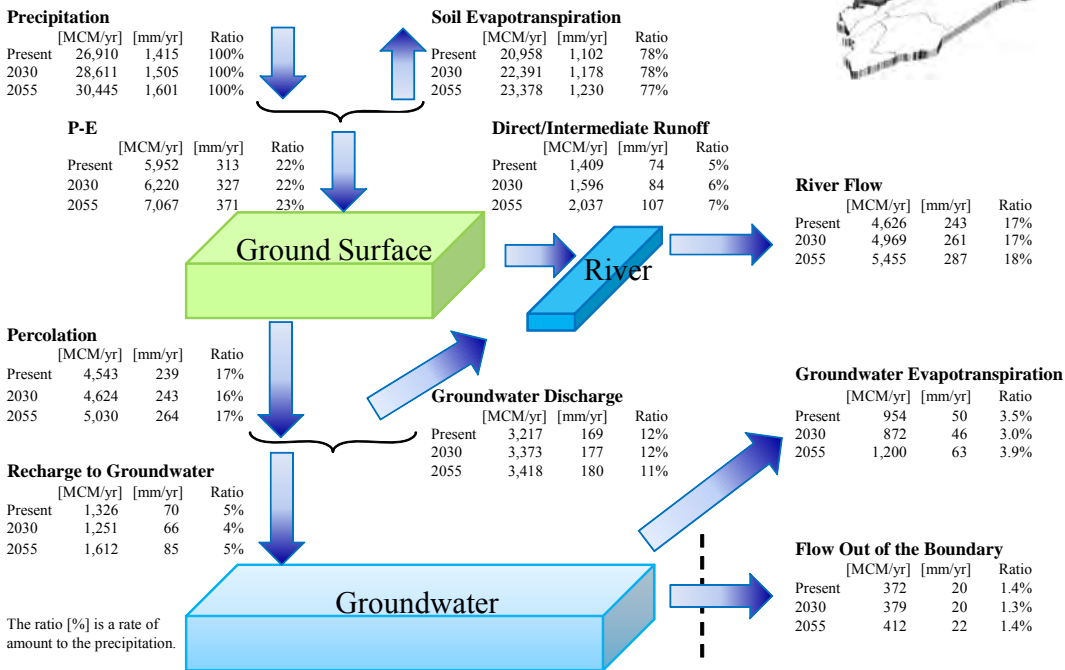
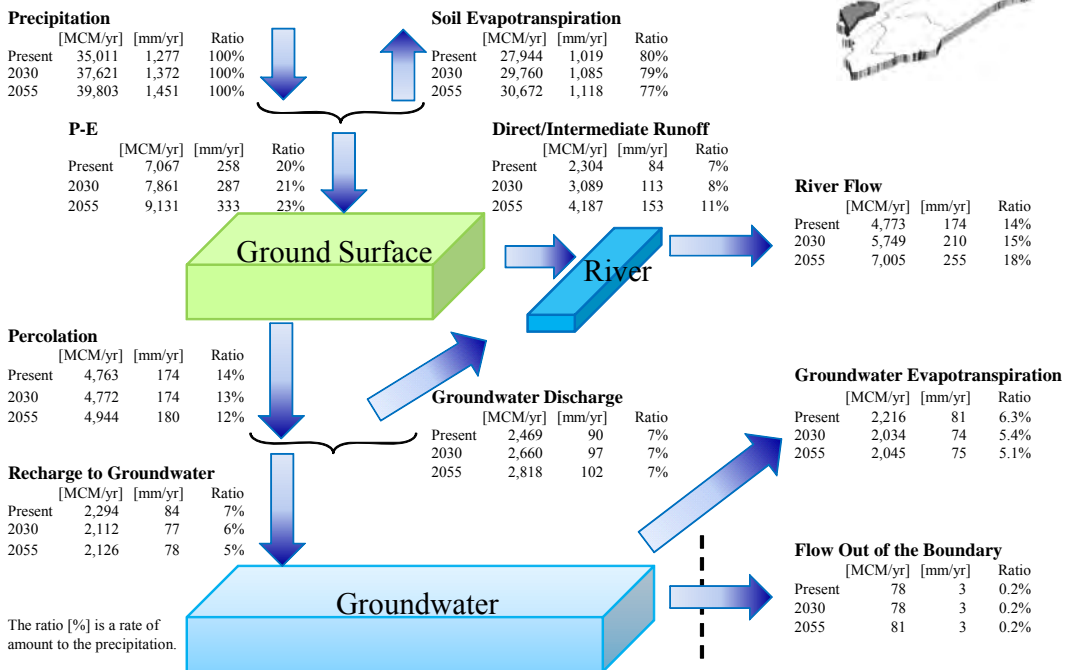


Water Budget of Lake Victoria North



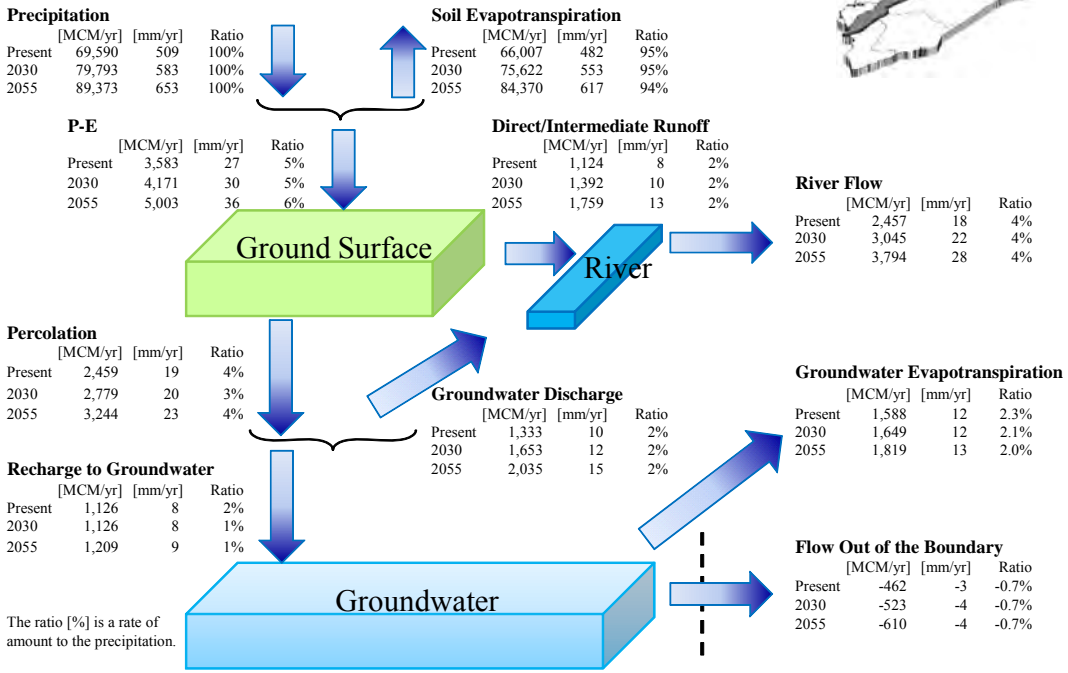
Water Budget of Lake Victoria South



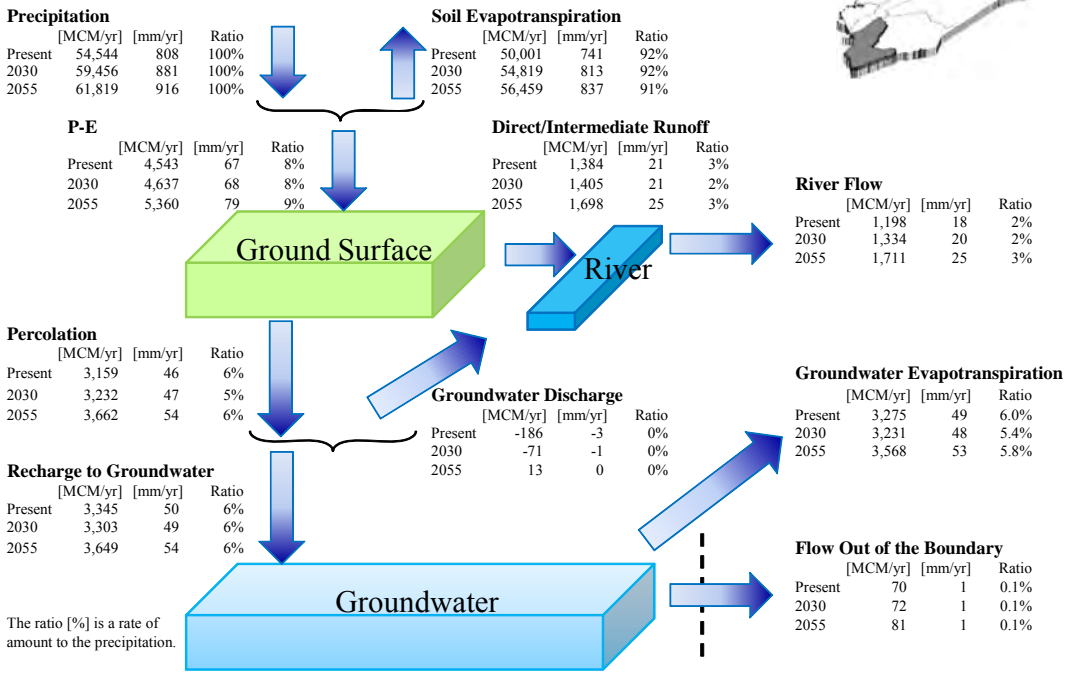
Source: JICA Study Team

<p>THE DEVELOPMENT OF THE NATIONAL WATER MASTER PLAN 2030</p>	<p>Figure 5.5.1 Annual Water Budget (Hamon Method) (1/4)</p>
<p>JAPAN INTERNATIONAL COOPERATION AGENCY</p>	

Water Budget of Rift Valley



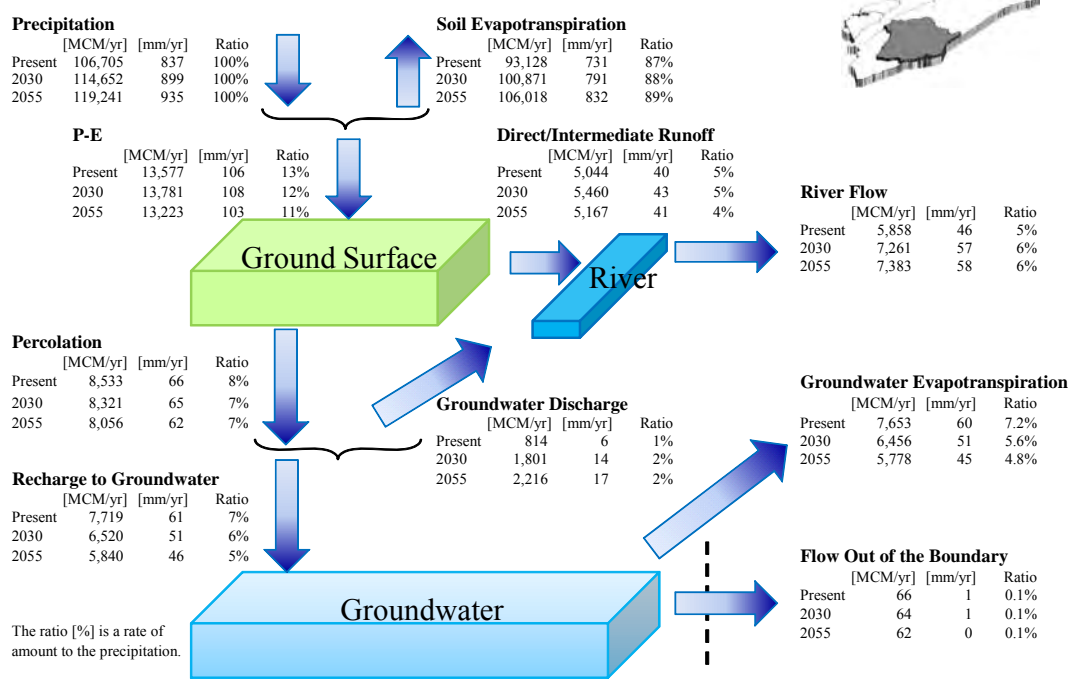
Water Budget of Athi



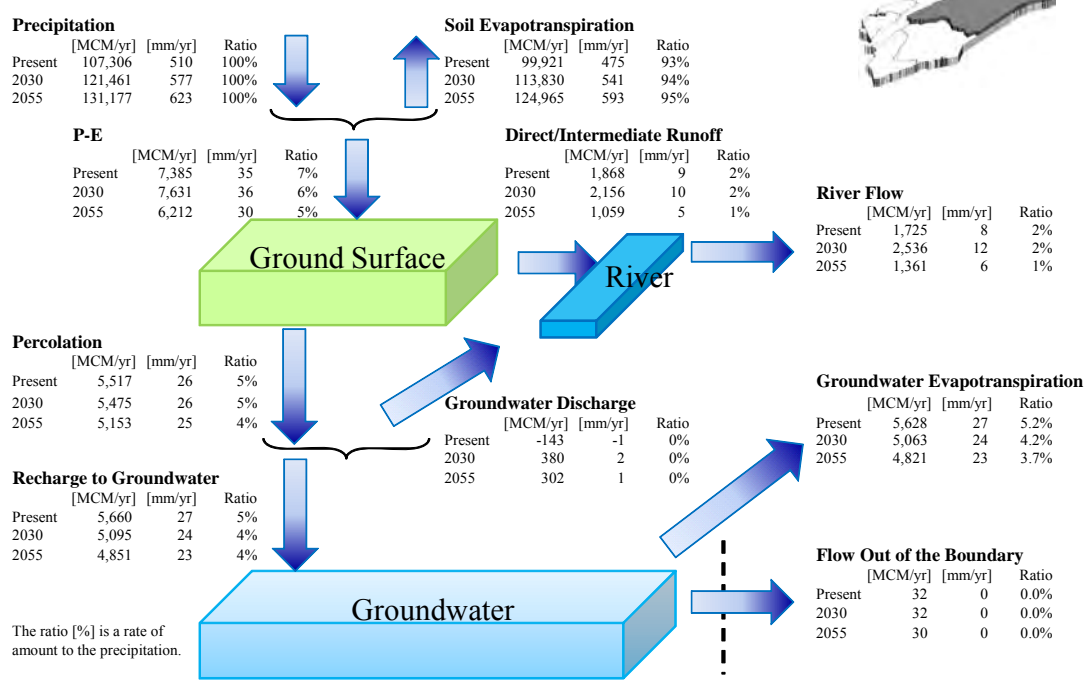
Source: JICA Study Team

<p>THE DEVELOPMENT OF THE NATIONAL WATER MASTER PLAN 2030</p> <p>JAPAN INTERNATIONAL COOPERATION AGENCY</p>	<p>Figure 5.5.1 Annual Water Budget (Hamon Method) (2/4)</p>
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Water Budget of Tana



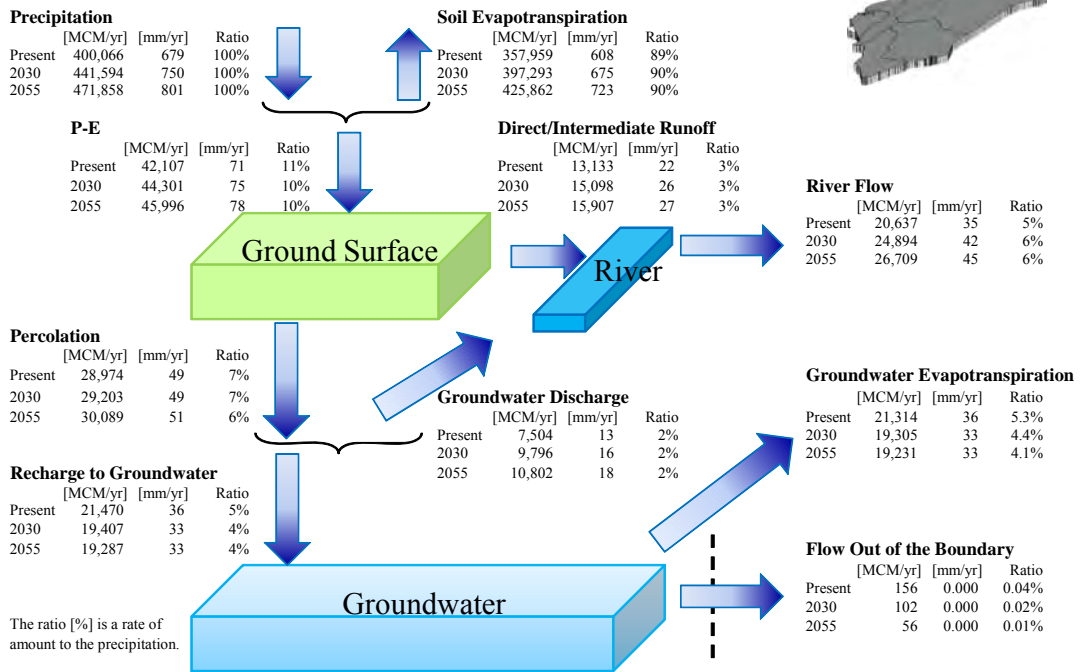
Water Budget of Ewaso Ng'iro North



Source: JICA Study Team

THE DEVELOPMENT OF THE NATIONAL WATER MASTER PLAN 2030	Figure 5.5.1 Annual Water Budget (Hamon Method) (3/4)
JAPAN INTERNATIONAL COOPERATION AGENCY	

