable Freshwater Supply
Annual Renewable Water Resourcesa (km^3/yr)
1400
1200
1000
800
600
400
200
0
Uganda, 66.0
Source: The World's Water: 2008-2009

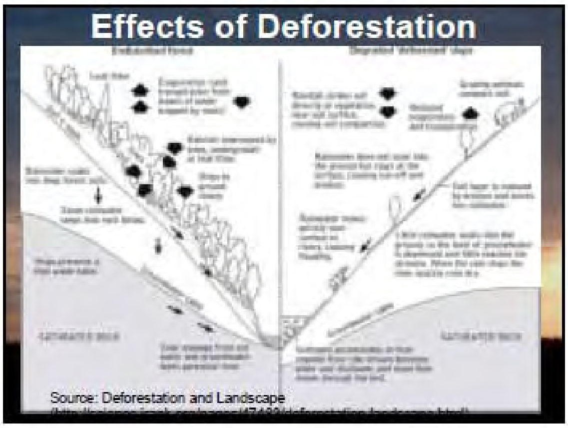

The world's forests
Source: The Global Forest Resources Assessment 2010 (FRA 2010)

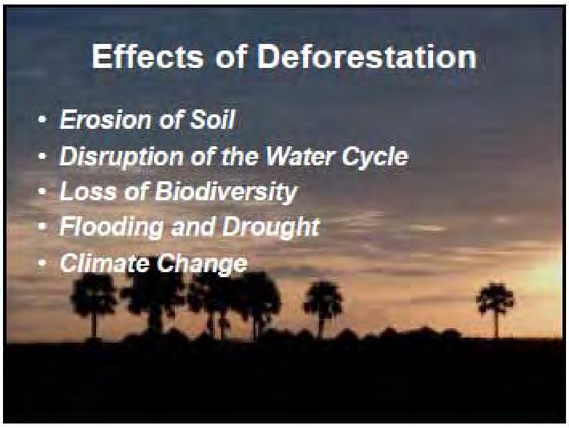

Trends in forest area, 1990-2010 (million ha)
1990
2000
2010
1 200
1 000
800
600
400
200
0
Africa
Asia
Europe
North and Central America
Oceania
South America

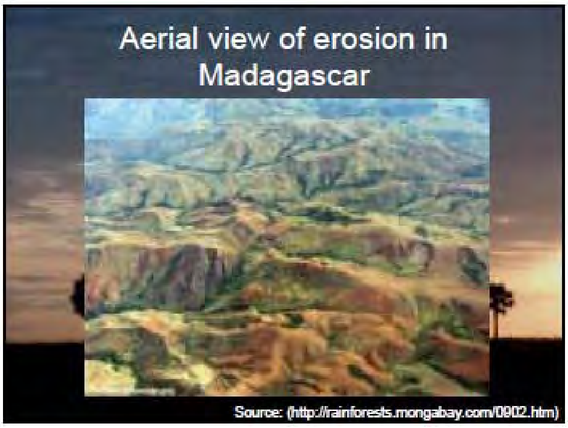

Deforestation hot spots

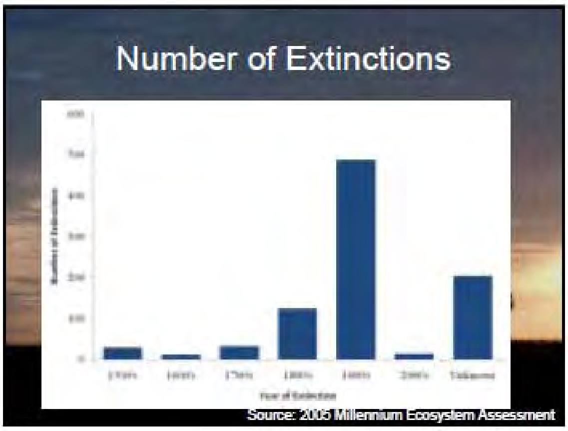

Forest change in Uganda
2010
2005
2000
1990
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Forests Other wooded land Other land Inland Water

