

# Quantification of Sand Erosion in Francis Turbine

By

Hari Prasad Neopane

PhD Student at Water Power Laboratory from  
Nepal

**Advisor:** Assoc. Prof. Ole Dahlhaug

**Co-advisor:** Prof. Torbjørn Nielsen

# Sand Erosion

- Erosion is caused by impacts of solid or liquid particles against the solid surface
- Erosion, cavitation and corrosion are major material removal processes in hydraulic turbine
- Erosion reduces efficiency and life of the turbine. And, moreover it also causes problem in operation & maintenance.
- Hydraulic turbine components operating in sand-laden water subject to erosive and abrasive wear.

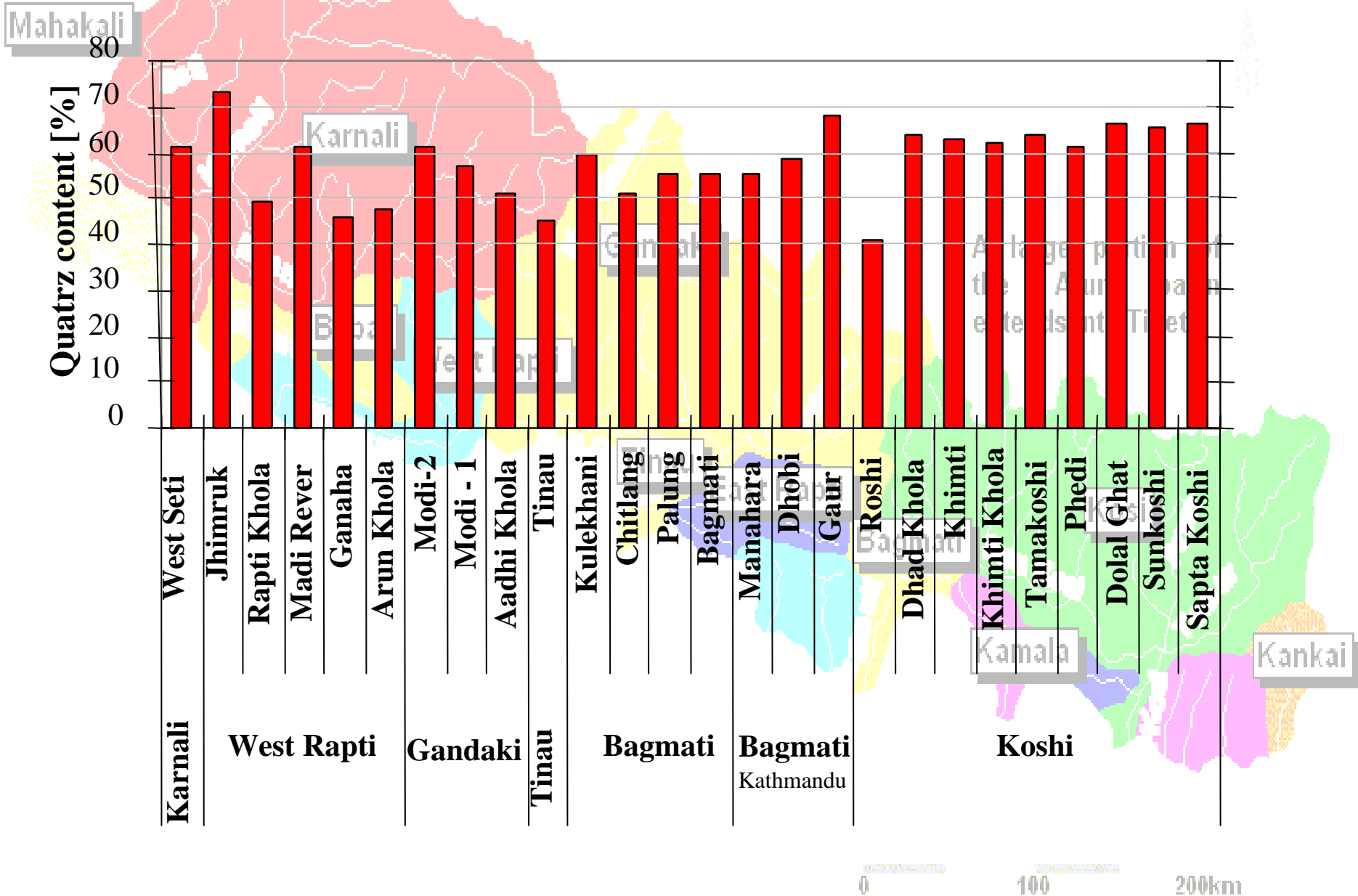
# Sediment transport in Nepali rivers

<b>River</b> Ref. KP Sharma <i>Sediment on the Mountainous Rivers of Nepal</i>	<b>Area</b> [km <sup>2</sup> ]	<b>Sediment Transport</b> [kg]
Karnali at Asara	19.260	17.200·10 <sup>6</sup>
Seti at Banga	7.460	19.000·10 <sup>6</sup>
Karnali at Chisapani	42.890	105.000·10 <sup>6</sup>
Rapti at Bagasoti	3.512	16.600·10 <sup>6</sup>
Kali Gandaki	7.130	32.200·10 <sup>6</sup>
Seti at Pokhara	582	3.310·10 <sup>6</sup>
Trishuli at Trishuli	4.640	3.410·10 <sup>6</sup>
Narayani at Narayanghat	31.100	176.000·10 <sup>6</sup>
Lothar at Lothar	169	1.400·10 <sup>6</sup>
Bagmati at Chovar	585	765·10 <sup>6</sup>
Kulekhani at Kulekhani	126	22·10 <sup>6</sup>
Kankai at Mainachuli	1148	5.830·10 <sup>6</sup>