Water Budget of Whole Country



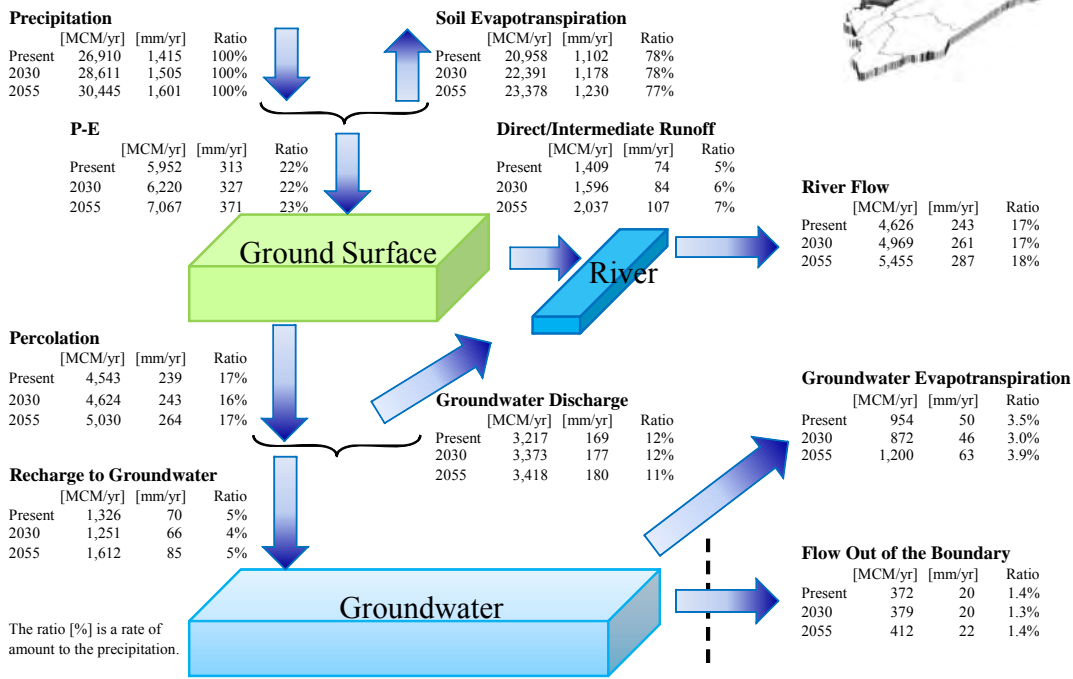
Source: JICA Study Team

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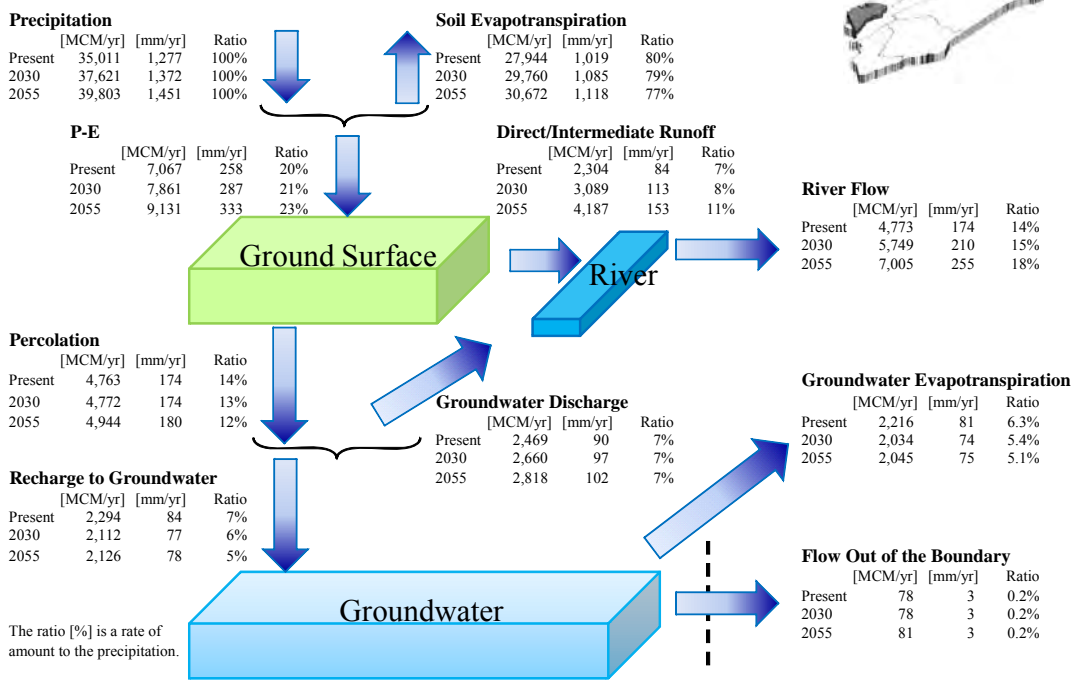
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**Figure 5.5.1
Annual Water Budget
(Hamon Method) (4/4)**

Water Budget of Lake Victoria North



Water Budget of Lake Victoria South



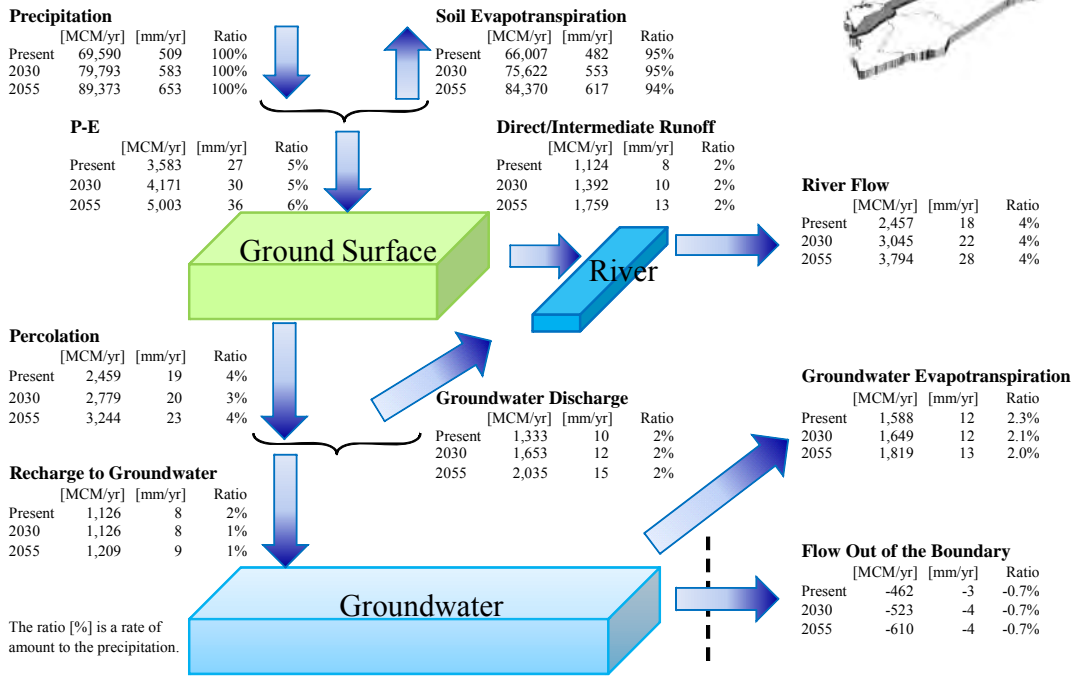
Source: JICA Study Team

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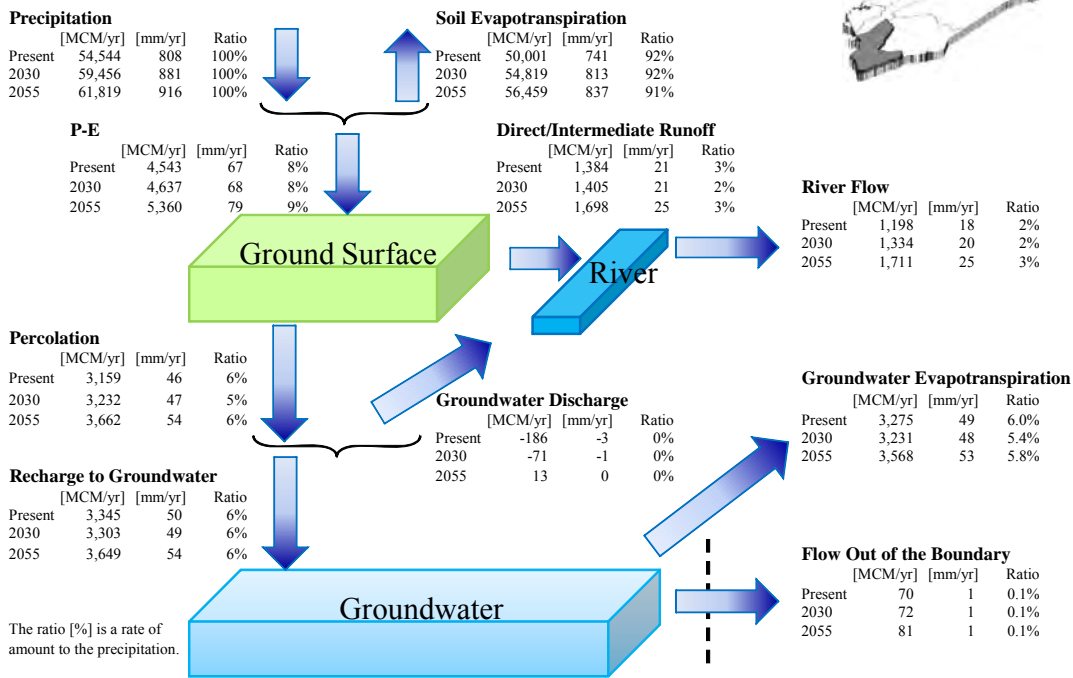
JAPAN INTERNATIONAL COOPERATION AGENCY

**Figure 5.5.2
Annual Water Budget
(FAO Penman – Monteith Method) (1/4)**

Water Budget of Rift Valley

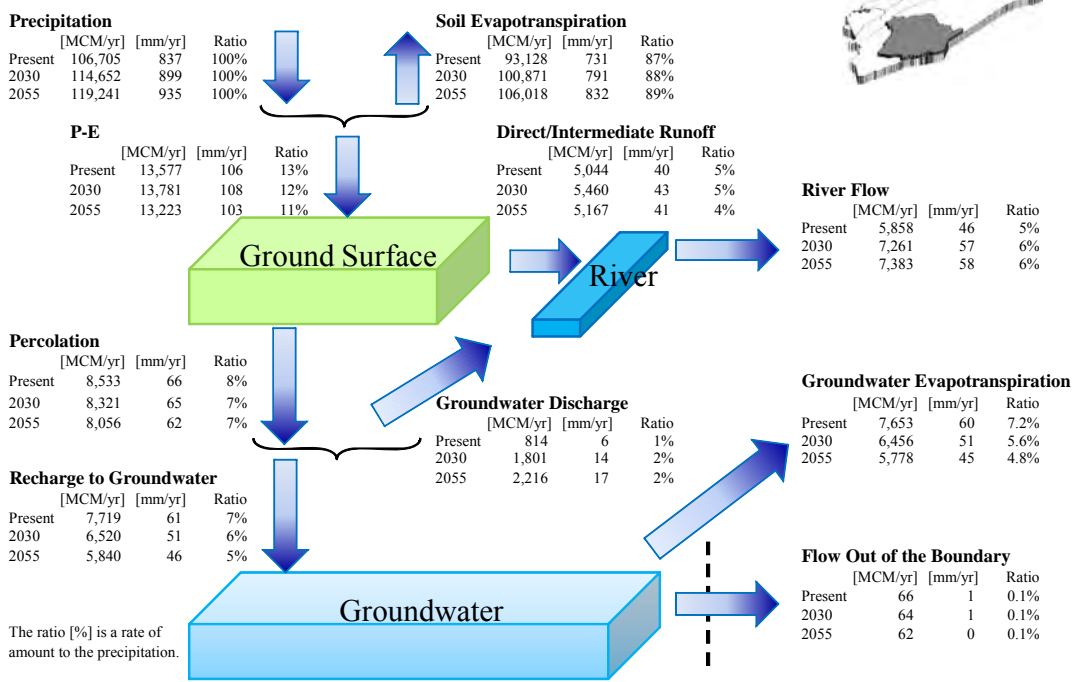


Water Budget of Athi

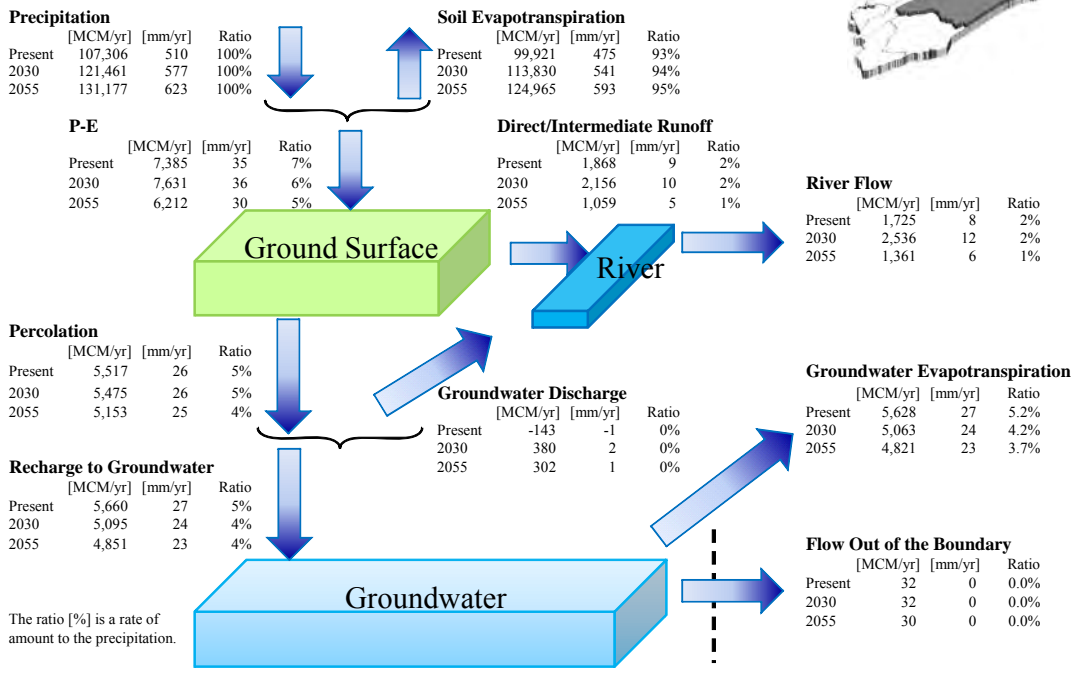


Source: JICA Study Team

Water Budget of Tana



Water Budget of Ewaso Ng'iro North



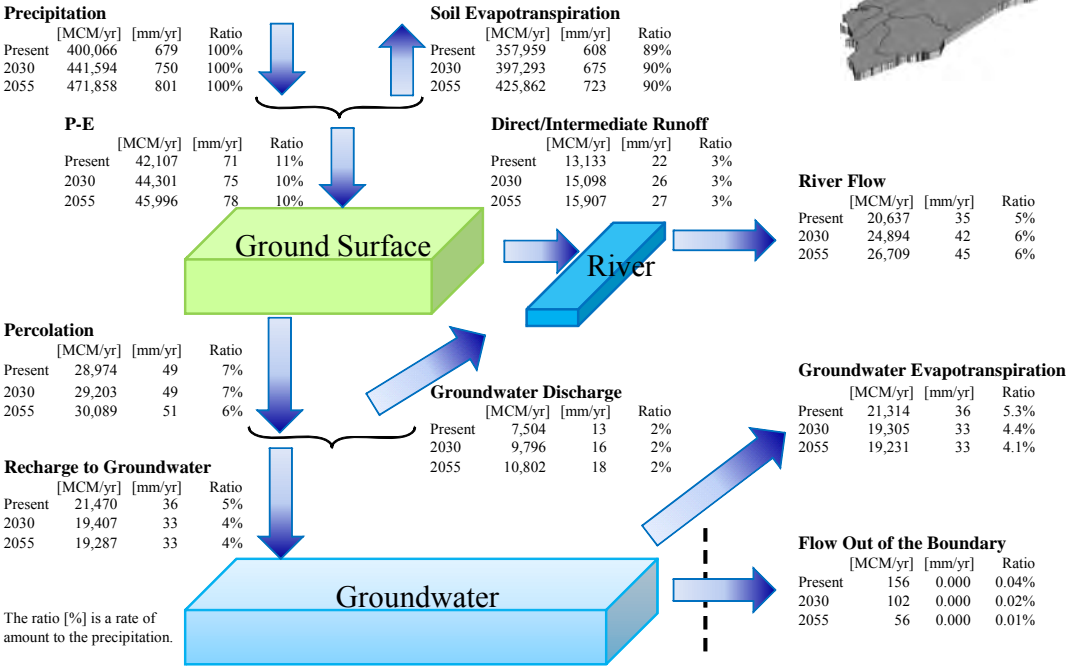
Source: JICA Study Team

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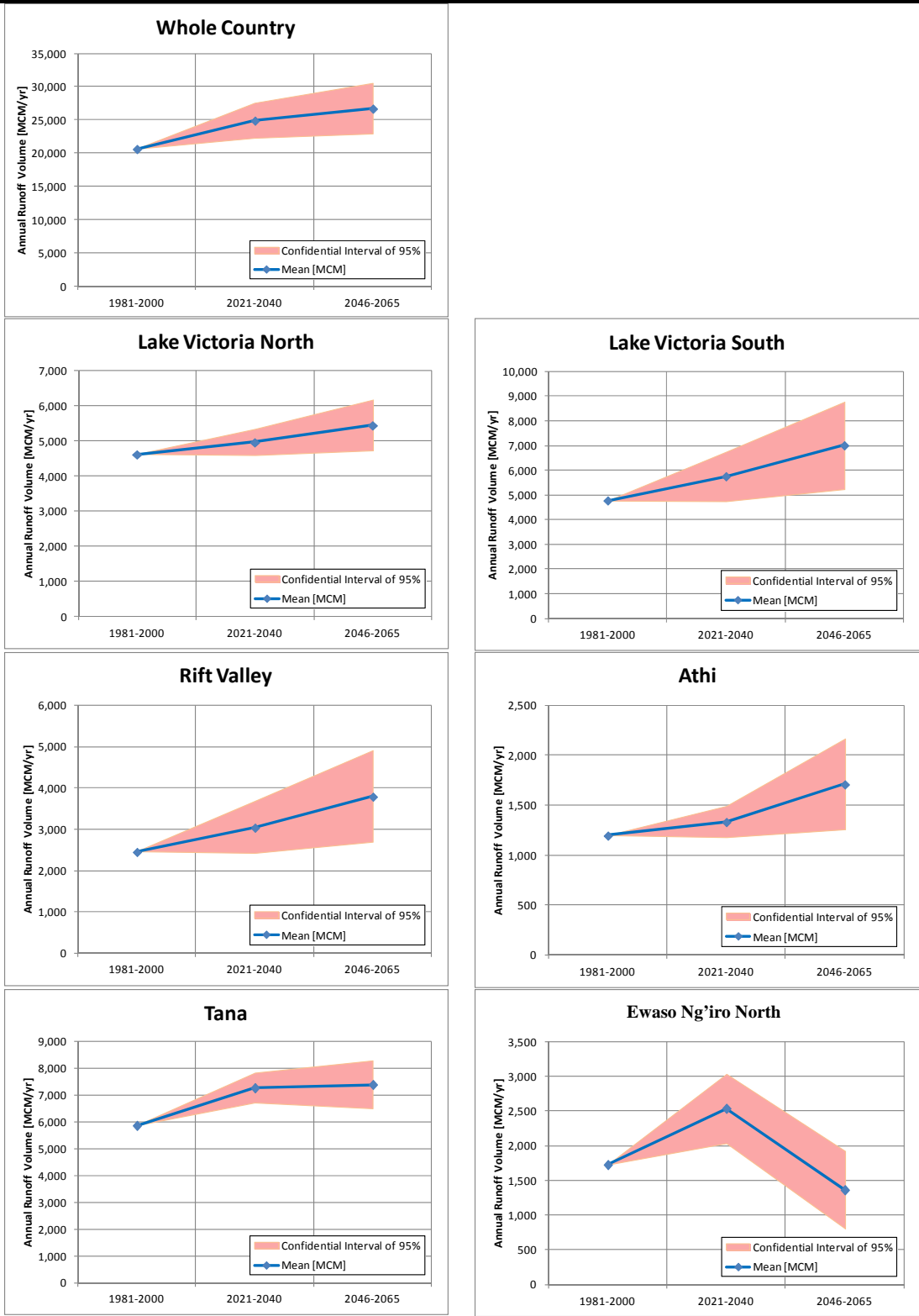
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**Figure 5.5.2
Annual Water Budget
(FAO Penman – Monteith Method) (3/4)**