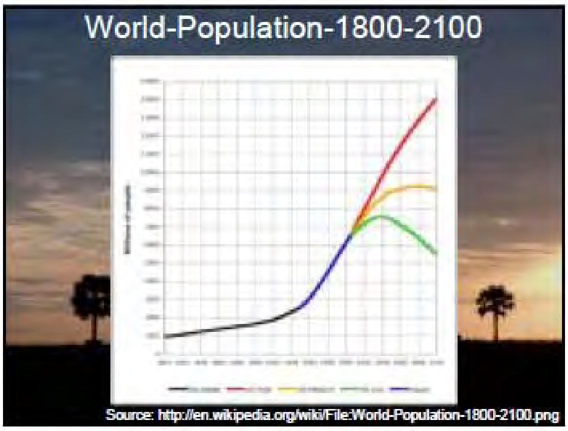

Hydrologic Cycle
Forests and Water- FAO Forestry Paper 155 (FAO, 2008)


Effects of Deforestation
Source: Deforestation and Landscape


Effects of Deforestation
• Erosion of Soil
• Disruption of the Water Cycle
• Loss of Biodiversity
• Flooding and Drought
• Climate Change

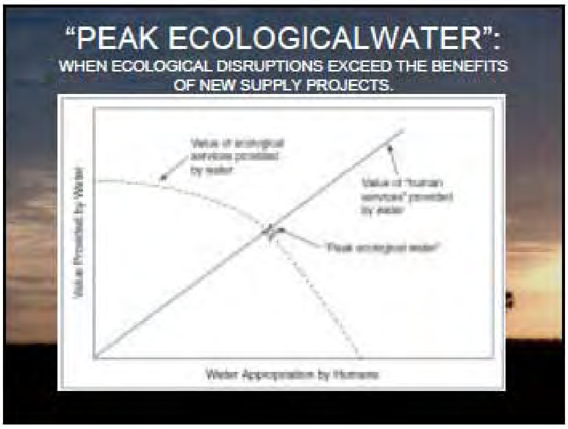

Aerial view of erosion in Madagascar
Source: (http://rainforests.mongabay.com/0902.htm)

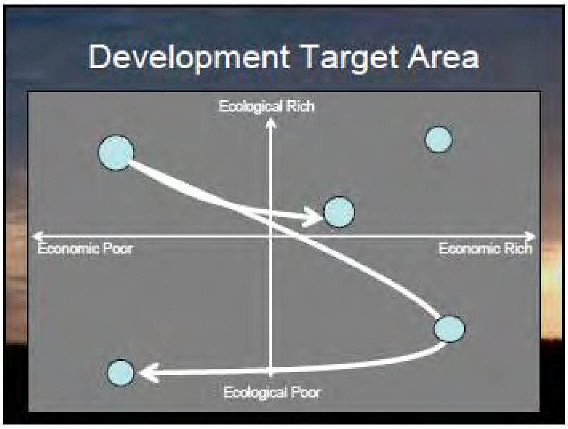

Number of Extinctions
Source: 2005 Millennium Ecosystem Assessment


World-Population-1800-2100
Source: http://en.wikipedia.org/wiki/File:World-Population-1800-2100.png


Review Natural Resources
• Resources (water, forest, etc.) area limited.
• Population is increasing.
• Demand (water use, electricity, etc.) is increasing.
• Forest area is decreasing.
• Wild species are decreasing.


Easter Island
• Increased population
• Deforestation
• Erosion
• Food crisis and war
• Decreased population
Source: http://en.wikipedia.org/wiki/Easter_Island


"PEAK ECOLOGICALWATER":
WHEN ECOLOGICAL DISRUPTIONS EXCEED THE BENEFITS OF NEW SUPPLY PROJECTS.
Value of ecological services provided by water
Value of "human services" provided by water
"Peak ecological water"
Value Provided by Water
Water Appropriation by Humans


Development Target Area
Ecological Rich
Economic Poor
Economic Rich
Ecological Poor


Sustainability Development
• Carrying Capacity
• Scenario Planning
• Strategic Environmental Assessment
• Environmental Impact Assessment


Review
• Water
• Forest
• Soil
• Wildlife
• Population
• Development target area
• Sustainability

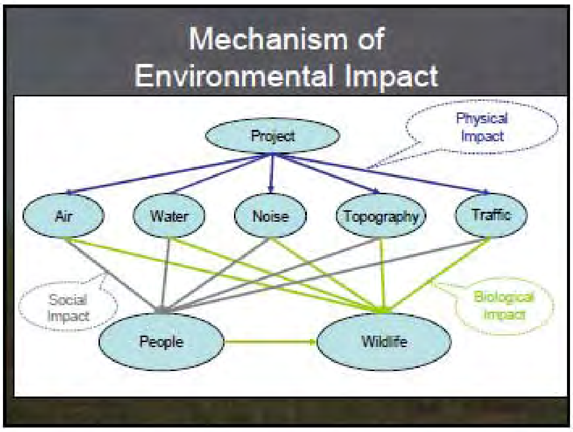

Questions?

