

Photo 2. Checkpoint No.2 (before Flood)



Photo 3. Checkpoint No.2 (after Flood)

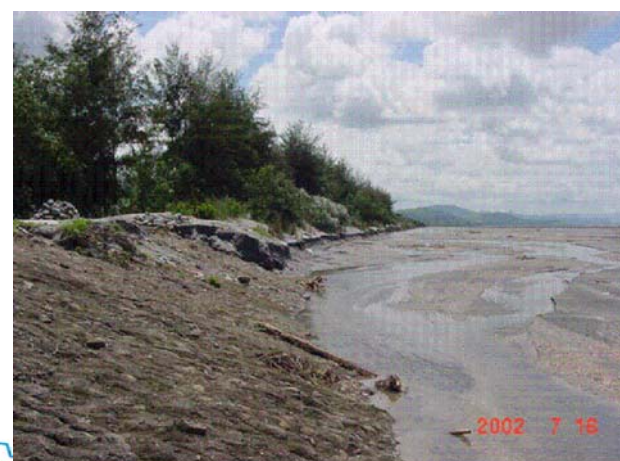


Photo 4. Checkpoint No.3 (before Flood)



Photo 5. Checkpoint No.3 (after Flood)



The existing culvert structure was completely buried due to sediment deposition caused by the lahar in July 2002 (sediment depth: 2 m)

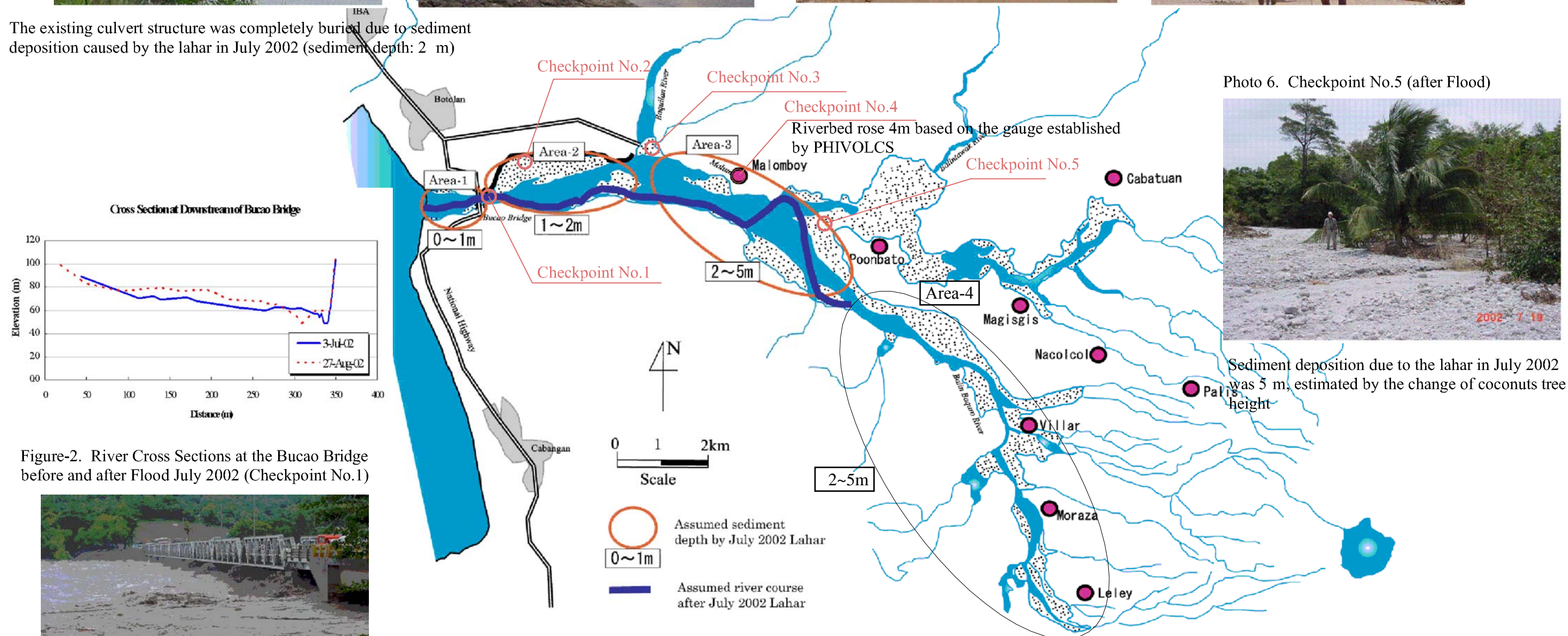


Figure-2. River Cross Sections at the Bucao Bridge before and after Flood July 2002 (Checkpoint No.1)