Water Budget of Whole Country



Source: JICA Study Team

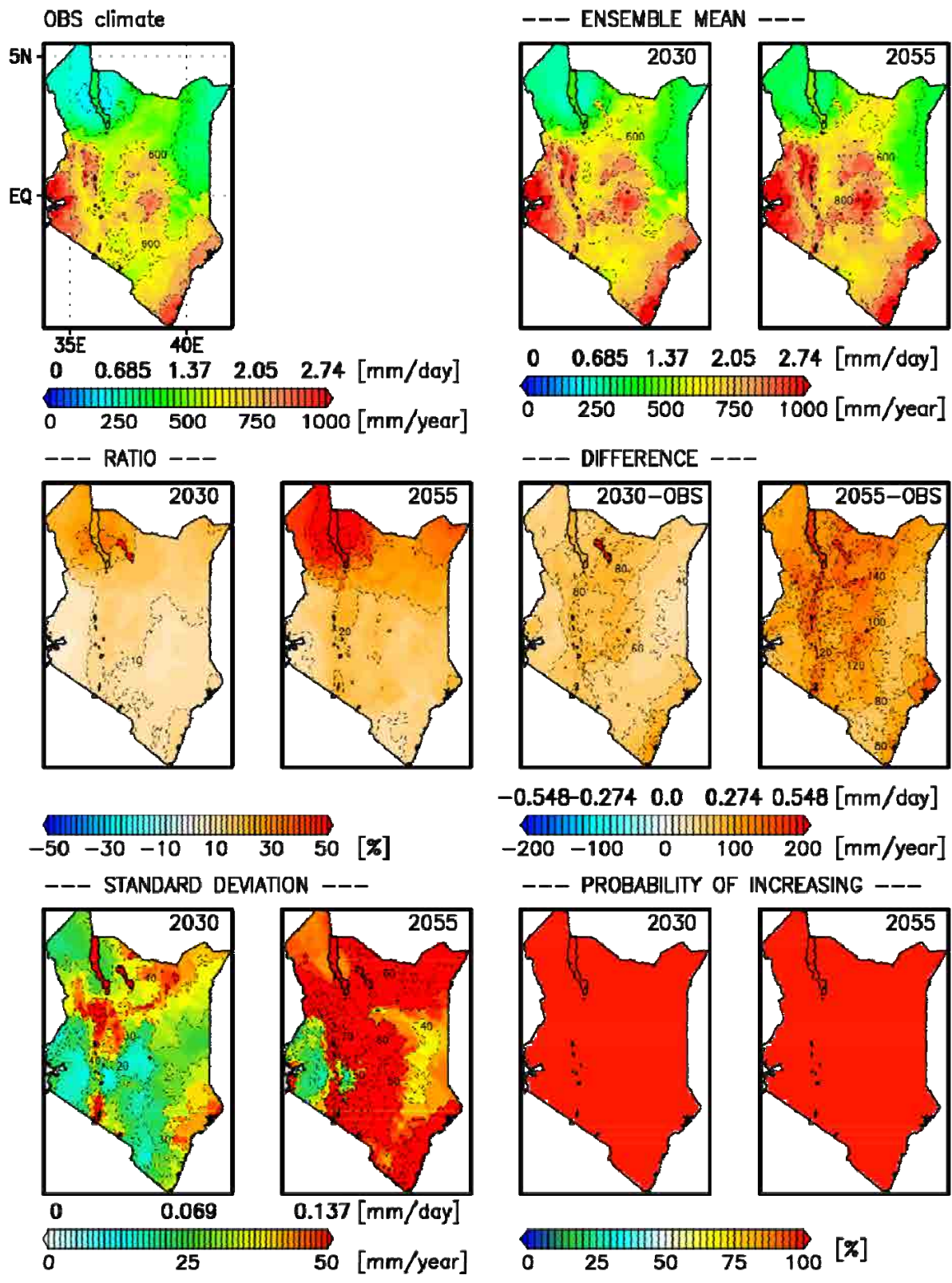


Source: JICA Study Team

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**Figure 5.5.3
Change of Rate of Annual Runoff Volume
(Based on 1981-2000)**

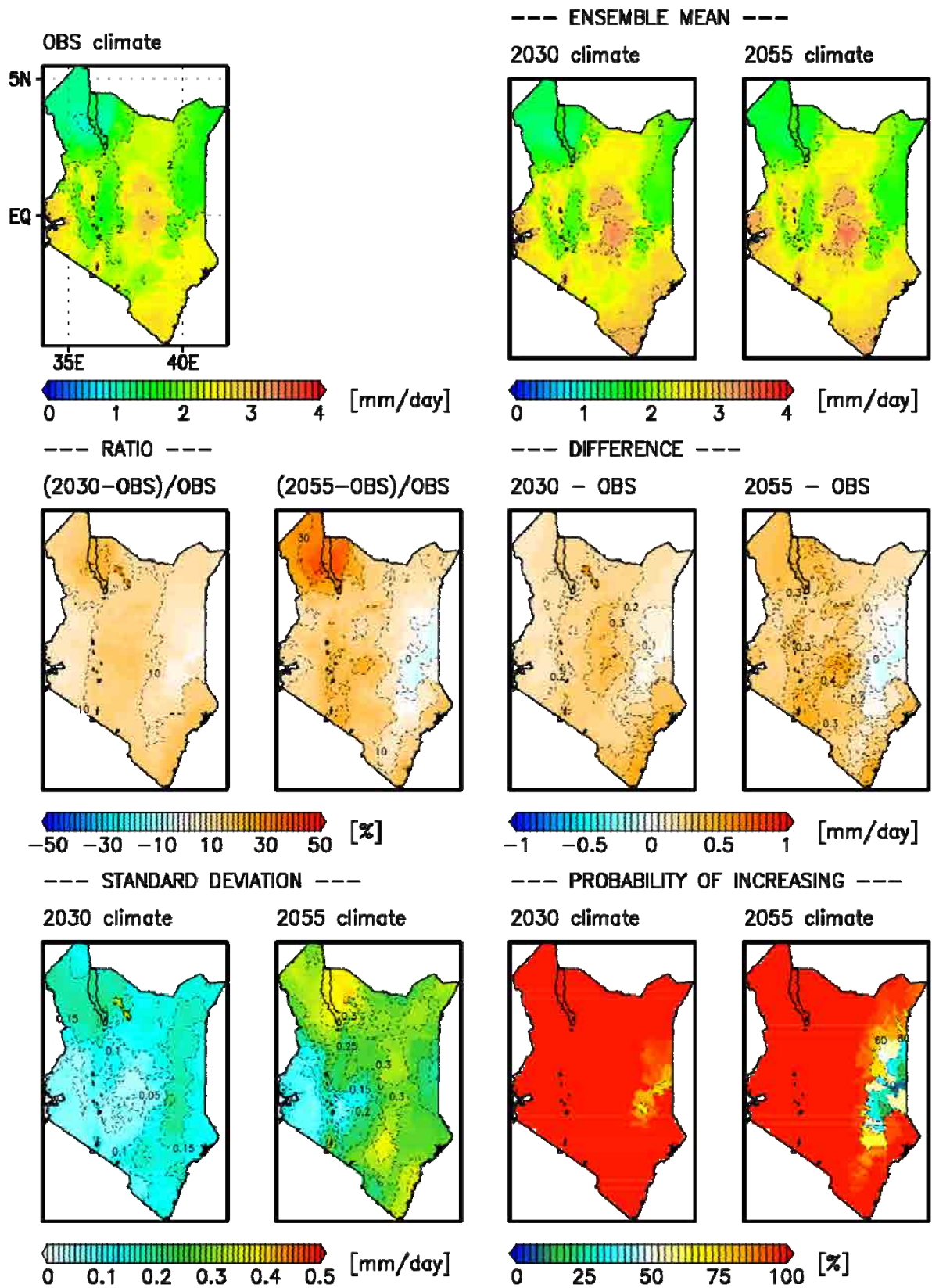


Source: JICA Study Team

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Figure 5.5.4
Spatial Distribution of
Mean Annual SET
(Hamon Method)

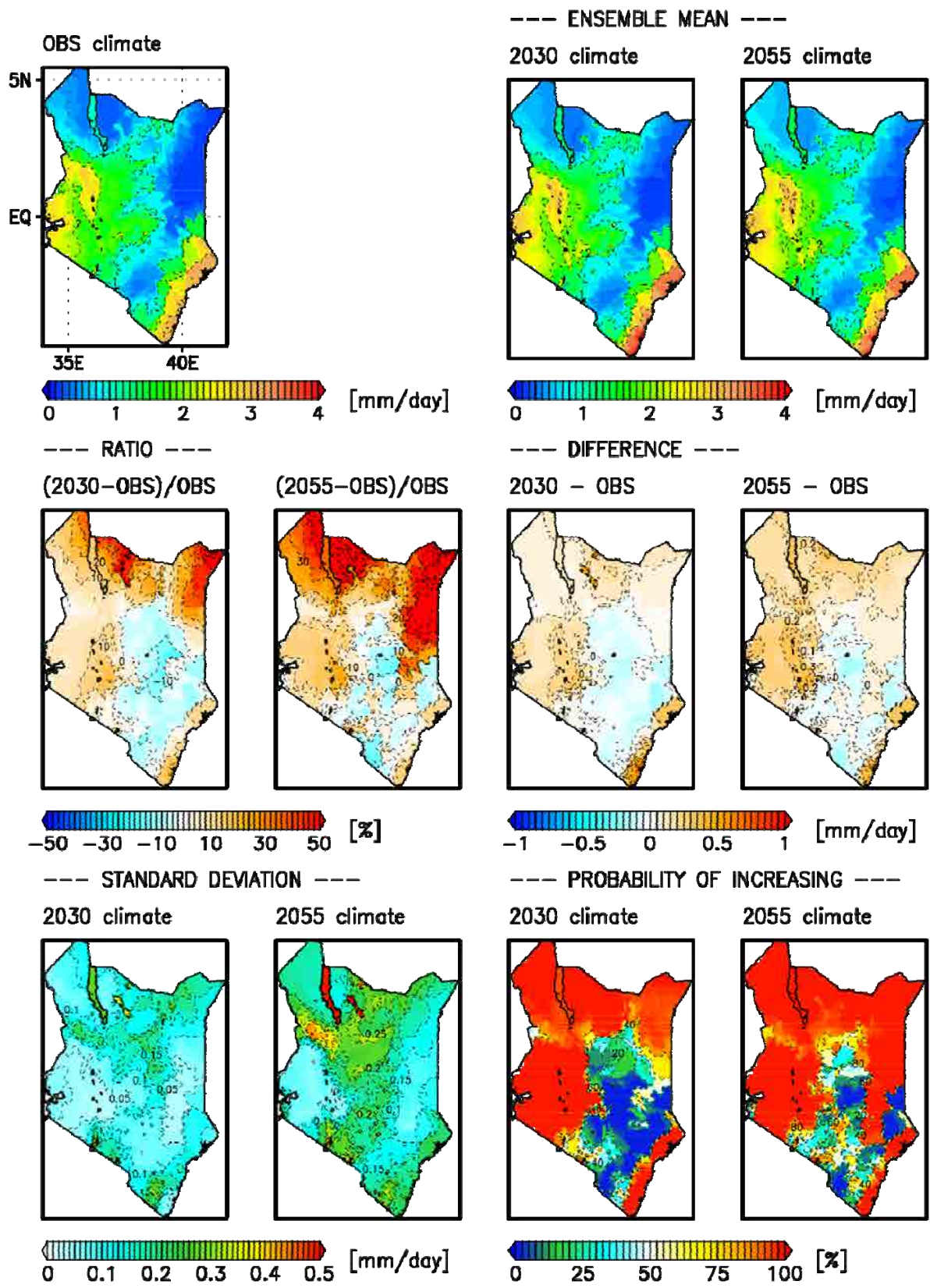


Source: JICA Study Team

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Figure 5.5.5
Spatial Distribution of
Mean Seasonal SET
(MAM, Hamon Method)