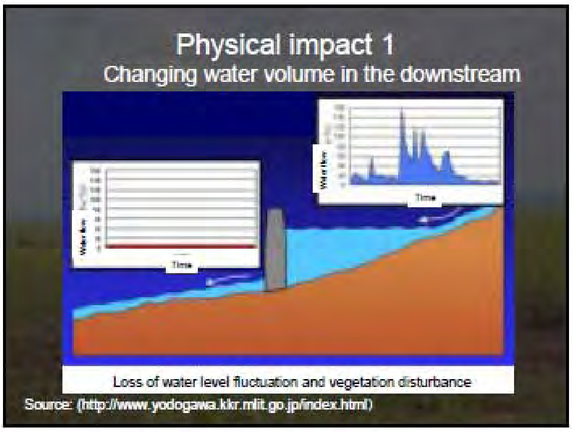

Exercise 1
What kind of environmental resources have to be protected in Uganda?
List up more than three items.

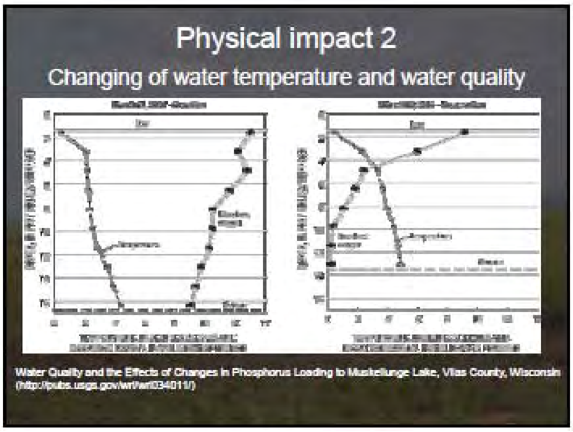

Break

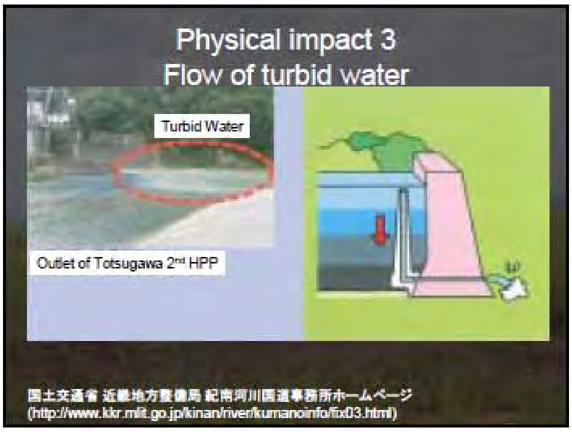

2. Environmental Impact

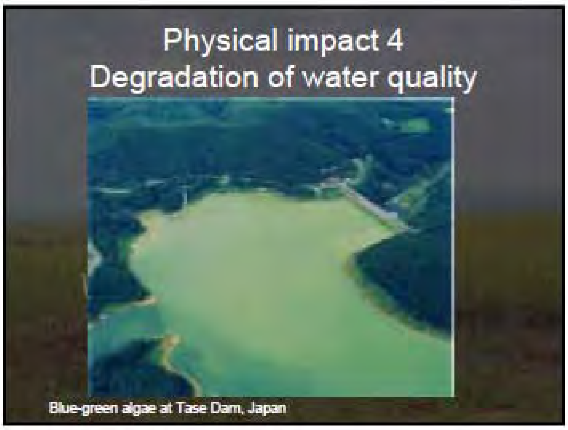

What is Environment?
• Physical items
– Air, Noise, Water, Light, Topography, Soil, Climate
• Biological items
– Plants (Flowering plants, Ferns, Bryophytes), Fungi, Animals (Mammals, birds, reptiles, amphibians, fish, insects, and other invertebrates such as spiders, crabs, squid, earthworms, etc.)
• Social items
– People, Land use, Infrastructure, Social service, Economic activities, Culture, Risk,