# Minerals content in Nepali rivers

Minerals	Khimti River [ % ]	Khimti Adit -4 [ % ]	Jhimruk Turbine [ % ]	Hardness Moh's scale	Special characteristics of the minerals
Quartz	62 - 64	61 - 63	72	7	Hard mineral, resist weathering
Feldspar	3 - 5	3 - 5	7	6	Gets weathered, white colour
Muscovite	8 - 9	6 - 7	4	2.0 – 2.5	Light colour soft flaky mineral
Biotite	15 - 16	18 - 20	3	2.5 – 3.0	Dark colour soft flaky mineral
Chlorite	< 1	< 1	5	2.0 – 2.5	Soft flaky mineral, green
Phlogopite			9		
Sillimanite	< 0.5	< 0.25		6.0 – 7.0	Colourless, transparent, elongated needle & blade like mineral
Magnetite	< 0.5	0.5 - 1		3.5 – 5.0	Shining dark grey, magnetic
Hematite/ limonite	< 1	<0.5		5.0 – 5.5	Earthy reddish brown iron oxide
Ilmenite	Traces	<0.5		5.5 – 6.5	Shining black/ silver grey
Garnet	< 1	1 - 2		6.5 – 7.5	Light pink colure
Tourmaline	0.5	<1		7.0 – 7.5	Fragments of black, green, pink
Other minor	< 4	< 4		--	very fine dust particles, clay and other minerals

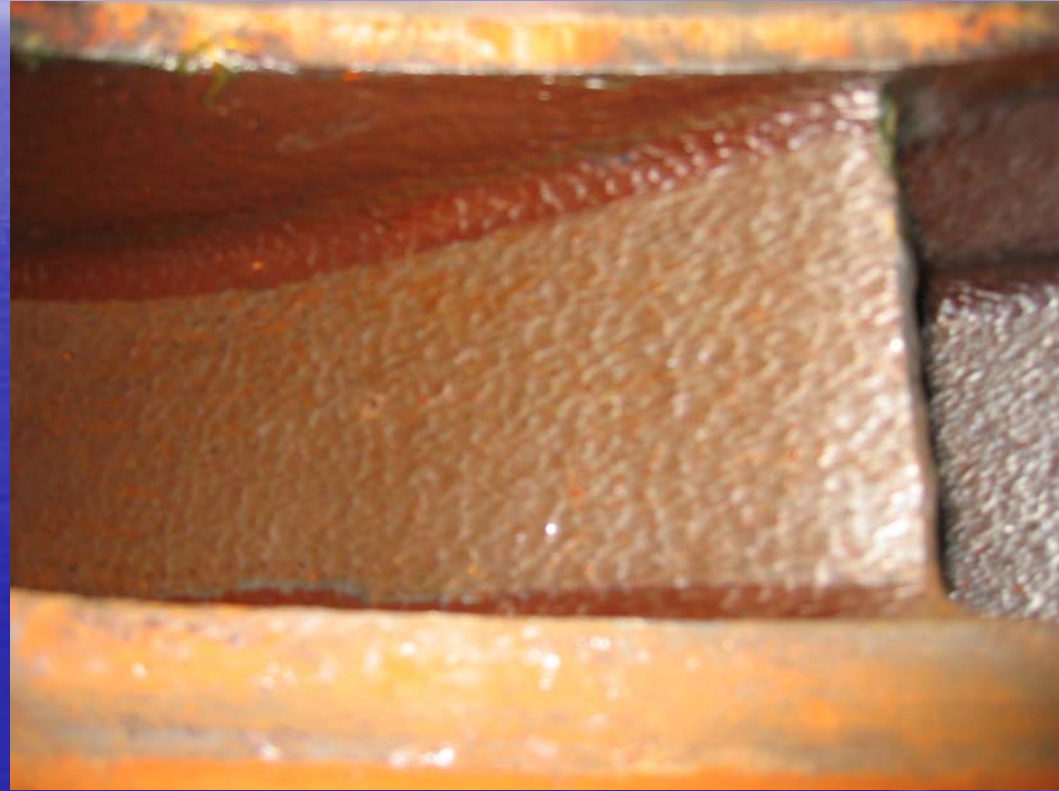
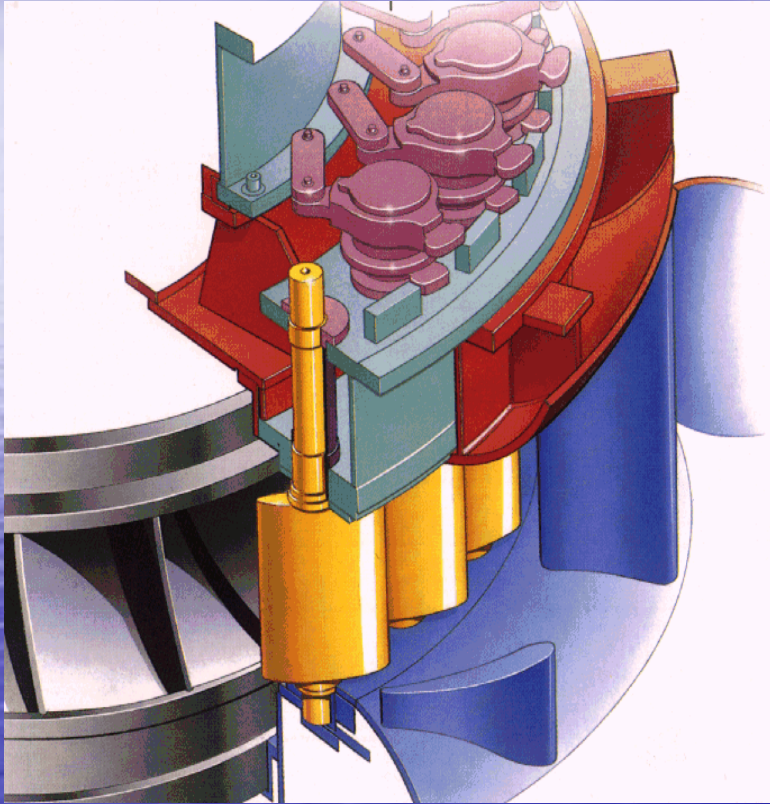
# Quartz content in Nepali rivers