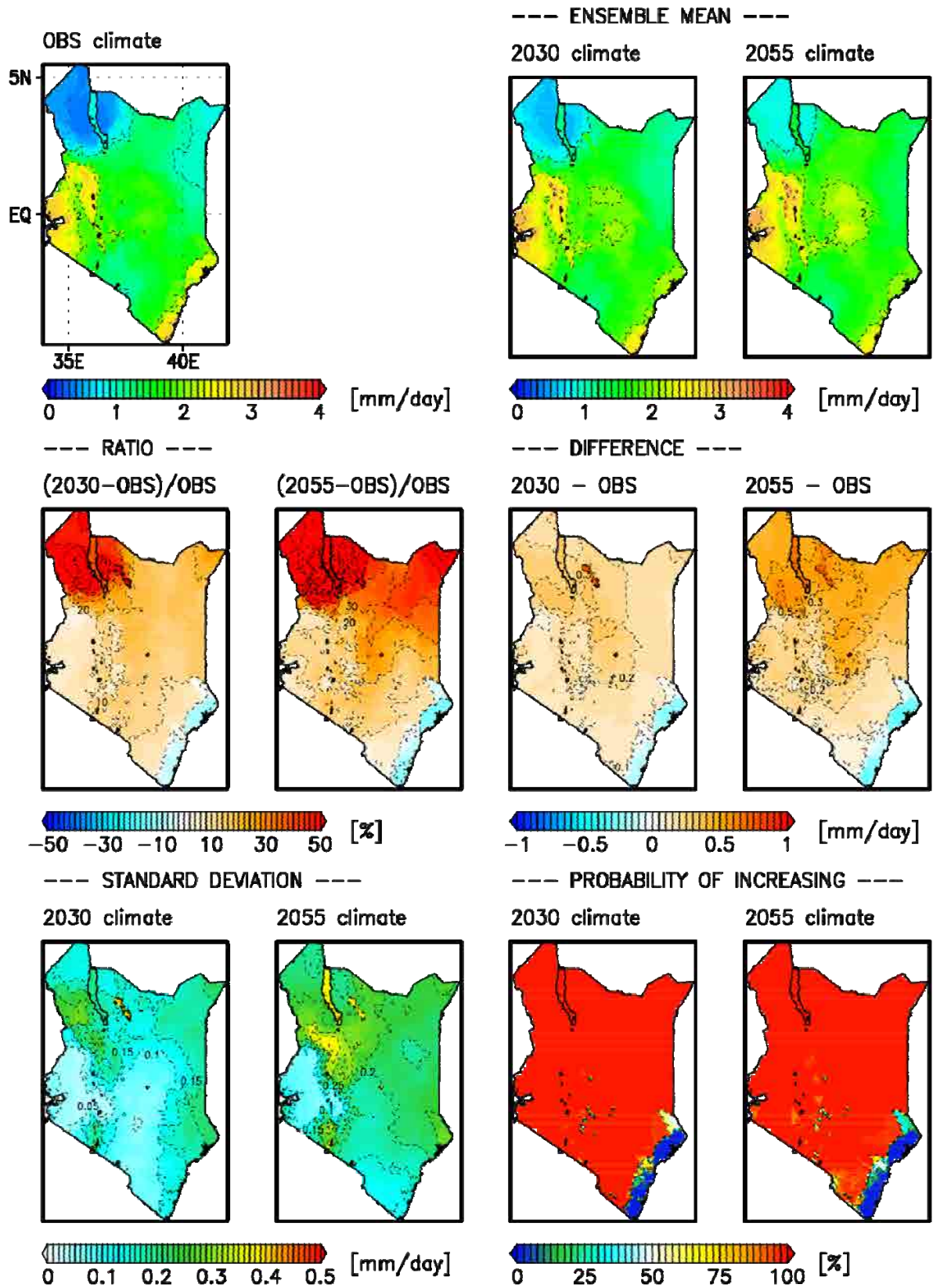


Source: JICA Study Team

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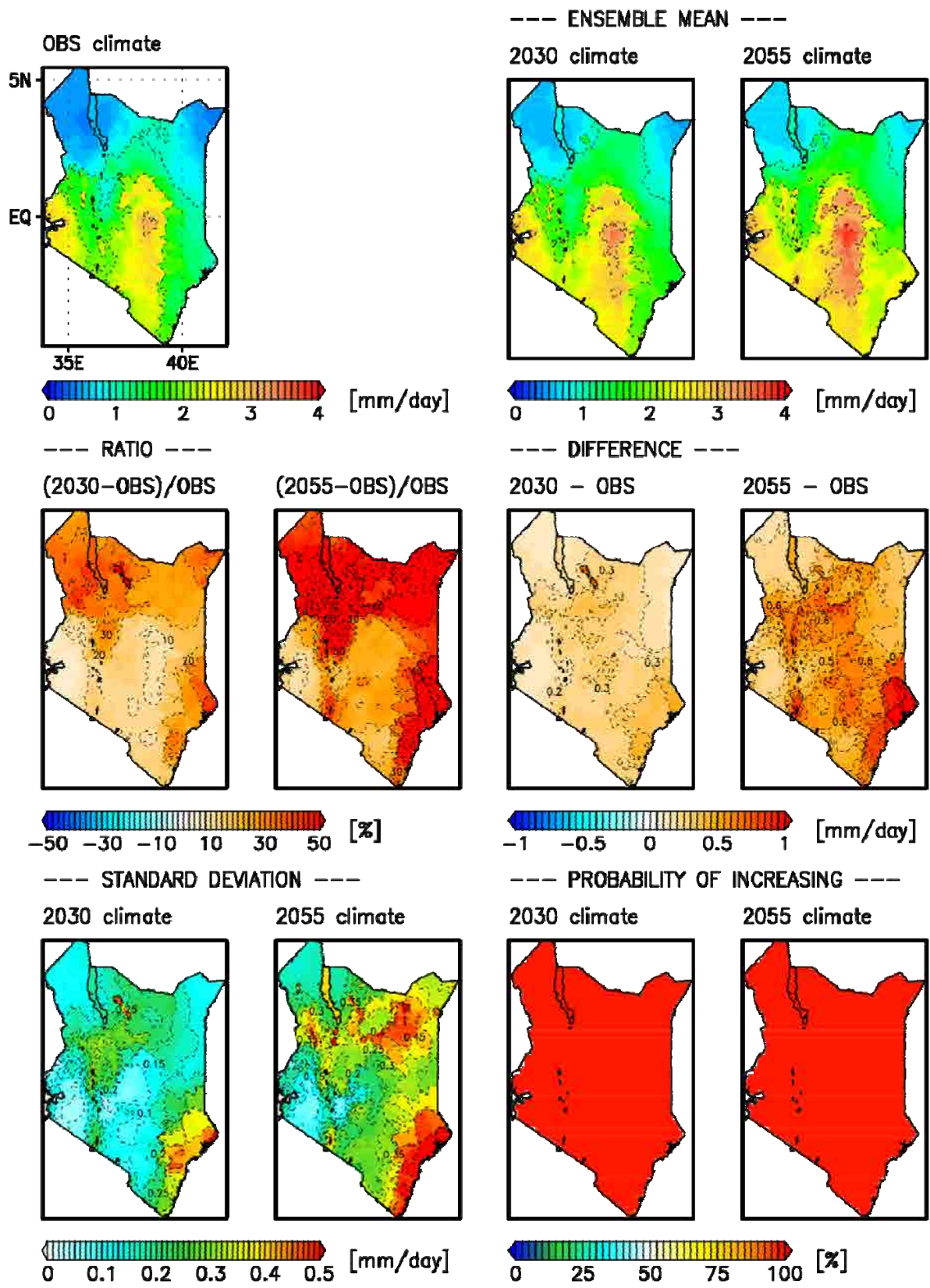
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Figure 5.5.6
Spatial Distribution of
Mean Seasonal SET
(JJA, Hamon Method)



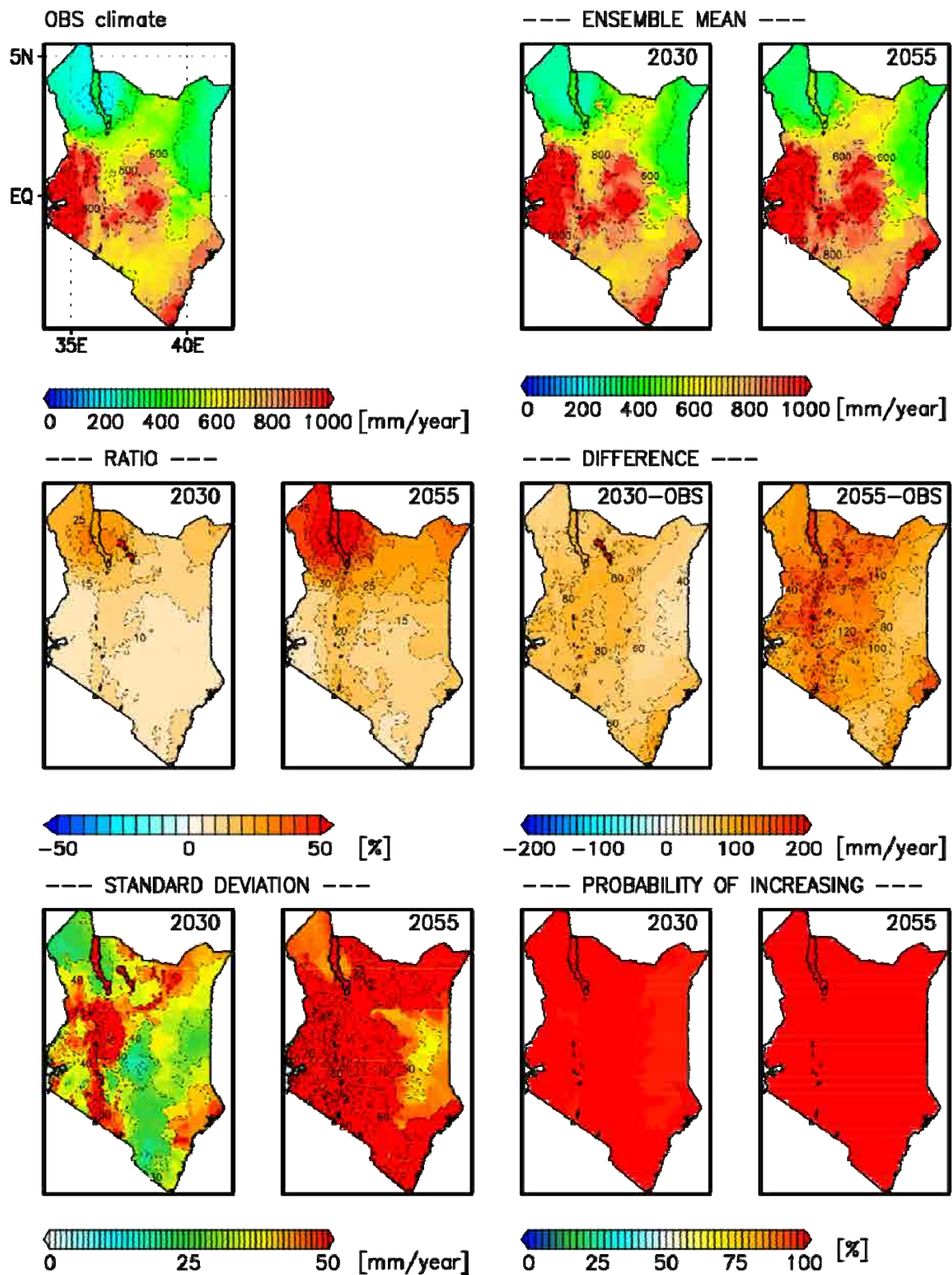
Source: JICA Study Team

Figure 5.5.7
Spatial Distribution of
Mean Seasonal SET
(SON, Hamon Method)



Source: JICA Study Team

Figure 5.5.8
Spatial Distribution of
Mean Seasonal SET
(DJF, Hamon Method)

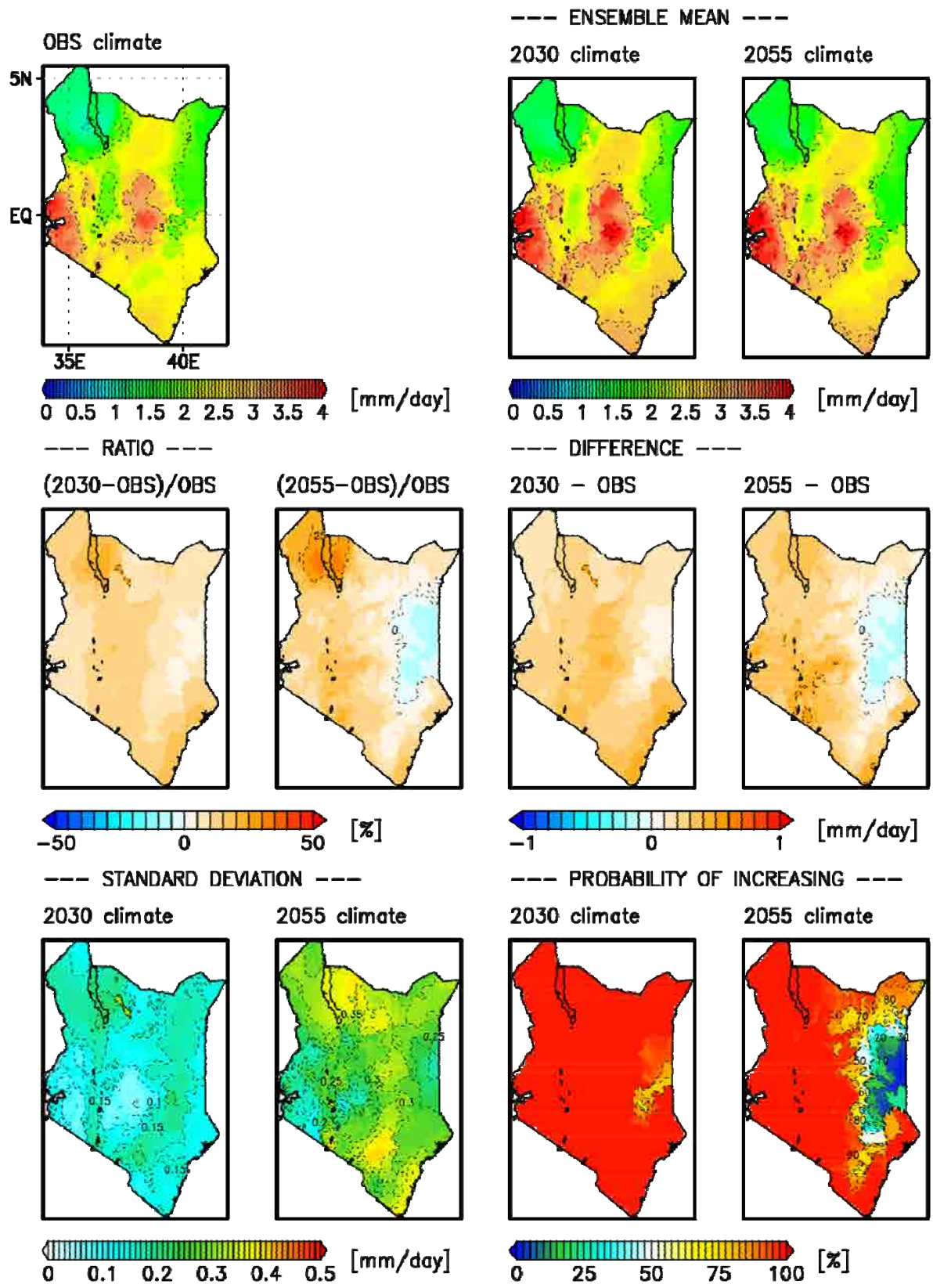


Source: JICA Study Team

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Figure 5.5.9
Spatial Distribution of Mean Annual SET
(FAO Penman – Monteith Method)

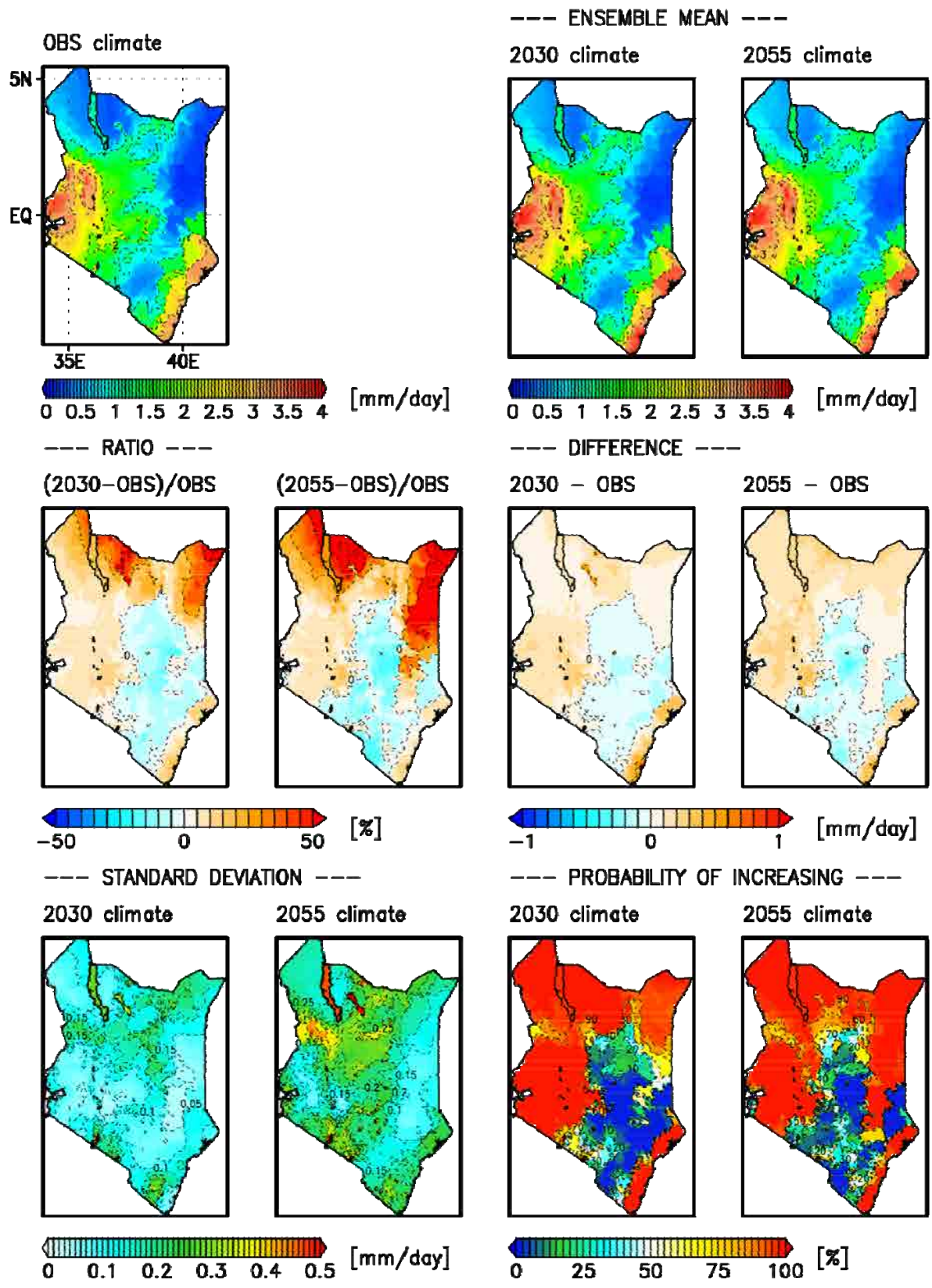


Source: JICA Study Team

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Figure 5.5.10
Spatial Distribution of
Mean Seasonal SET
(MAM, FAO Penman – Monteith
Method)

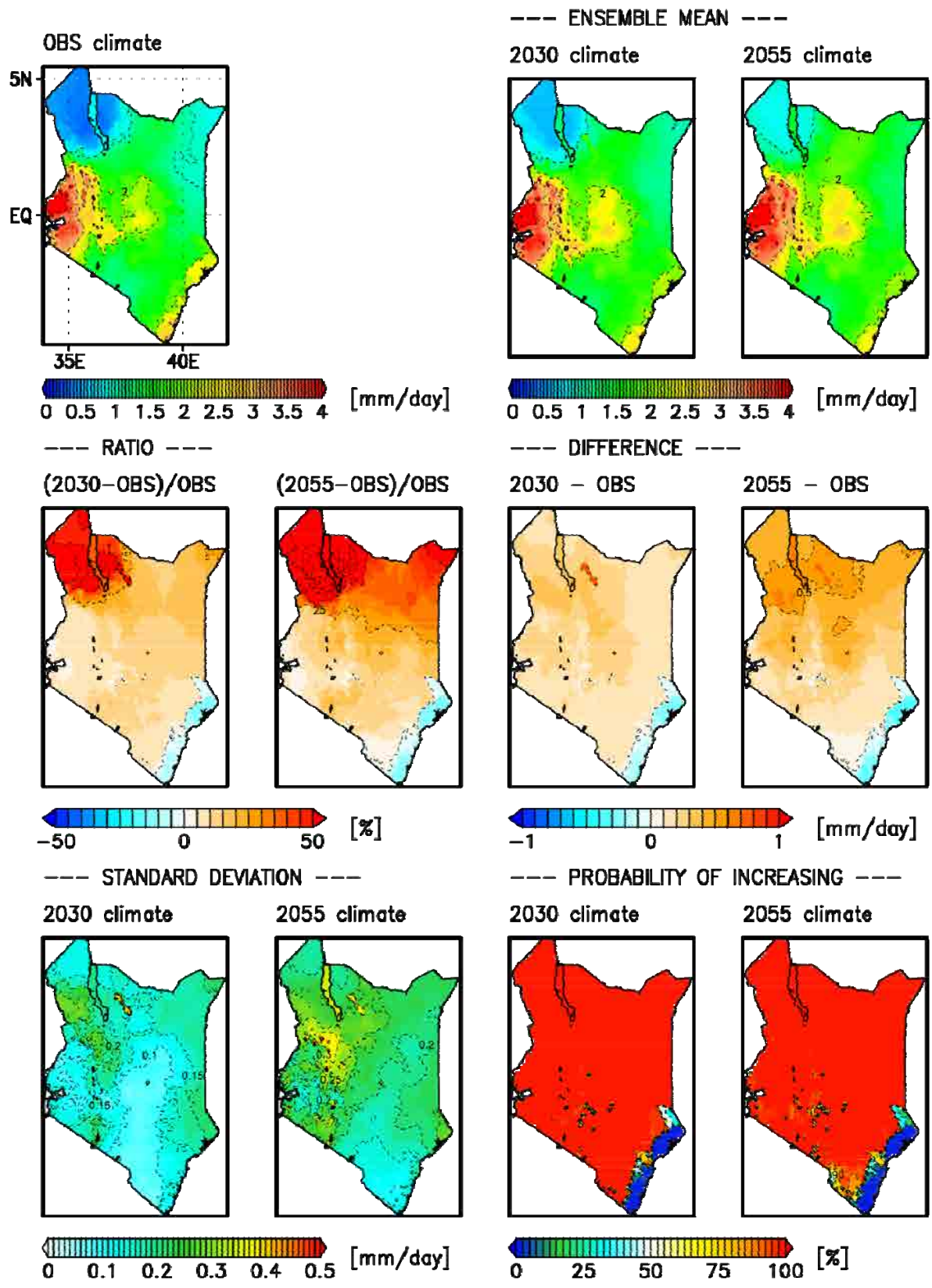


Source: JICA Study Team

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Figure 5.5.11
Spatial Distribution of
Mean Seasonal SET
(JJA, FAO Penman – Monteith Method)