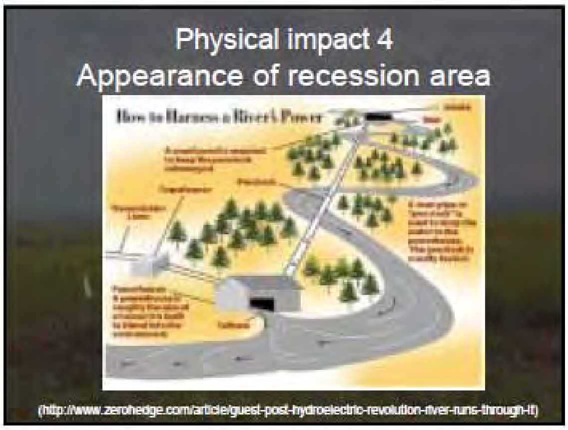

Mechanism of Environmental Impact
Project
Physical Impact
Air
Water
Noise
Topography
Traffic
Social Impact
Biological Impact
People
Wildlife

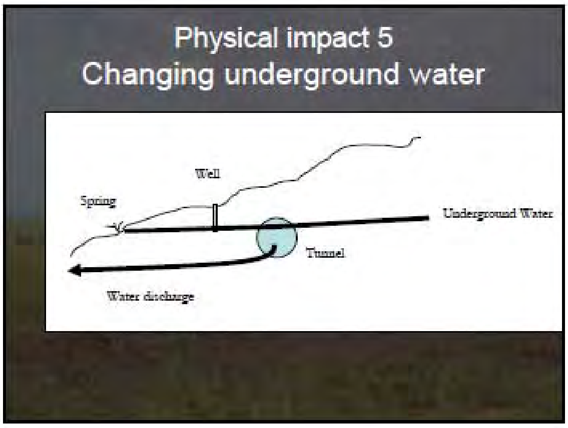

Physical impact 1
Changing water volume in the downstream
Time
Time
Loss of water level fluctuation and vegetation disturbance
Source: (http://www.yodogawa.kkr.mlit.go.jp/index.html)

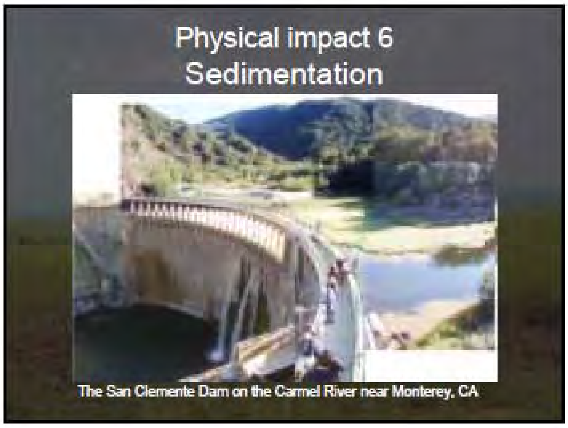

Physical impact 2
Changing of water temperature and water quality
Water Quality and the Effects of Changes in Phosphorus Loading to Muskellunge Lake, Vilas County, Wisconsin
(http://pubs.usgs.gov/wri/wri034011/)

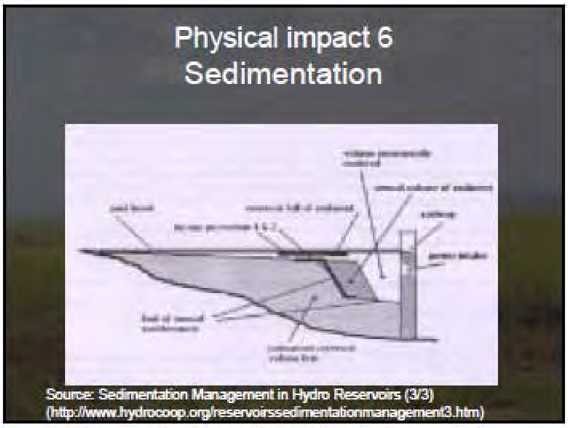

Physical impact 3
Flow of turbid water
Turbid Water
Outlet of Totsugawa 2nd HPP
国土交通省 近畿地方整備局 紀南河川国道事務所ホームページ
(http://www.kkr.mlit.go.jp/kinan/river/kumanoinfo/fix03.html)


Physical impact 4
Degradation of water quality
Blue-green algae at Tase Dam, Japan


Physical impact 4
Appearance of recession area
How to Harness a River's Power
(http://www.zerohedge.com/article/guest-post-hydroelectric-revolution-river-runs-through-it)