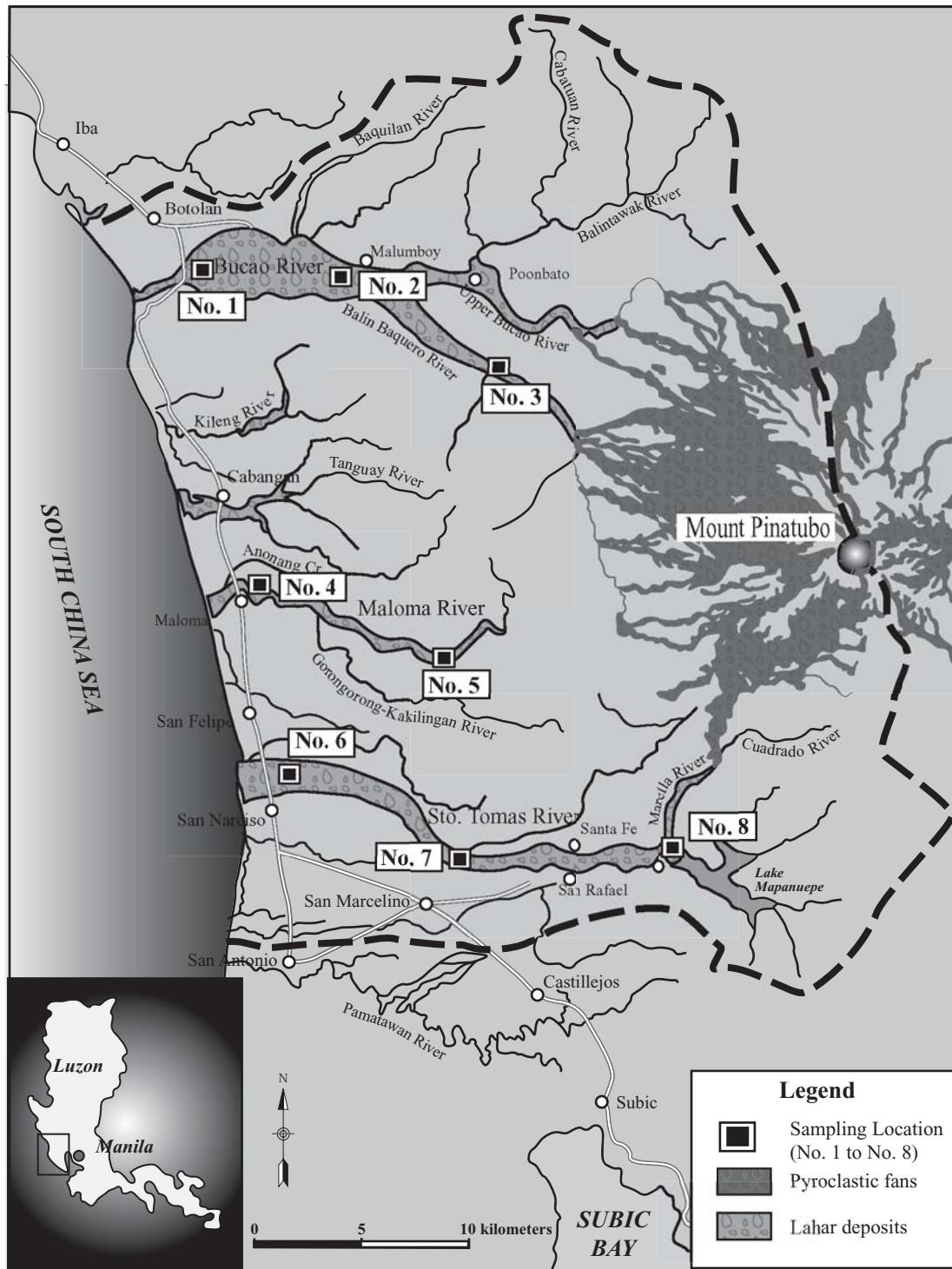
Photo 1. Bucao Bridge during the Lahar on 10 July 2002 (Checkpoint No.1)