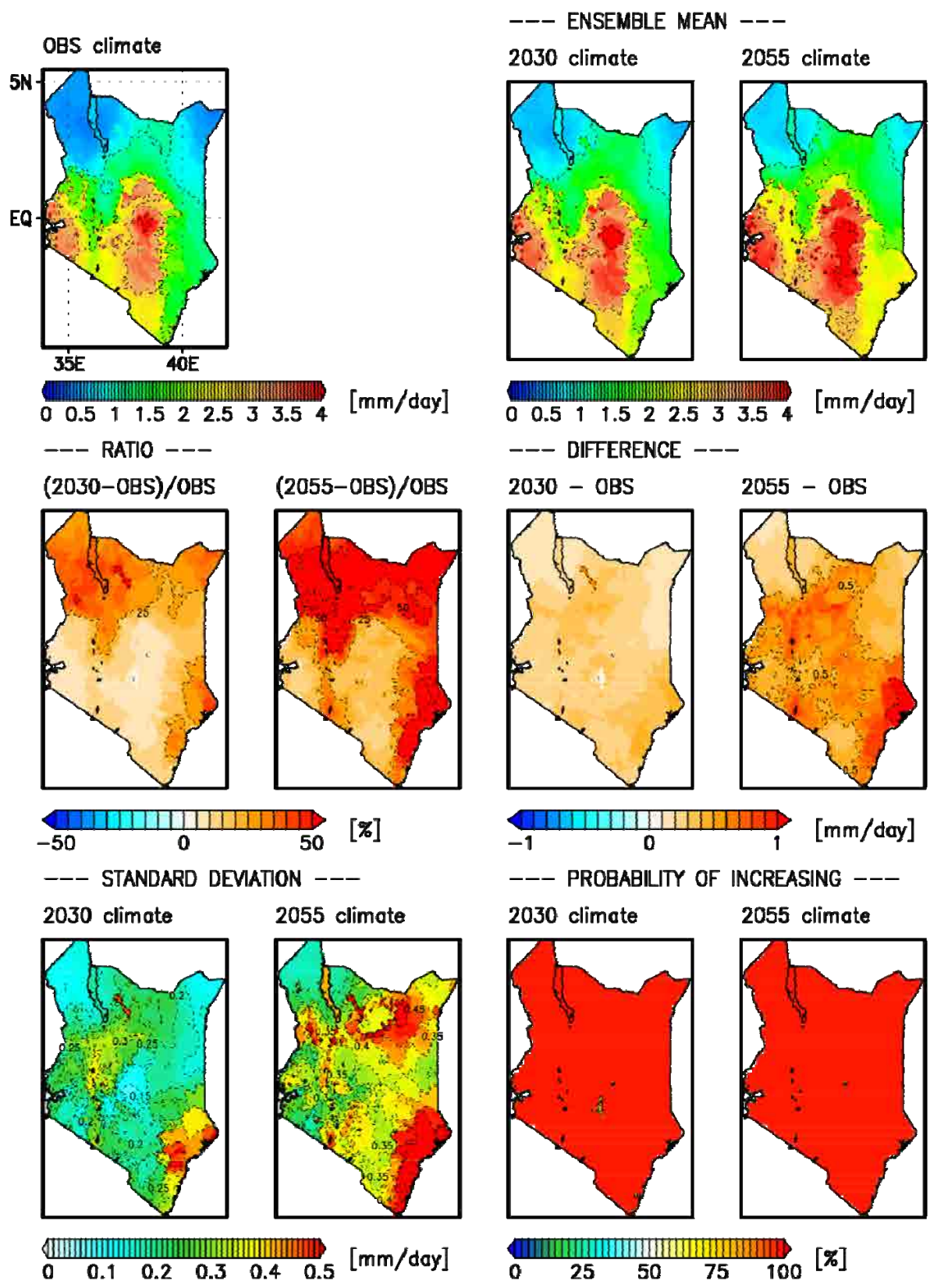


Source: JICA Study Team

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Figure 5.5.12
Spatial Distribution of
Mean Seasonal SET
(SON, FAO Penman – Monteith Method)

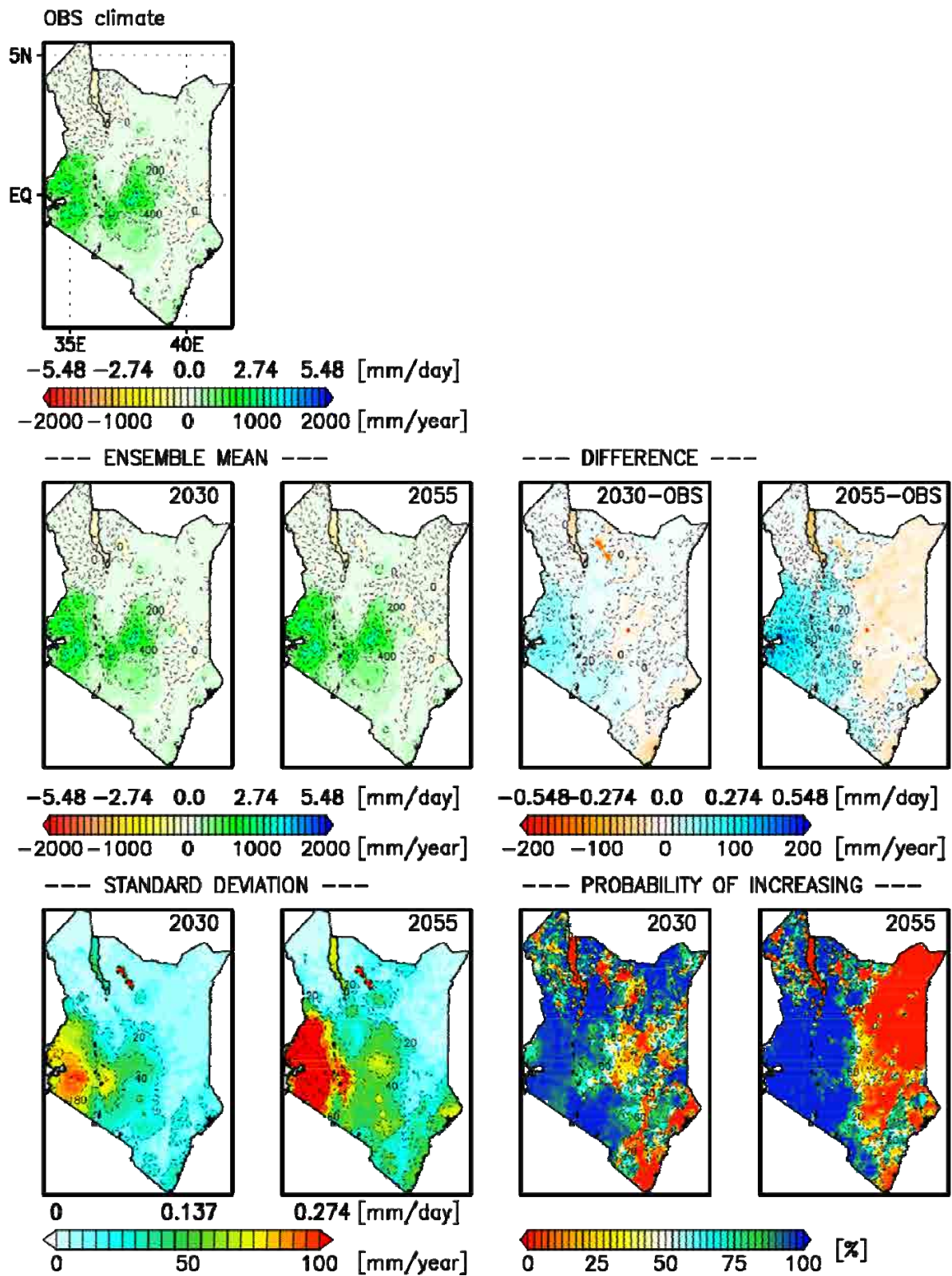


Source: JICA Study Team

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Figure 5.5.13
Spatial Distribution of
Mean Seasonal SET
(DJF, FAO Penman – Monteith Method)

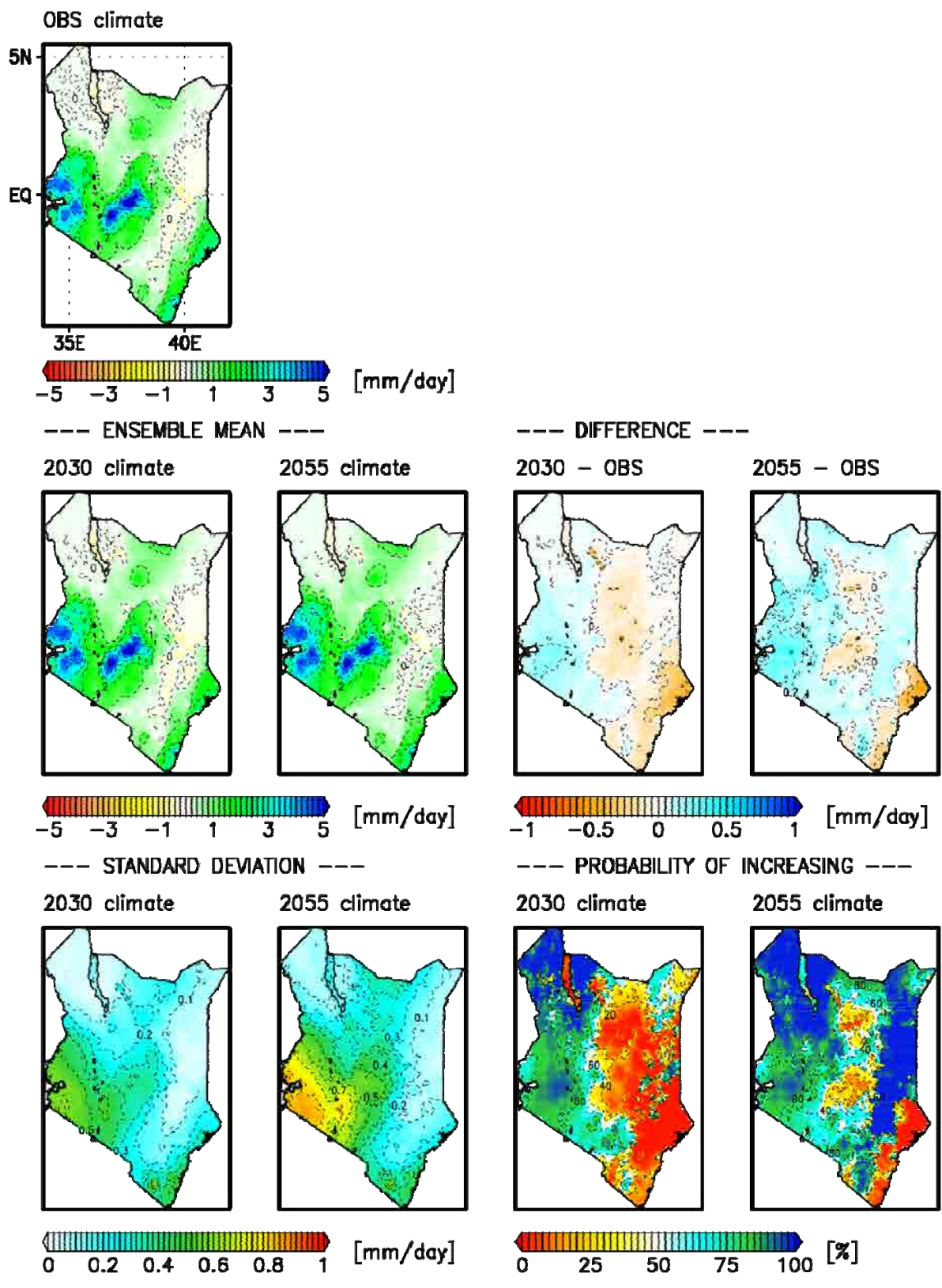


Source: JICA Study Team

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Figure 5.5.14
Spatial Distribution of
Mean Annual P-SET
(Hamon Method)

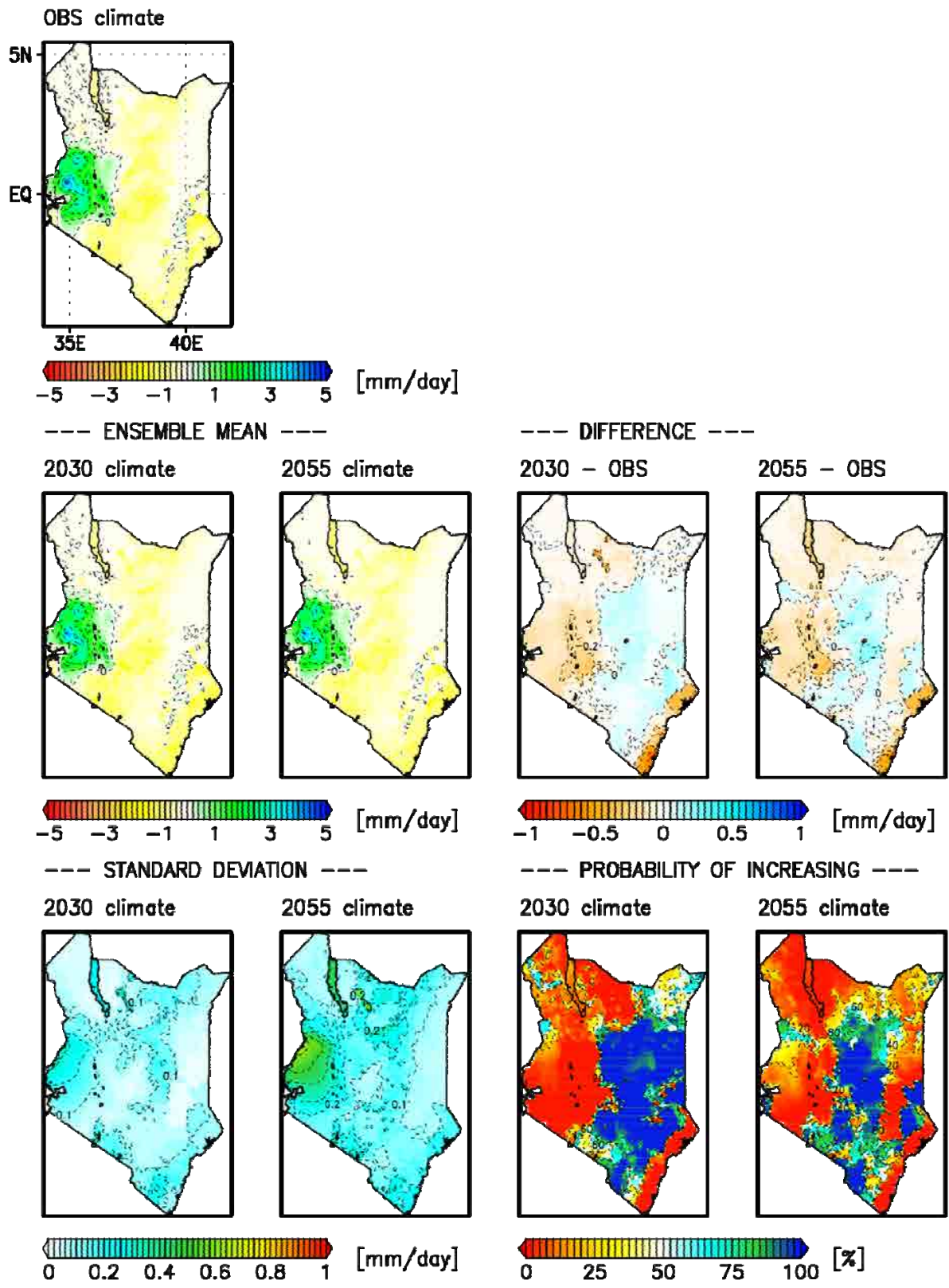


Source: JICA Study Team

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Figure 5.5.15
Spatial Distribution of
Mean Seasonal P-SET
(MAM, Hamon Method)