Physical impact 5
Changing underground water
Well
Spring
Underground Water
Tunnel
Water discharge


Physical impact 6
Sedimentation
The San Clemente Dam on the Carmel River near Monterey, CA

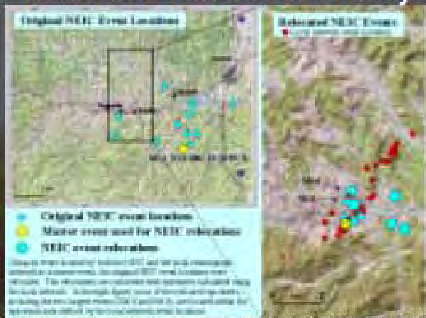

Physical impact 6
Sedimentation
Source: Sedimentation Management in Hydro Reservoirs (3/3)
(http://www.hydrocoop.org/reservoirssedimentationmanagement3.htm)


Physical impact 7
Downstream river bed degradation
見市川の砂防ダムと河床低下・河岸崩壊
稗田 一俊「魚が育む川のしくみ」(http://hffnet.hp.infoseek.co.jp/forums/5th/hieda005.html)

Physical impact 8
Coast erosion in Enshunada

Motoyuki Inoue (2009)「山地から河川、海岸にわたる[illegible]」(2009年 科学技術動向)

Physical impact 9
Reservoir induced seismicity



Trinidad, Colorado (http://pubs.usgs.gov/of/2002/ofr-02-0073/ofr-02-0073.html)

Physical impact 10
Recorded dam failures since 1980 which have killed more than 10 people

Dam	Country	Type	Height (m)	Year completed	Year failed	Cause of failure	People killed
[illegible]	India			[illegible]	[illegible]	OT	[illegible]
Tous	Spain	R	77	[illegible]	1982	OT	[illegible]
Stava	Italy	Ta		1960s	[illegible]		[illegible]
Kantale	Sri Lanka	R	[illegible]	[illegible]	1986	PI	[illegible]
[illegible]	Tajikistan		[illegible]	[illegible]	1987		[illegible]
Belci	Romania	E	18	[illegible]	1991	OT	[illegible]
[illegible]	China	R	71	[illegible]	1993	PI	[illegible]
[illegible]	Russia	E	[illegible]	[illegible]	1994	OT	[illegible]
[illegible]	S.Africa	Ta	[illegible]		1994		[illegible]
Lake Blackshear Project/Flint River Dam	GA, USA	E	[illegible]		1994	OT	[illegible]
N/A	Philippines	N/A	N/A	N/A	[illegible]	N/A	[illegible]

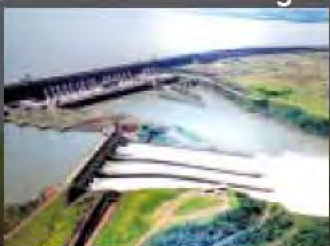
Dam types: E=EarthEll; R=RockEll; G=Gravity; M=Multi-arch; B=Buttress; A=Arch; Ta=Tailings
Cause of failure: OT=overtopping; PI=piping; SF=structural failure; F=geological foundation weakness

WCD, Operation, Monitoring and Decommissioning of Large Dams in India (http://www.dams.org/docs/kbase/contrib/opt180.pdf)

Physical impact 11
Topographic change

- Excavation for collection of aggregate and fill for dam construction
- Preparation of damping site for excavated material of tailrace tunnel or underground power plant
- Construction accesses road
- Temporally facility area and/or road

Physical impact 12
Local climate change



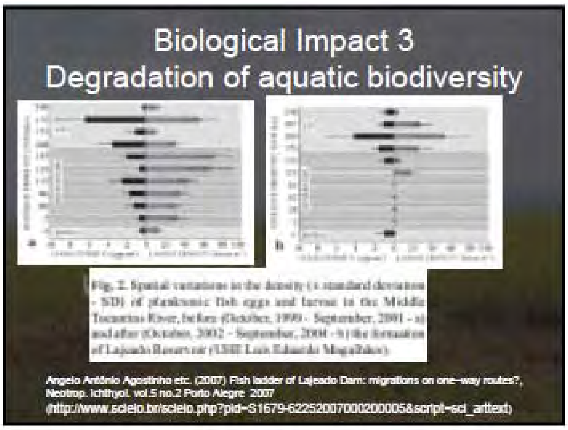
- Itaipu Dam (Brazil-Paraguay) has changed local climate such as wind and temperature.