Photo 6. Checkpoint No.5 (after Flood)



Sediment deposition due to the lahar in July 2002 was 5 m, estimated by the change of coconuts tree height

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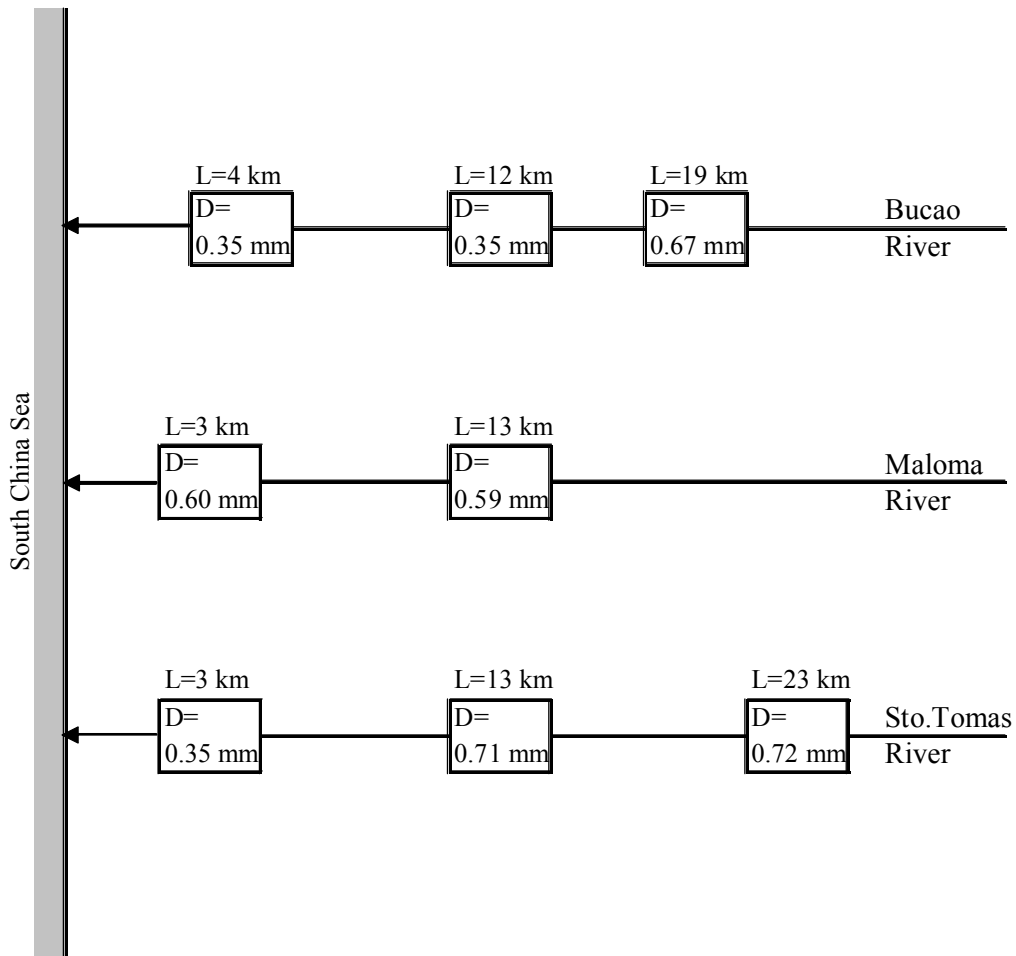
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Figure 2.1.1