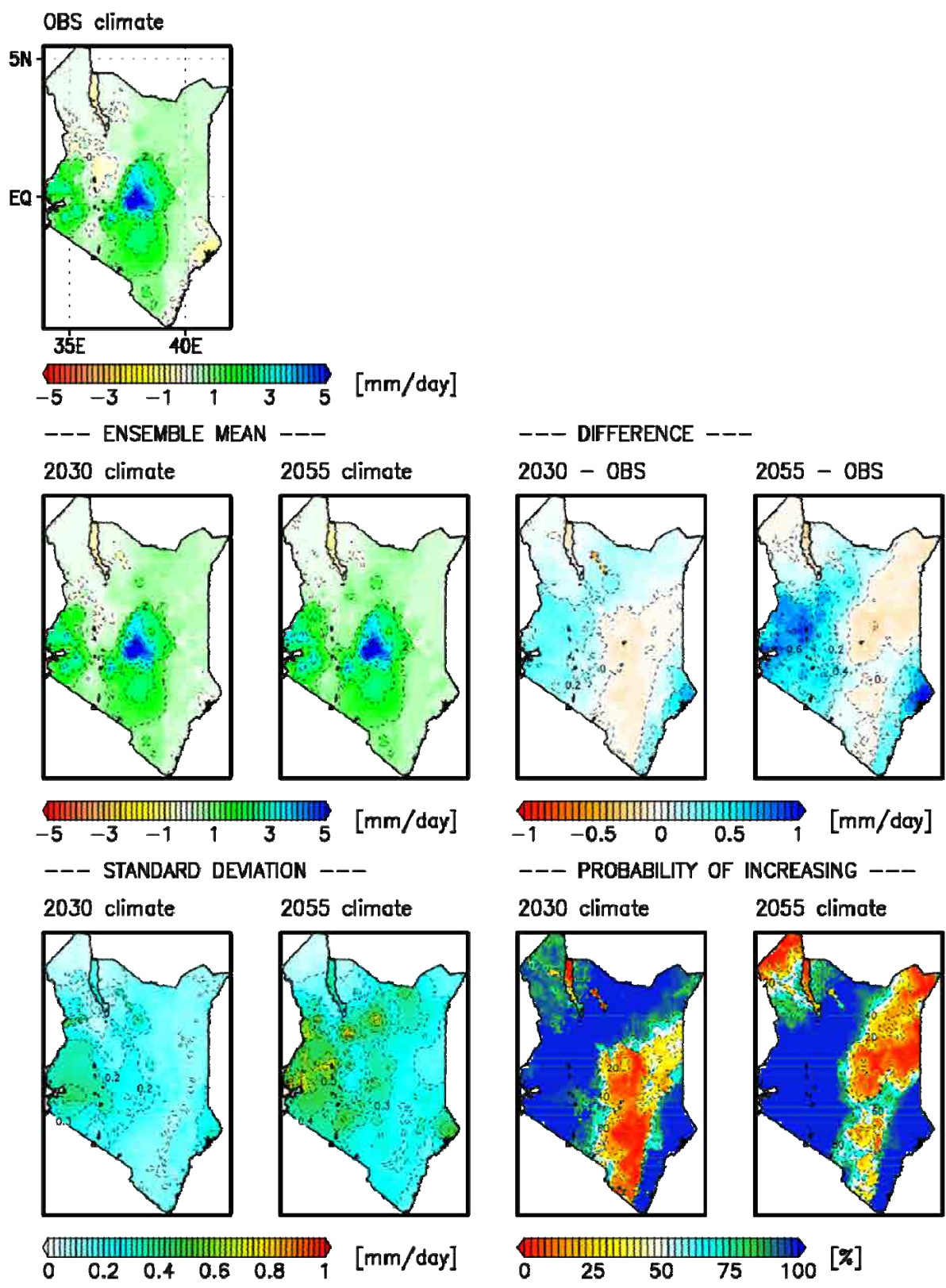


Source: JICA Study Team

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Figure 5.5.16
Spatial Distribution of
Mean Seasonal P- Soil ET
(JJA, Hamon Method)

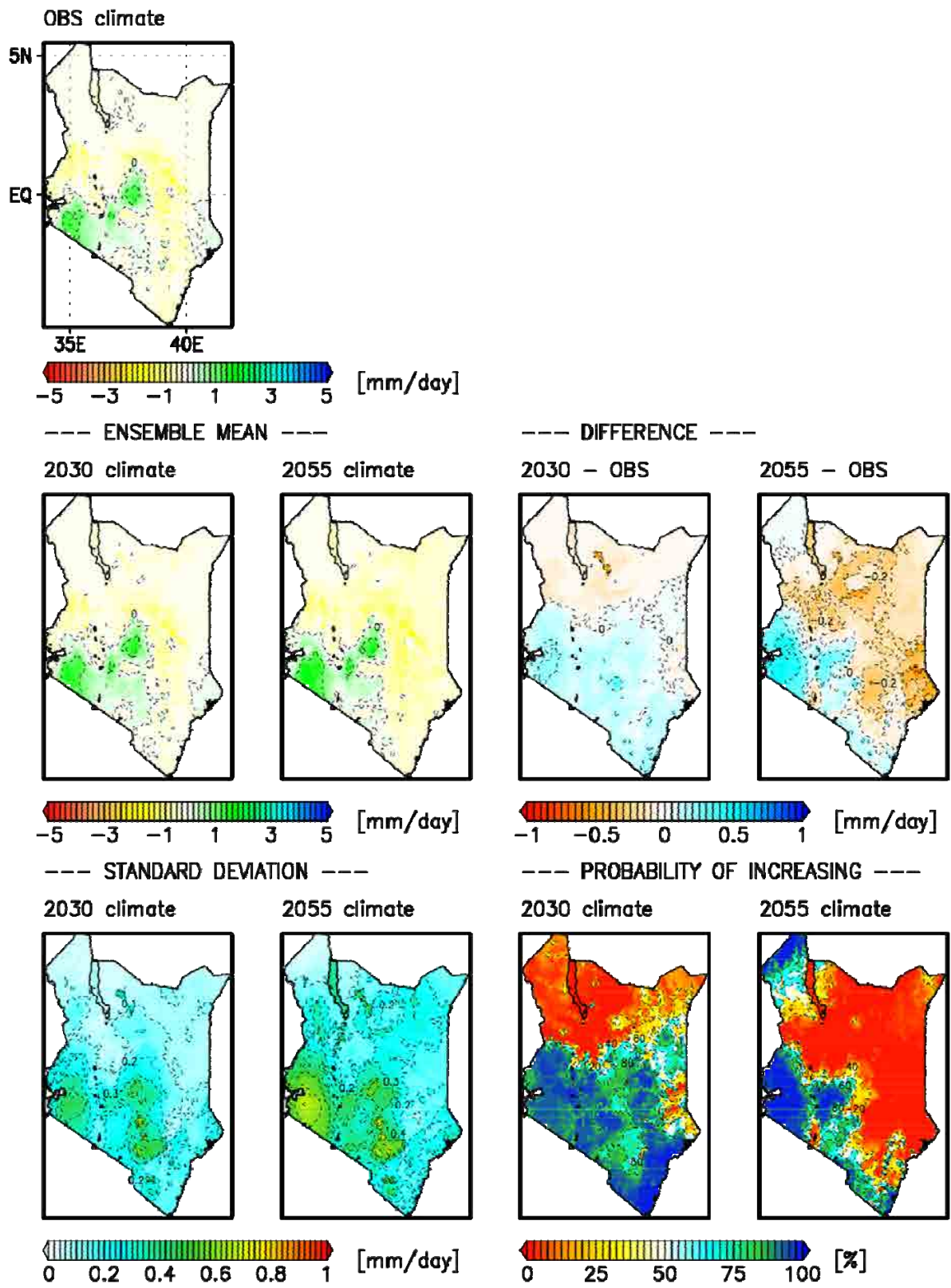


Source: JICA Study Team

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Figure 5.5.17
Spatial Distribution of
Mean Seasonal P-SET
(SON, Hamon Method)

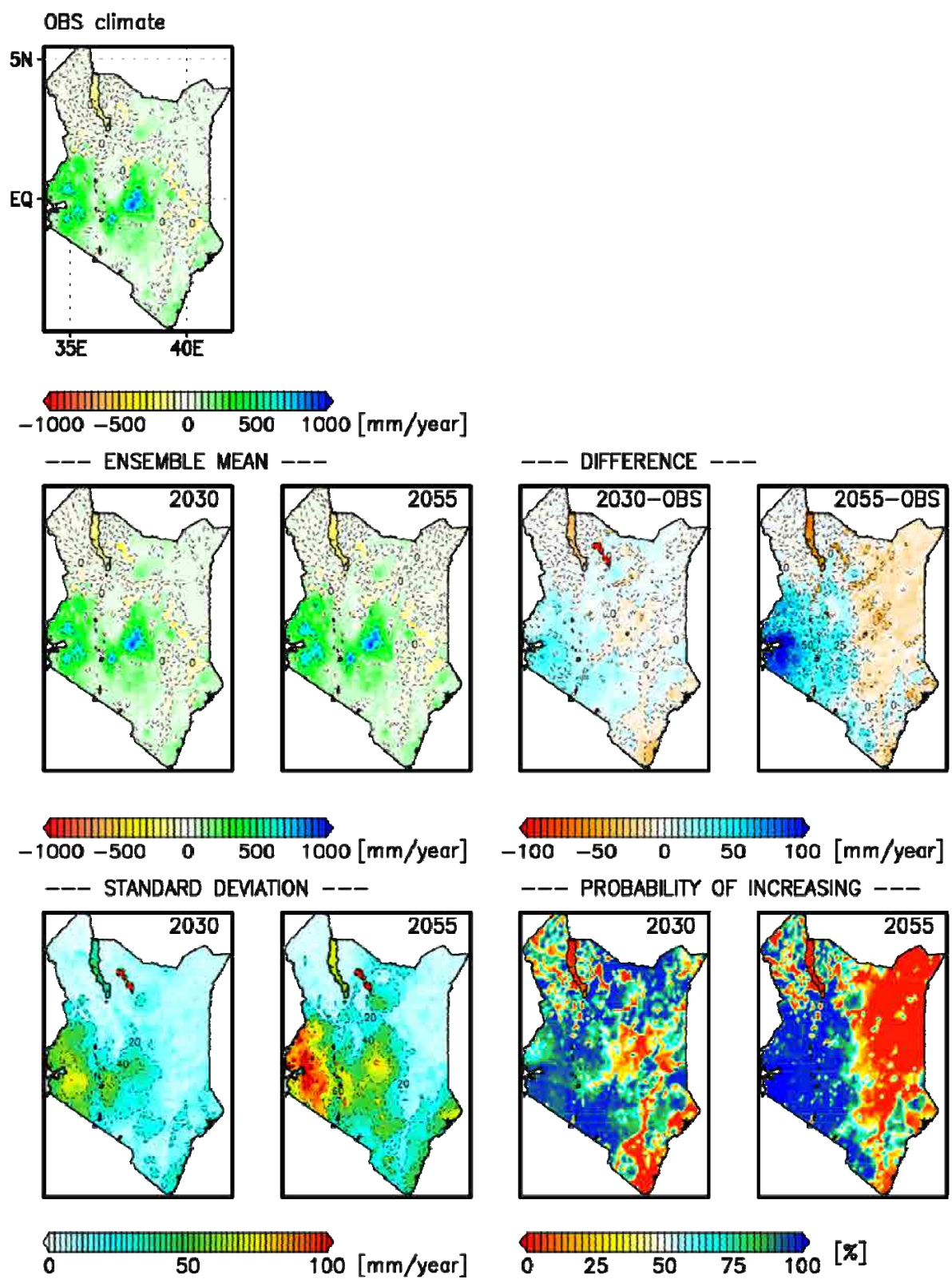


Source: JICA Study Team

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Figure 5.5.18
Spatial Distribution of
Mean Seasonal P-SET
(DJF, Hamon Method)

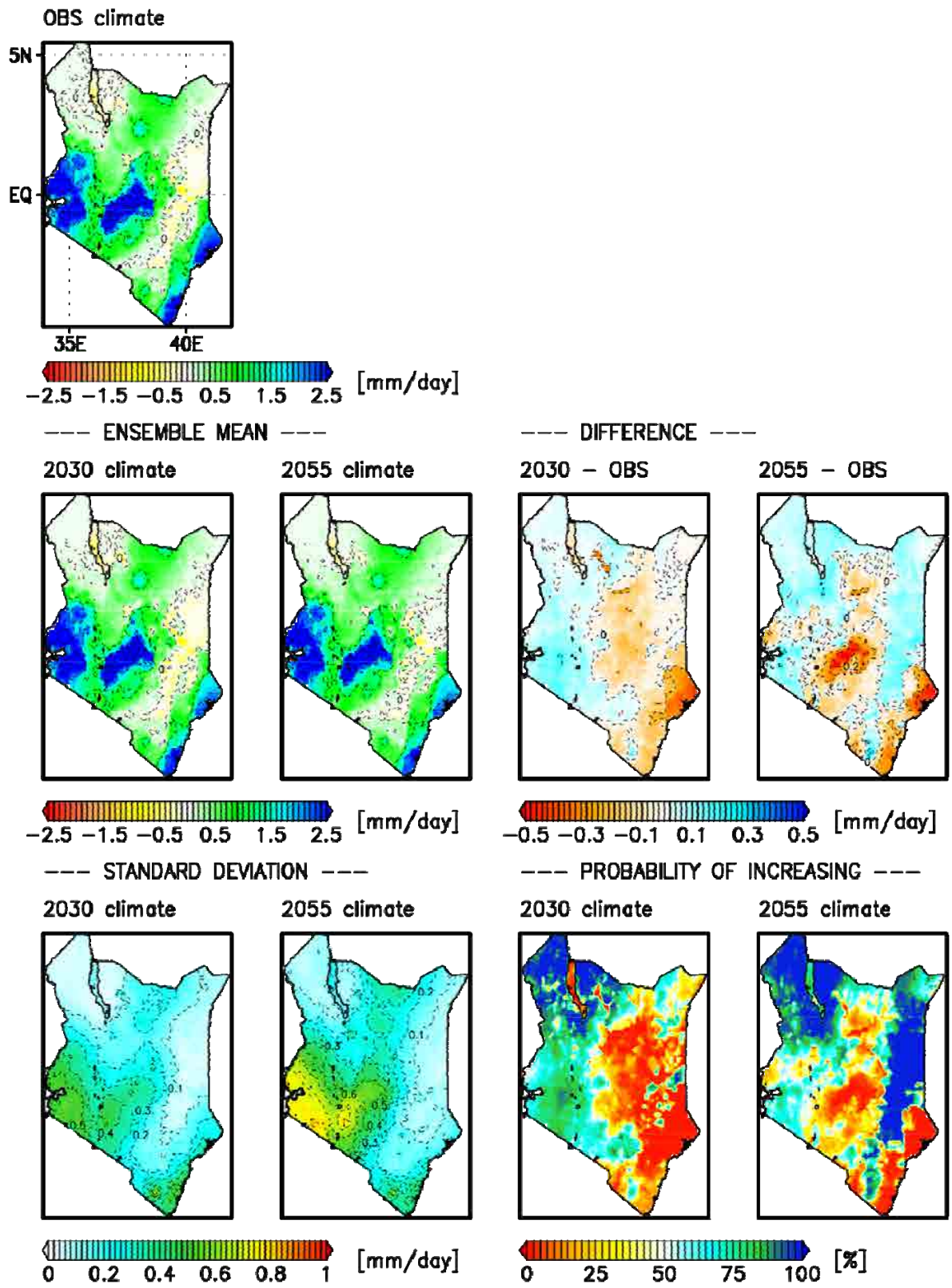


Source: JICA Study Team

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Figure 5.5.19
Spatial Distribution of
Mean Annual P- SET
(FAO Penman – Monteith Method)

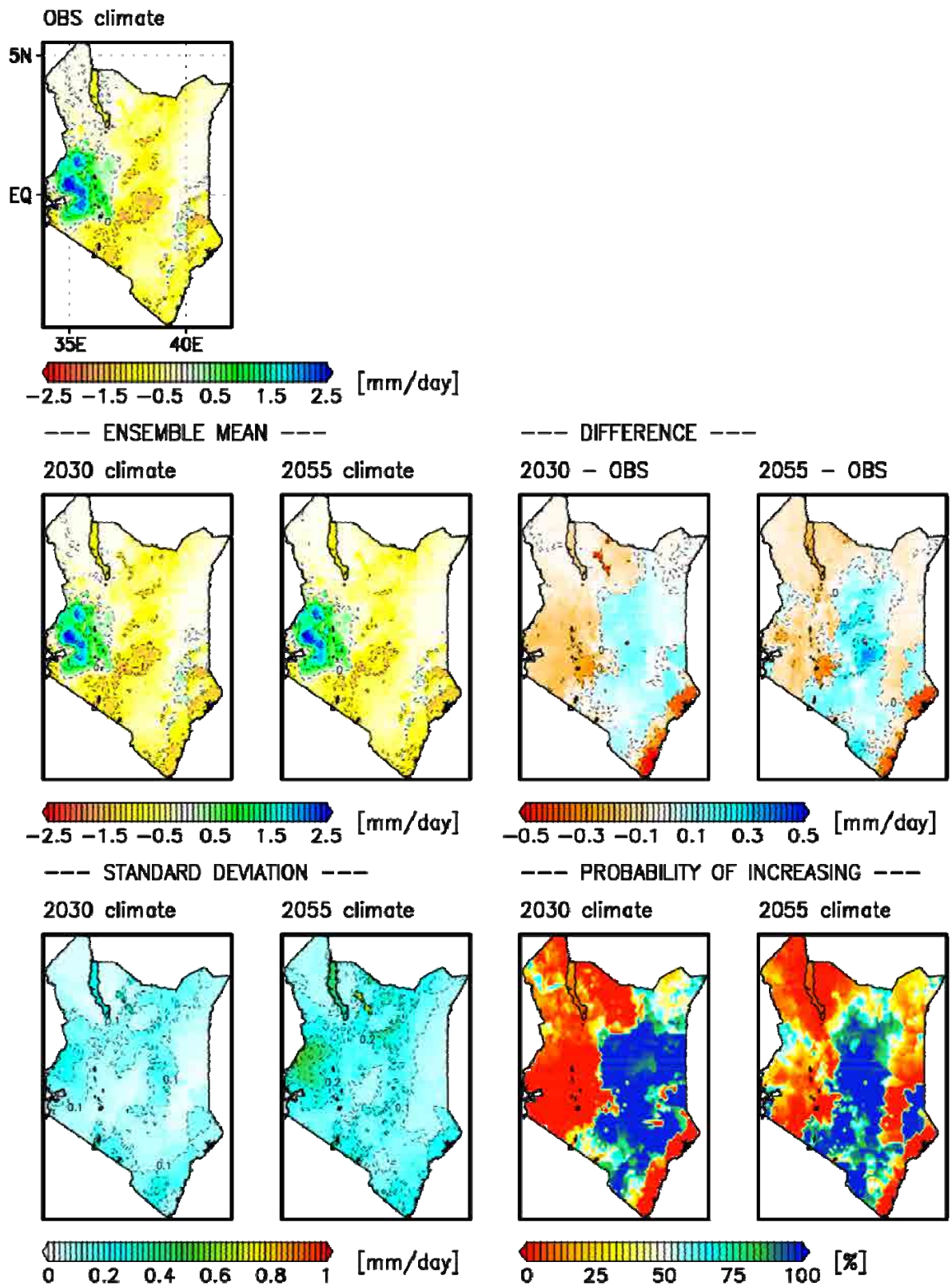


Source: JICA Study Team

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Figure 5.5.20
Spatial Distribution of
Mean Seasonal P- SET
(MAM, FAO Penman – Monteith
Method)