Source: Sônia M. S. Stivari, Amauri P. Oliveira and Jacyra Soares, (2005) On the Climate Impact of the Local Circulation in the Itaipu Lake Area Climatic Change, Volume 72, Numbers 1-2

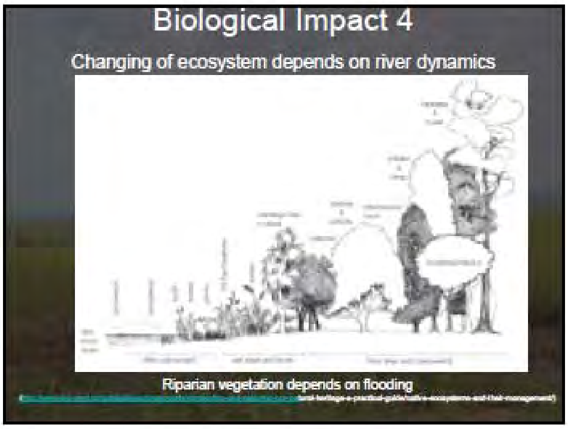
Biological Impact 1
Emergence of new ecosystem

Source: http://www.ogwa-hydrog.ca/en/node?page=10

Biological Impact 2
Habitat loss caused by inundation
Feeding site
Drinking site
Hiding site
Nest, lair, den
Breeding site
Migration root
Mammals
Birds
Reptiles
Amphibians
(Fish)
Insects
Other invertebrates such as spiders, crabs, squid, earthworms, etc.

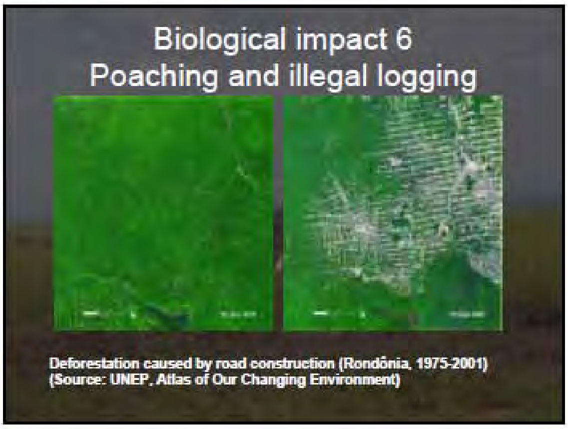


Biological Impact 3
Degradation of aquatic biodiversity
Angelo Antônio Agostinho etc. (2007) Fish ladder of Lajeado Dam: migrations on one-way routes?, Neotrop. Ichthyol. vol.5 no.2 Porto Alegre 2007
(http://www.scielo.br/scielo.php?pid=S1679-62252007000200005&script=sci_arttext)



Biological Impact 4
Changing of ecosystem depends on river dynamics
Riparian vegetation depends on flooding

Biological Impact 5
Migration barrier on wingless species
Animals being killed by motor vehicles in the United States annually
41 million squirrels
26 million cats
22 million rats
19 million opossums
15 million raccoons
6 million dogs
350,000 deer
(http://www.animalpeoplenews.org/)



Biological impact 6
Poaching and illegal logging
Deforestation caused by road construction (Rondônia, 1975-2001)
(Source: UNEP, Atlas of Our Changing Environment)

Biological Impact 7
Invasive species
Ecological impacts
Genetic pollution
Economic impacts
Health impacts
Source: http://en.wikipedia.org/wiki/Invasive_species

Social Impact 1
Positive impact

- Reduction of flood damage
- Expansion of available land use area
- Expansion of job opportunities
- Emergence of new industry
- Improvement of life condition

Social Impact 2
Resettlement

Name Of Dam	Country/ Countries	Date of Completion	Number Of Reservoir Resettlers
Kariba	Zambia(Z)	1959	34,000
Aswan	Egypt (E)	1967	50,000
Kainji	Nigeria	1968	44,000
[illegible]	India	1982	30,000
Shuikou	China	1993	67,000
Yantan	China	1992	43,176
Kinzua	U.S.A.	1964	576
Katse	Lesotho	1995	1,479
La Grande	Canada	1995	One Village
Grand Coulee	U.S.A.	1959	2,000
Nam Theun 2	Laos	Planned Only	6,000
Pak Mun	Thailand	1994	1,285
Zimapán	Mexico	1995	2,452