Location Map for Riverbed Material Sampling



Note : L= Distance from River-mouth
D = Mean Grain Size

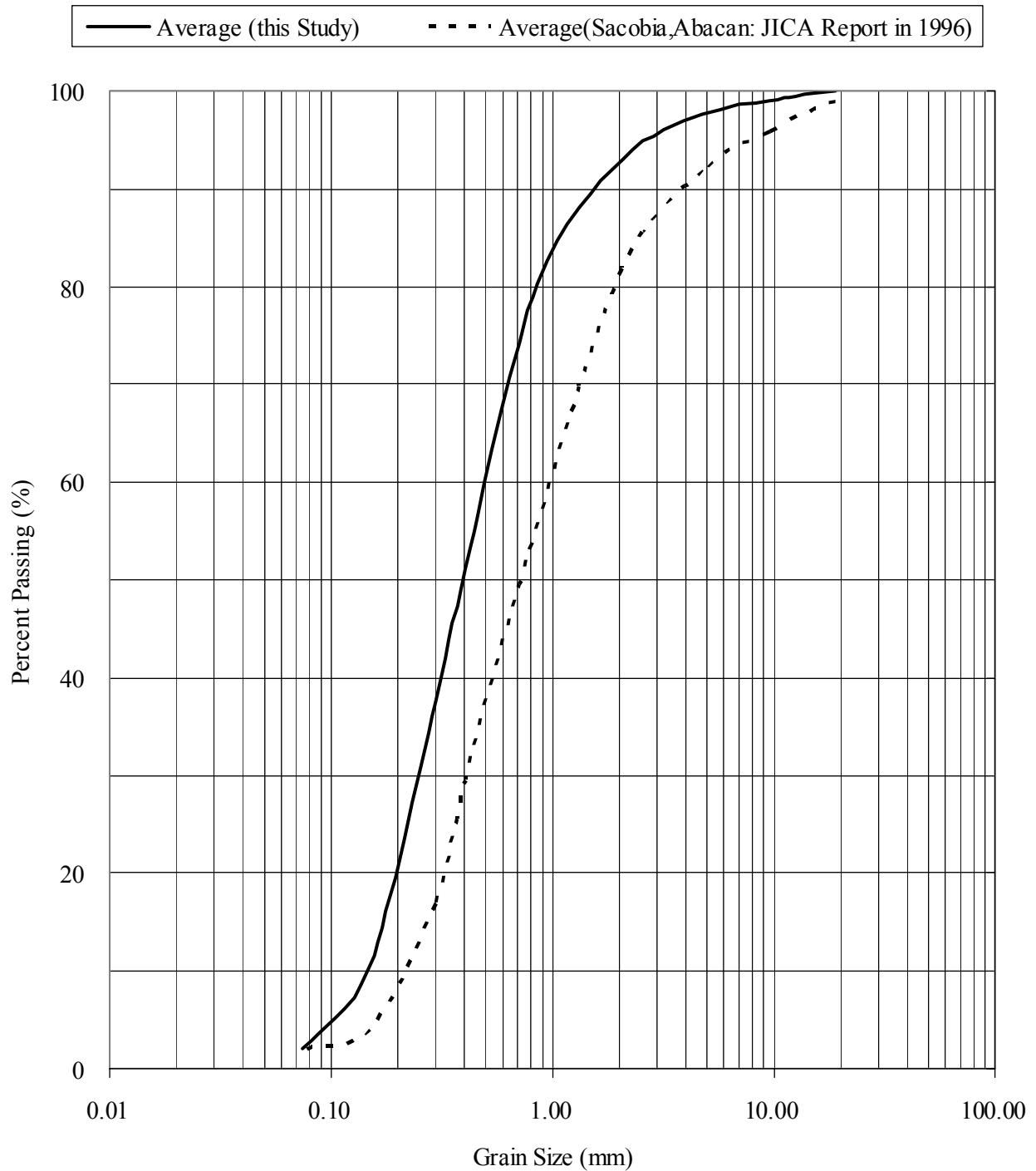
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Figure 2.1.2

Grain Size of Riverbed Materials in the Study Area



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Figure 2.1.3

**Comparison of Grain Size Distribution of
Riverbed Materials**

Data Input

Grain Size of Riverbed Material : D(cm)

Specific Gravity of Grain : S=2.60

Bed Slope : I

Roughness Coefficient : n=0.030

Flow Discharge : Q(m³/sec)

$$g = 9.8 \text{ m/sec}^2$$

$$s = S - 1 = 1.6$$

$$d \text{ (m)} = D \text{ (cm)} / 100$$

Hydraulic Calculation

Flow Width : B(m)
using Regime Formula
 $B = 7 Q^{0.5}$ (B ≤ River Width)