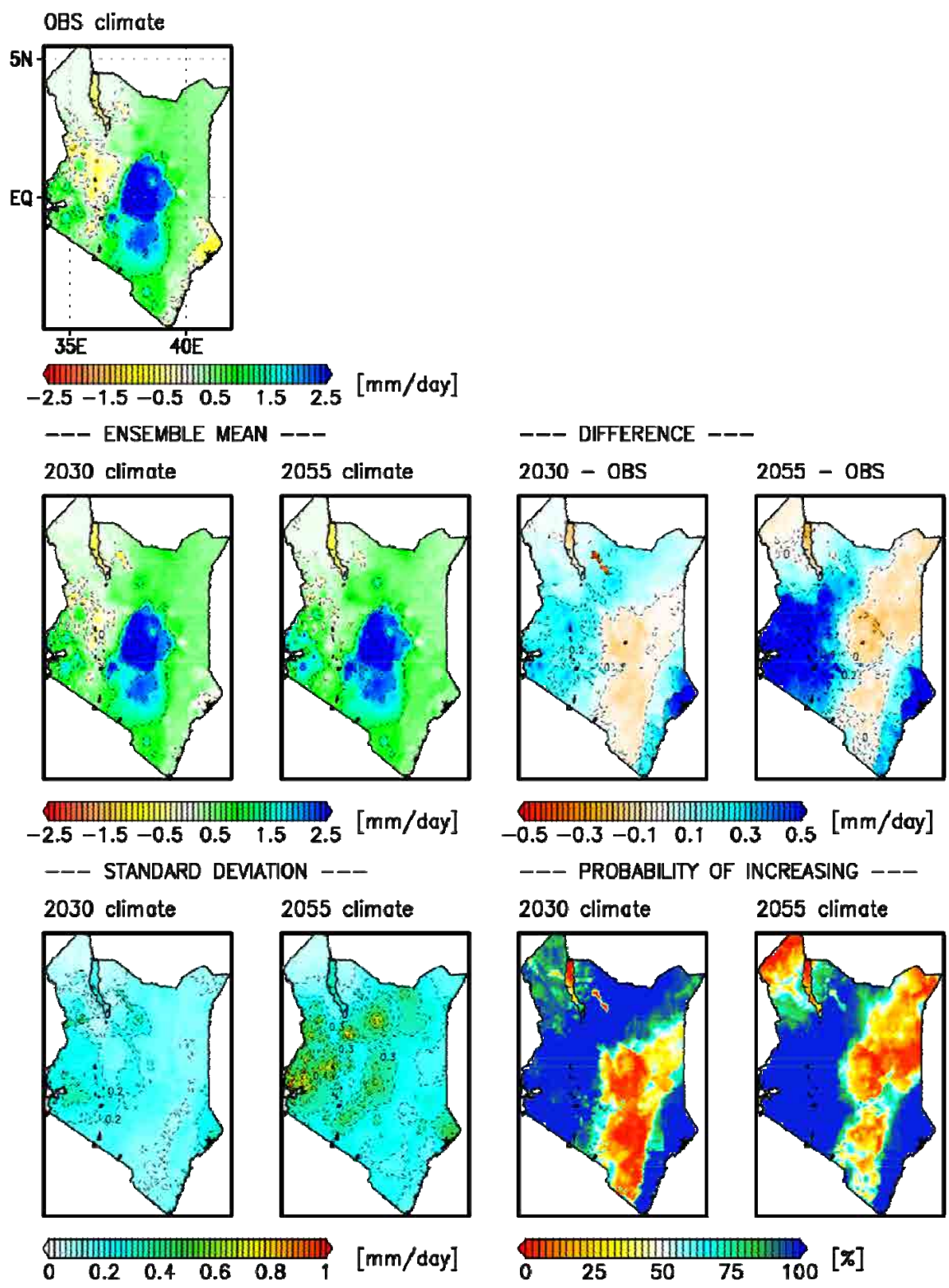


Source: JICA Study Team

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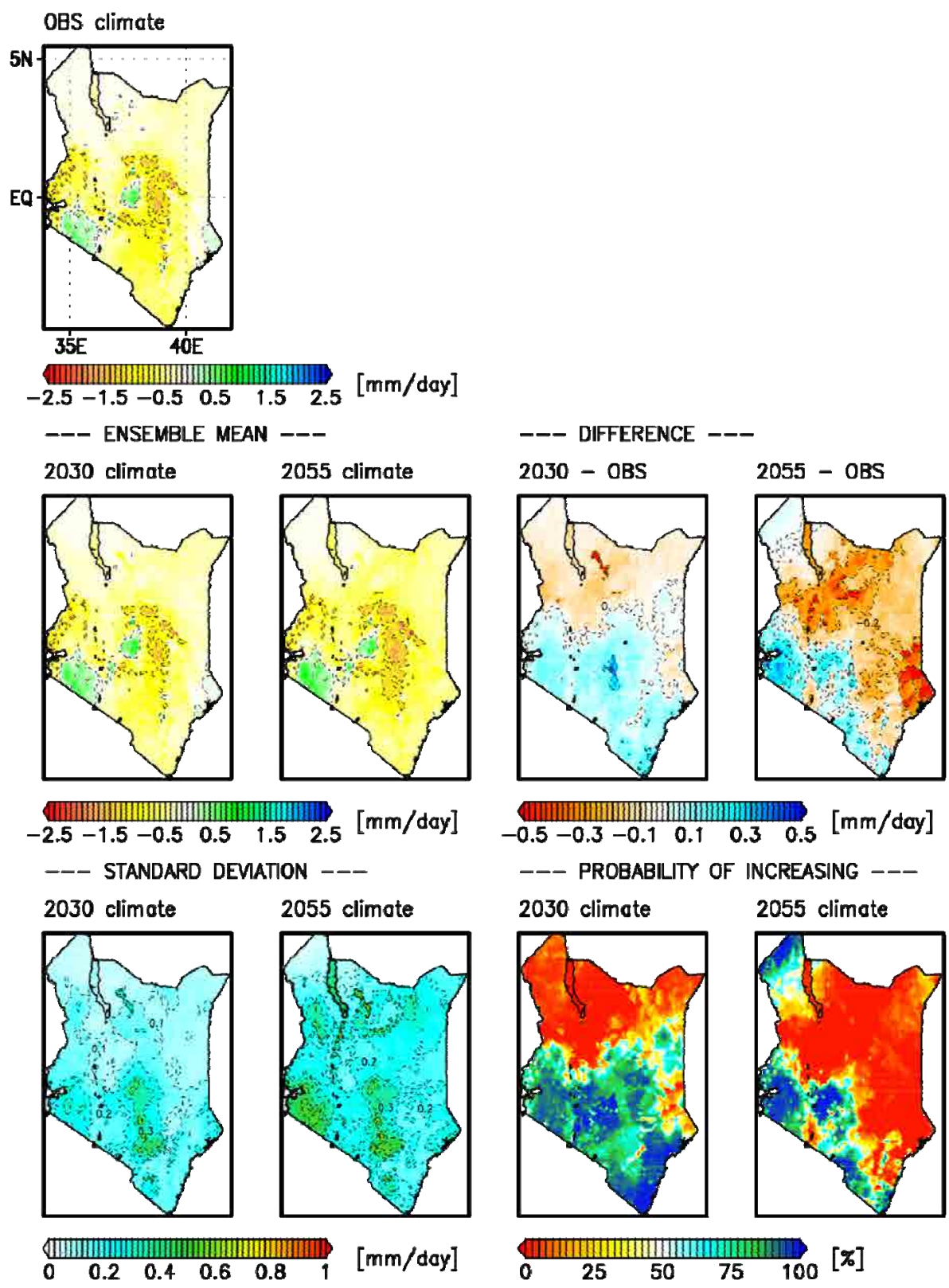
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Figure 5.5.21
Spatial Distribution of
Mean Seasonal P-SET
(JJA, FAO Penman – Monteith Method)



Source: JICA Study Team

Figure 5.5.22
Spatial Distribution of
Mean Seasonal P- Soil ET (SON, FAO
Penman – Monteith Method)

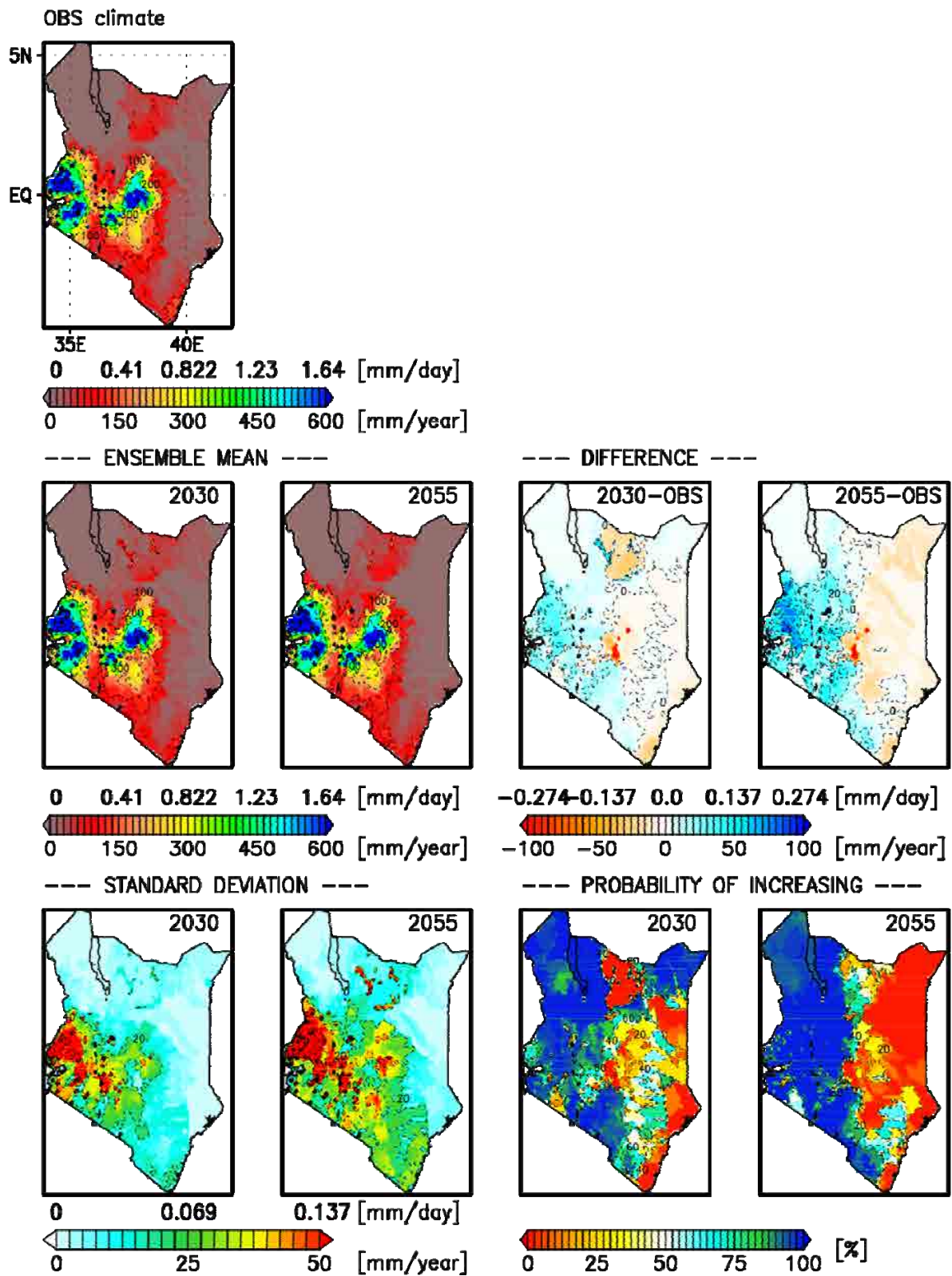


Source: JICA Study Team

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Figure 5.5.23
Spatial Distribution of
Mean Seasonal P- SET (DJF, FAO
Penman – Monteith Method)

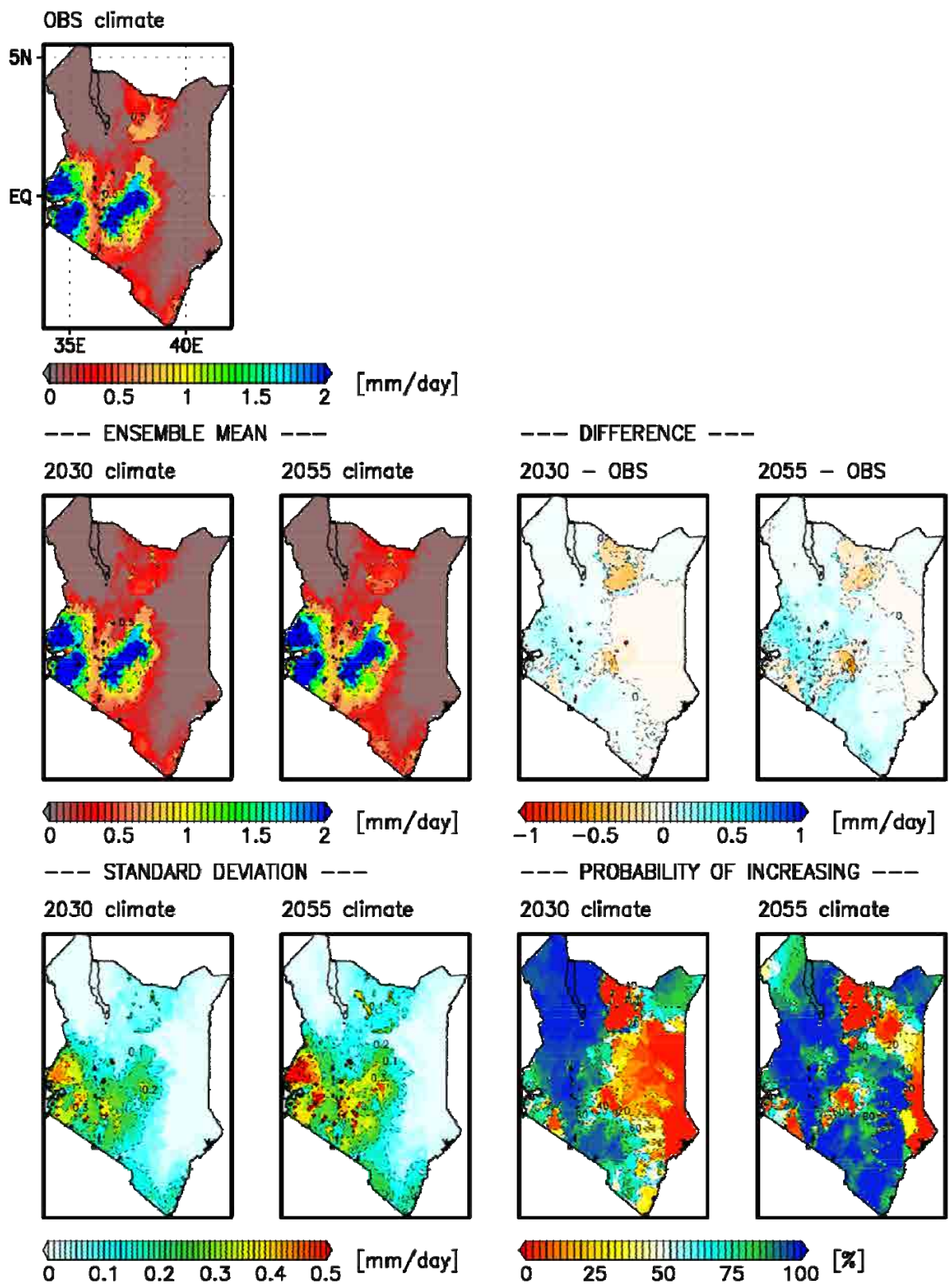


Source: JICA Study Team

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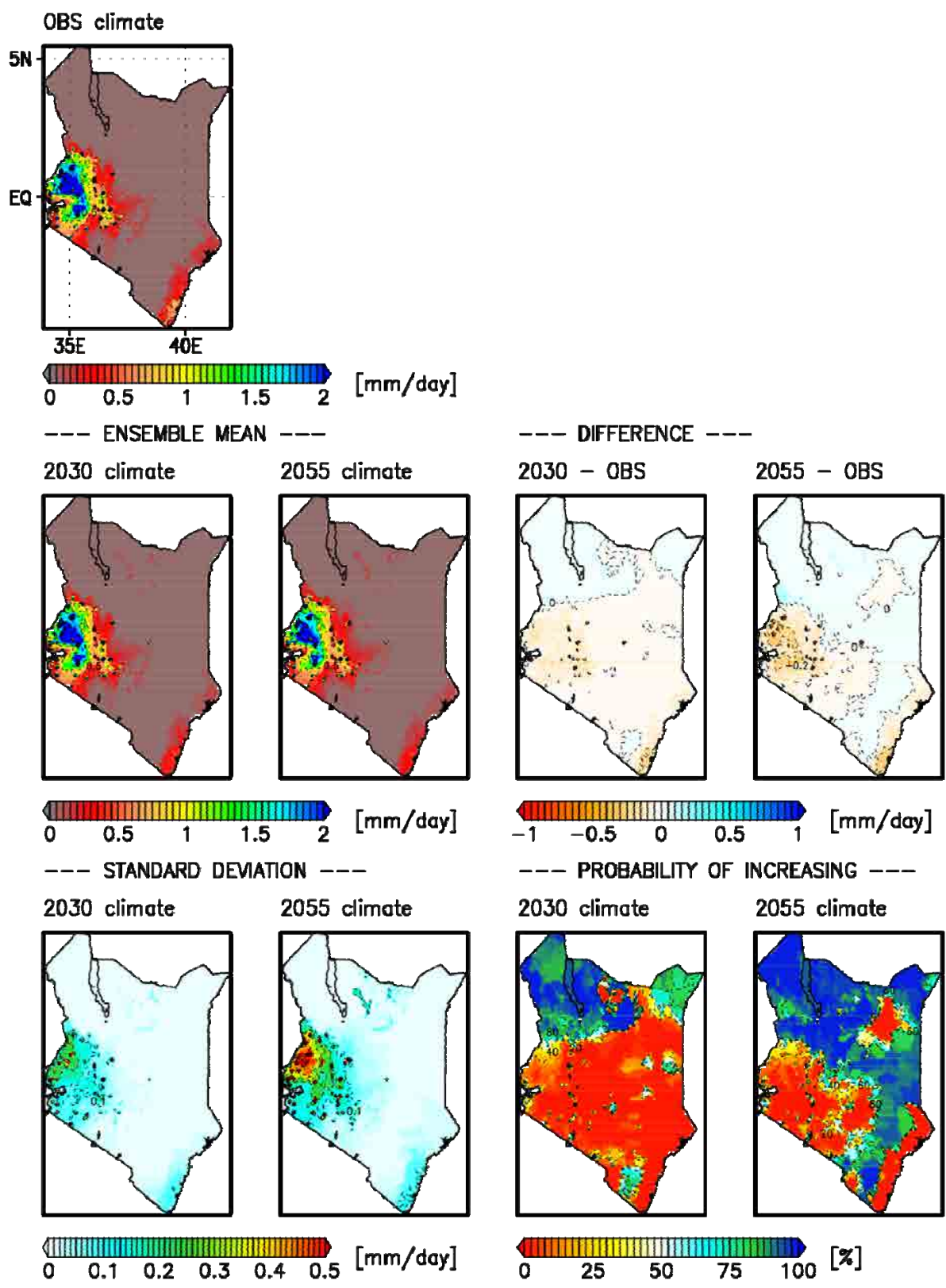
Figure 5.5.24
Spatial Distribution of
Mean Annual Groundwater Recharge
(Hamon Method)