Thayer Scudder (2005) A Comparative Survey of Dam-induced Resettlement in 50 Cases With the Statistical Assistance of John Gay

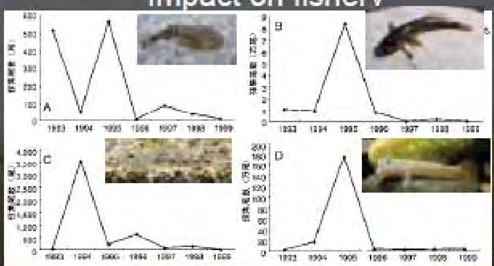
Social Impact 3
Loss of agricultural land

- Reservoir area
- Dumping site
- Excavation area
- Access road

Social Impact 4
Infection disease

- Measles
- Mumps
- Rubella
- HIV/AIDS

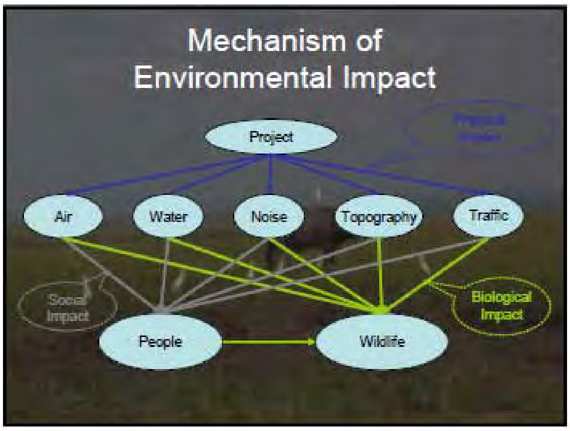
Social Impact 5
Impact on fishery



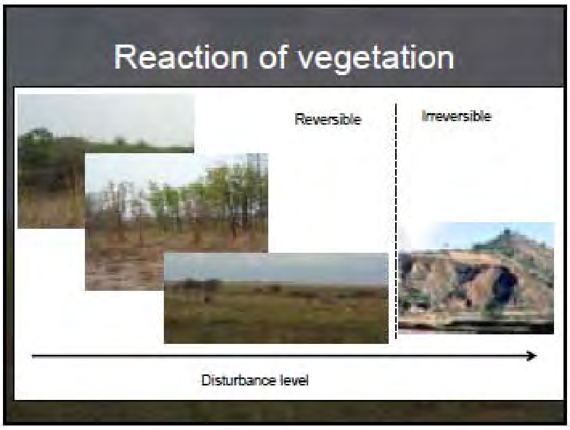
Adachi (2010) (http://homepage2.nifty.com/PhD-mukai/nagara/06_adachi.pdf)

Social impact 6
Other impact

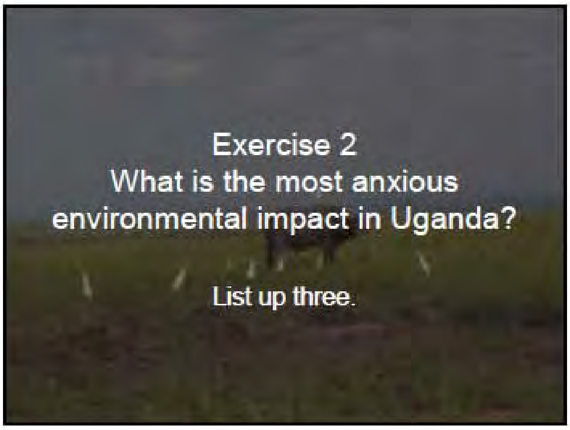
- Impact on tourism
- Impact on transport
- Impact cultural assets or fossil remains
- Accident of discharged water


Mechanism of
Environmental Impact
Project
Air
Water
Noise
Topography
Traffic
Social
Impact
Biological
Impact
People
Wildlife


Environmental Impacts
• Type- biophysical, social, health or economic
• Nature- direct or indirect, cummulative, etc
• Magnitude- high, moderate, low
• Extent- local, regional, transboundary or global
• Timing- immediate/ long term
• Duration- temporary/ permanent
• Uncertainty- low likelihood/ high probability
• Reversibility- reversible/ irreversible
• Significance- unimportant/ important
Source: EIA Training Resource Manual (UNEP, 2002)


Reaction of vegetation
Reversible
Irreversible
Disturbance level


Questions?


Exercise 2
What is the most anxious
environmental impact in Uganda?
List up three.


Break