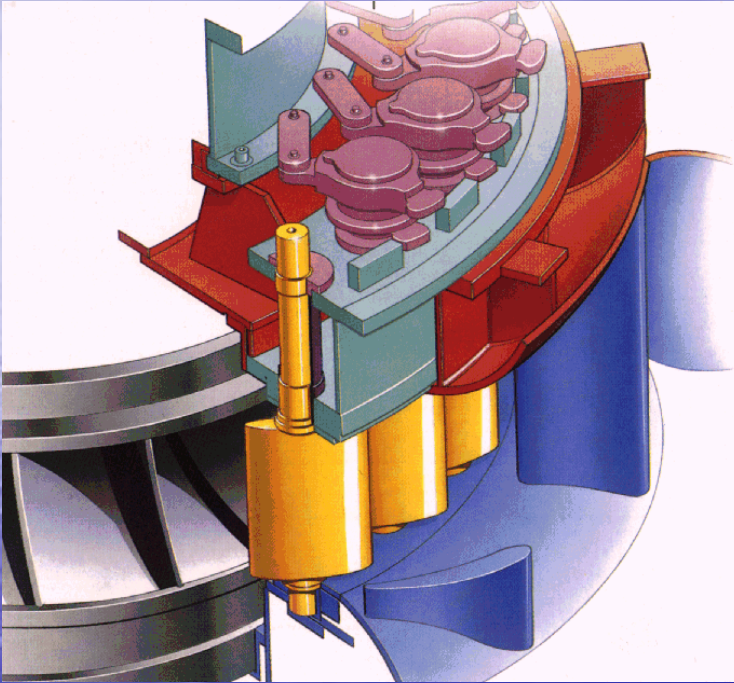
# Erosion in Francis turbine:

- Inlet valve system, spiral casing, bypass valve system, stay vanes, guide vanes, runner vanes, runner shaft seals, draft tube etc.
- Erosion in stay vanes, guide vanes, runner vanes and sealing rings are the most serious sand erosion in Francis turbine.
- Erosion in stay vanes : due to high velocity
- Erosion in guide vanes: due to leakage flow, horseshoe vortex and high velocity
- Erosion in runner vanes: due to horseshoe vortex and high velocity
- Erosion in sealing ring :due to high velocity and acceleration

# Erosion in stay vanes:



# Erosion in guide vanes



# Erosion at the outlet from the runner:



# Erosion at the outlet from the runner



# Objectives

- To calculate the particles trajectories which describe the average behavior of suspended particle and its influence in the fluid flow field
- To calculate the velocity of particles, angle of impact and assess the critical diameter of the particle
- To establish the operating strategy for Francis turbine operating in sand laden water and
- To investigate the relationship between the particle movement and erosion inside the Francis turbine

# Work plan & Resources

- Started in the February 2007 and expected to complete before beginning of 2011
- The PhD candidate is supported by Quota Scheme, State Education Loan Fund for the students from developing countries and EBL Norway.
- The resources and funding needed for the research is water power laboratory.