Flow Depth : H(m)
using Manning's Formula
 $H = (nQ/B)^{0.5} / I^{0.6}$

Tractive Force : U*² (m²/sec²)
 $U_*^2 = gHI$

Critical Tractive Force : U*_c (m²/sec²)
using Iwagaki's Formula
 $U_{*c}^2 = 8.41D^{11/32} / 10,000$
(for D < 0.0565 cm)
 $U_{*c}^2 = 55.0D / 10,000$
(for 0.0565 cm < D)

Decision: $U_*^2 > U_{*c}^2$
Yes / No

Qb = 0

Sediment Transport Discharge : Qb (m³/s)
using Brown's Formula
 $Qb = 10(U_*^2 / gsd)^{2.5} * (gsd)^{0.5} * dB$

Daily Flow Duration Curve

Stepwise Approximation

Annual Volume

Annual Sediment Transport Volume : Vo (m³/year)
 $Vo = \text{Sum}(Qb * \text{Days} * 86,400)$

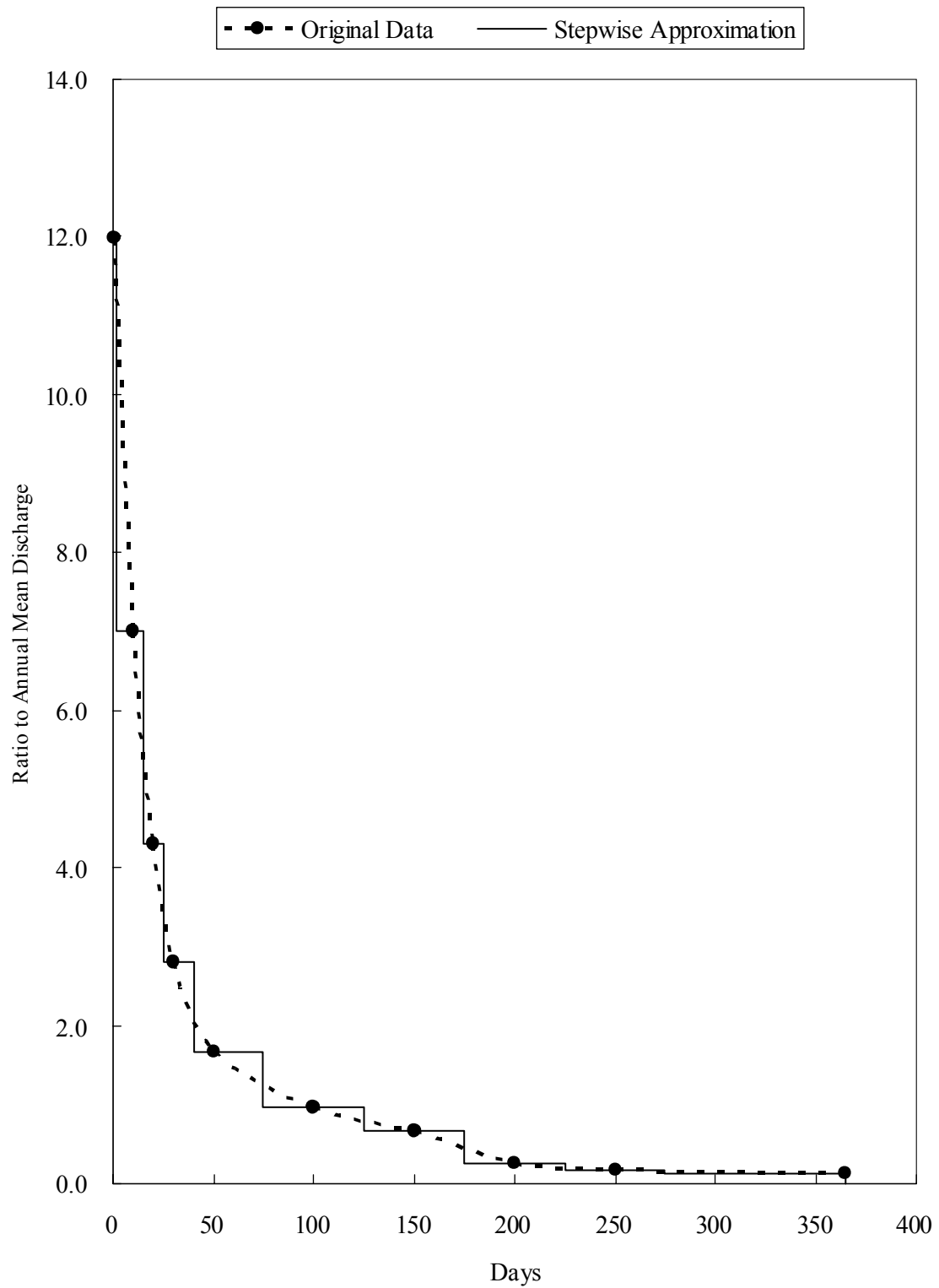
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Figure 2.2.1

Flow Chart of Calculation of Annual Sediment Transport



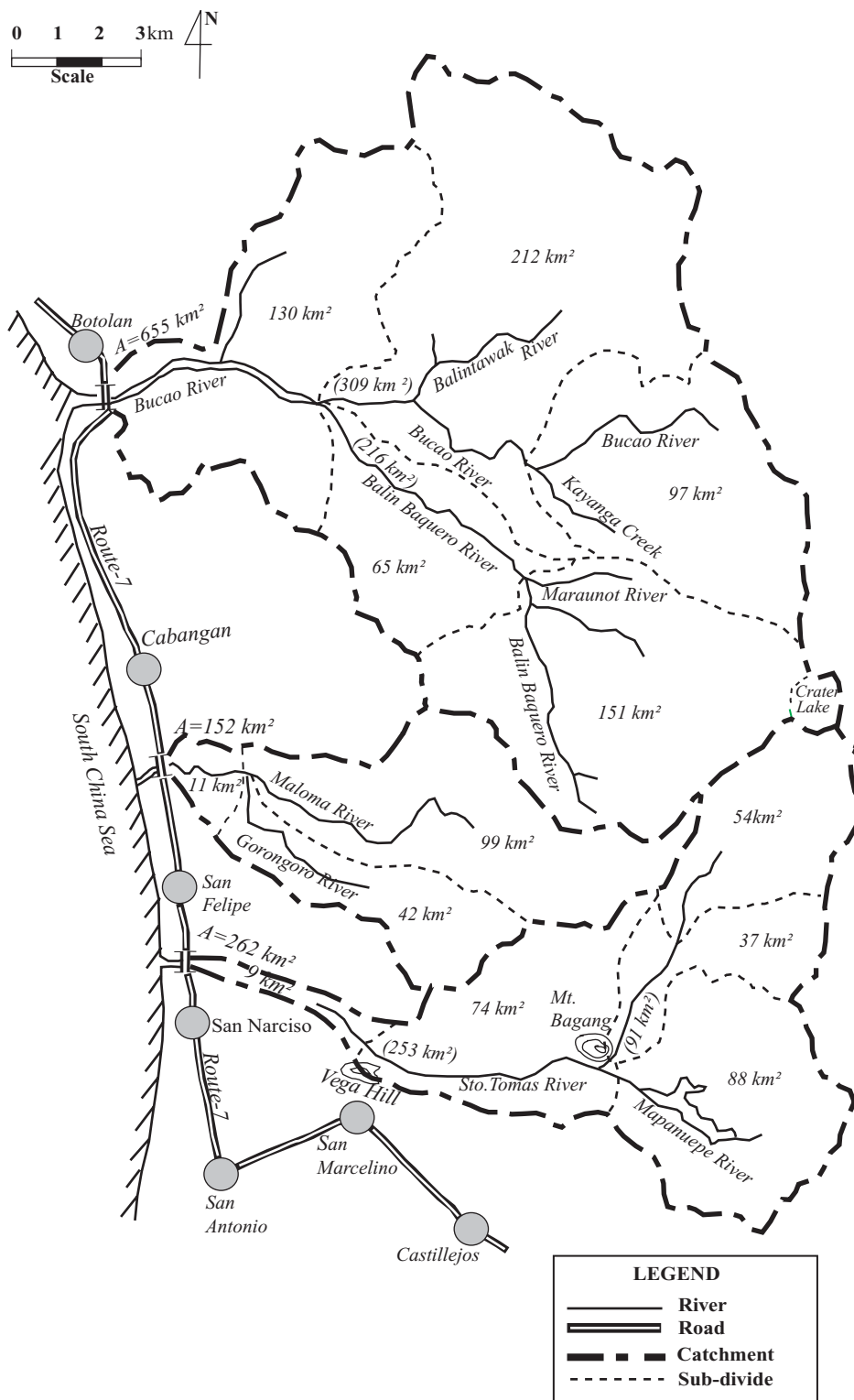
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Figure 2.2.2

Stepwise Approximation of Duration Curve



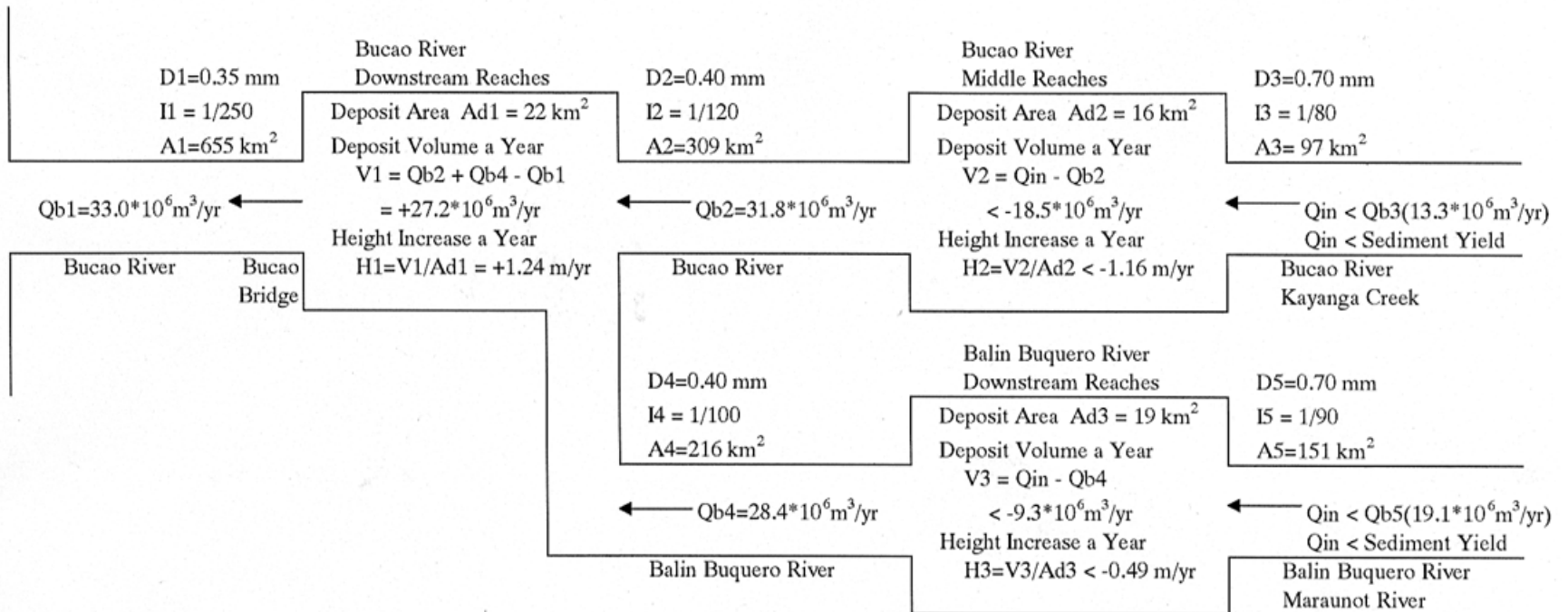
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Figure 2.2.3

**Sub-Division of River Basins for Annual
Sediment Balance Analysis**



Note : D= Grain Size of Riverbed Material, I = Bed Slope, A= Catchment Area
Qb= Sediment Transport Capacity by Water Flow (using Brown's Formula)