Source: JICA Study Team

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Figure 5.5.25
Spatial Distribution of
Mean Seasonal Groundwater Recharge
(MAM, Hamon Method)

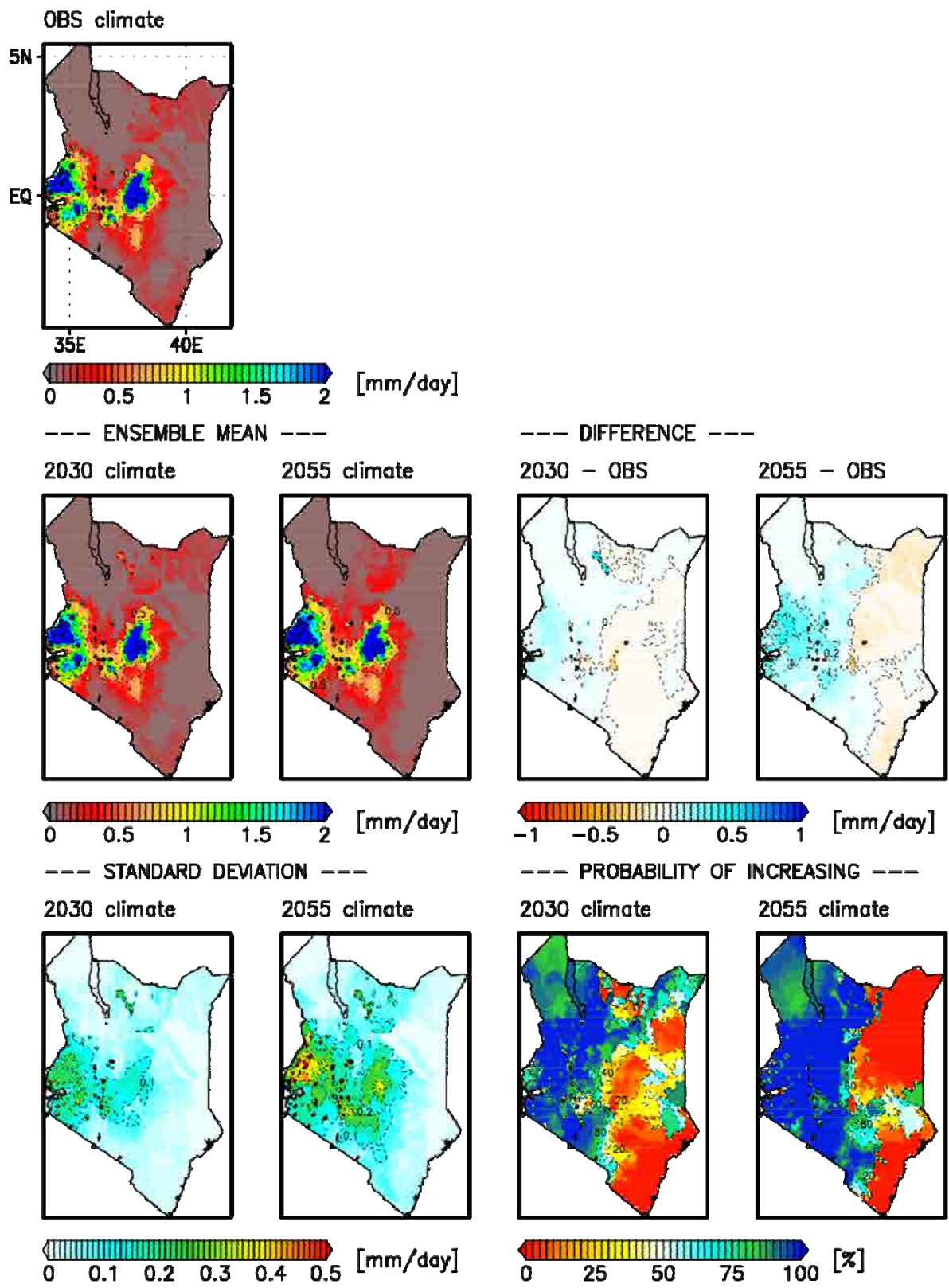


Source: JICA Study Team

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Figure 5.5.26
Spatial Distribution of
Mean Seasonal Groundwater Recharge
(JJA, Hamon Method)

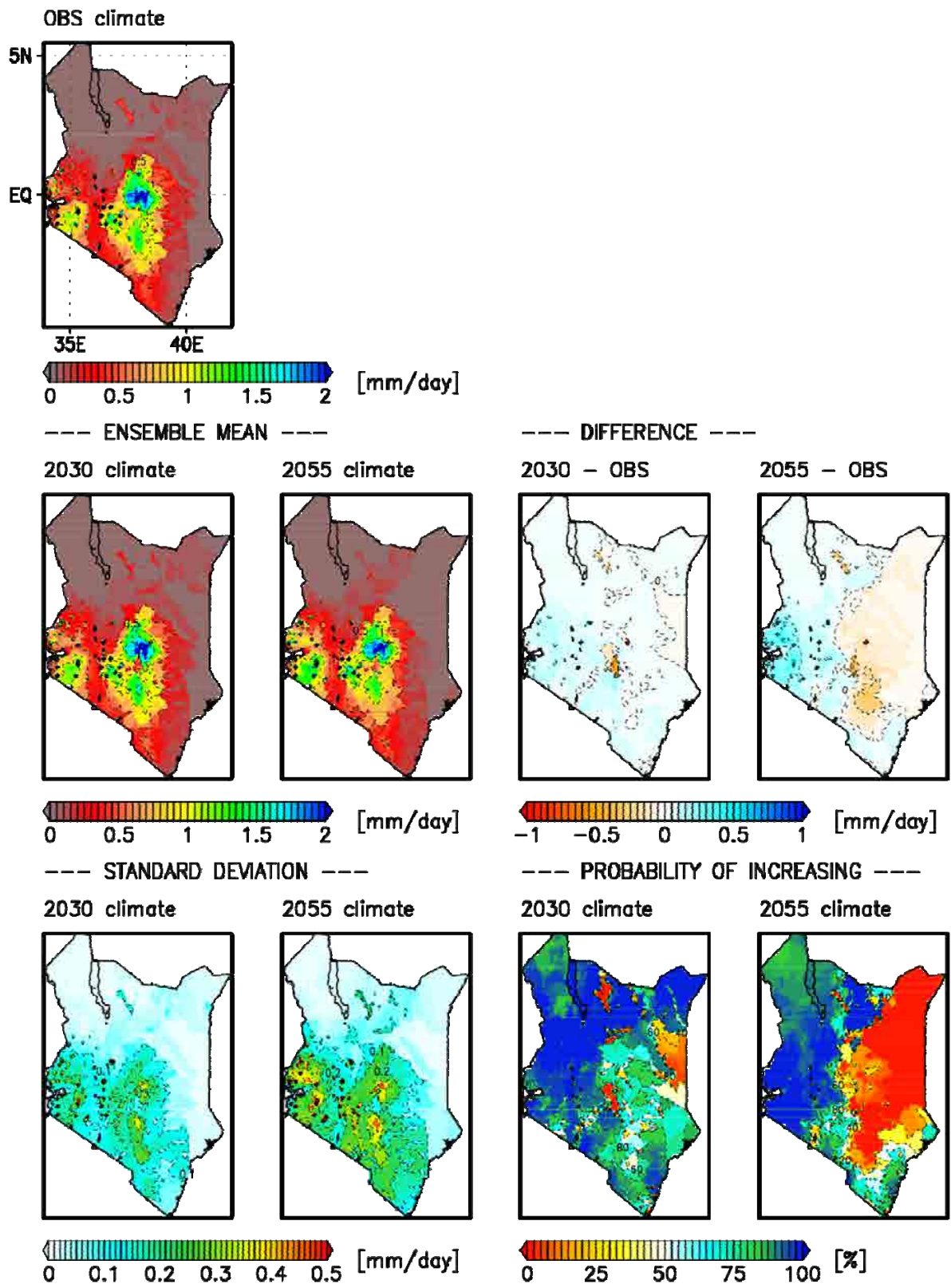


Source: JICA Study Team

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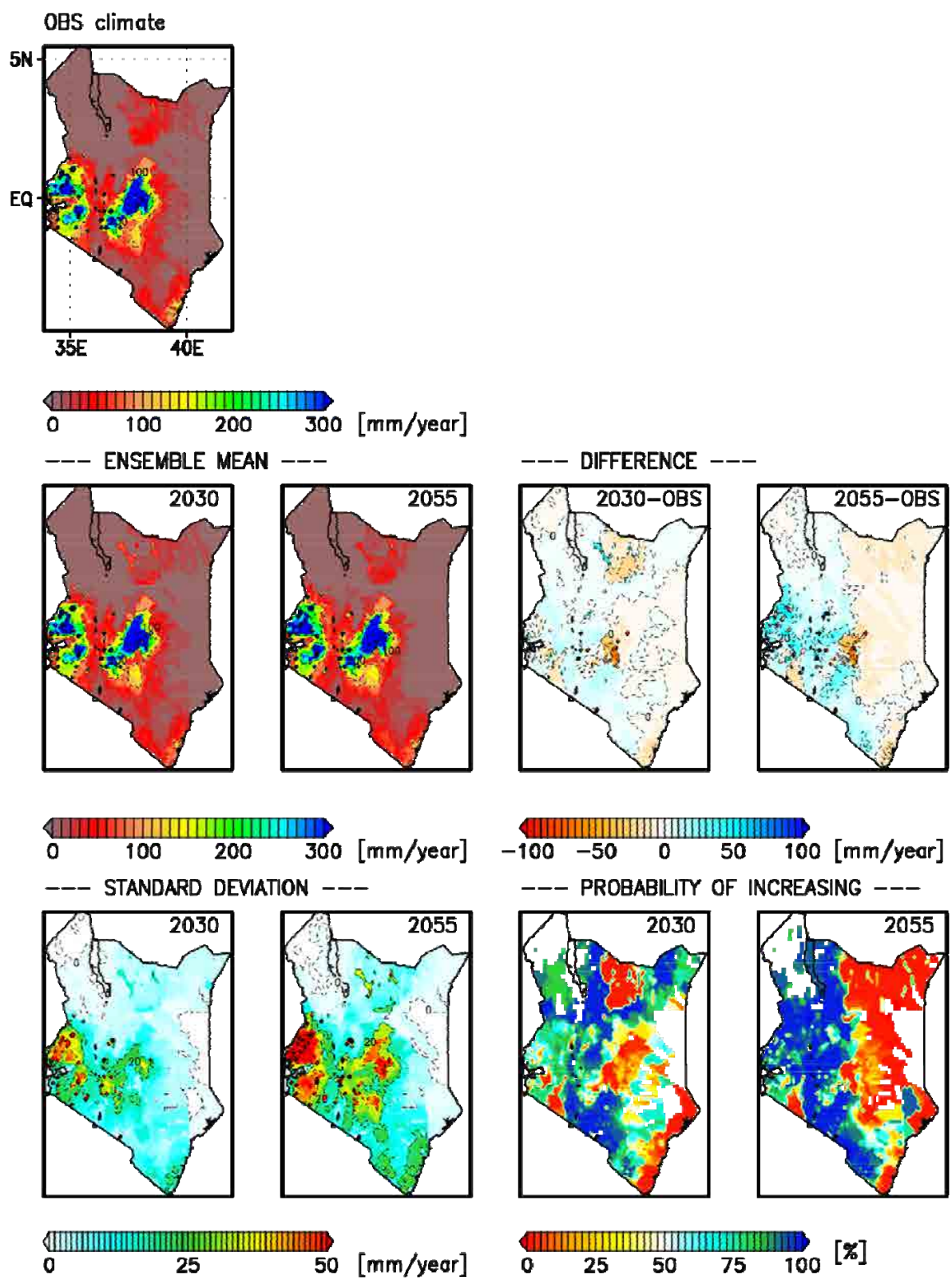
Figure 5.5.27
Spatial Distribution of
Mean Seasonal Groundwater Recharge
(SON, Hamon Method)



Source: JICA Study Team

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Figure 5.5.28
Spatial Distribution of
Mean Seasonal Groundwater Recharge
(DJF, Hamon Method)

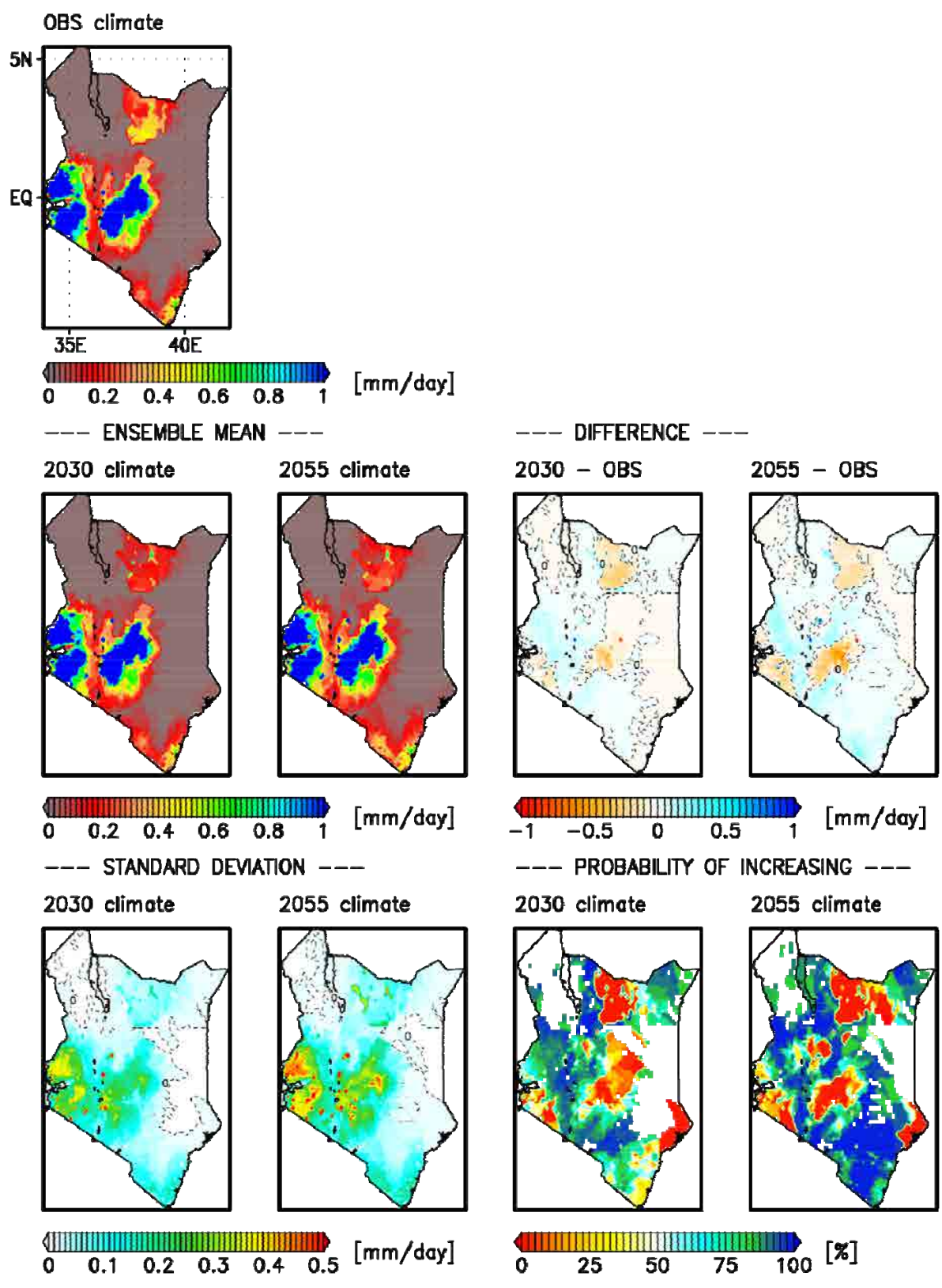


Source: JICA Study Team

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Figure 5.5.29
Spatial Distribution of
Mean Annual Groundwater Recharge
(FAO Penman – Monteith Method)

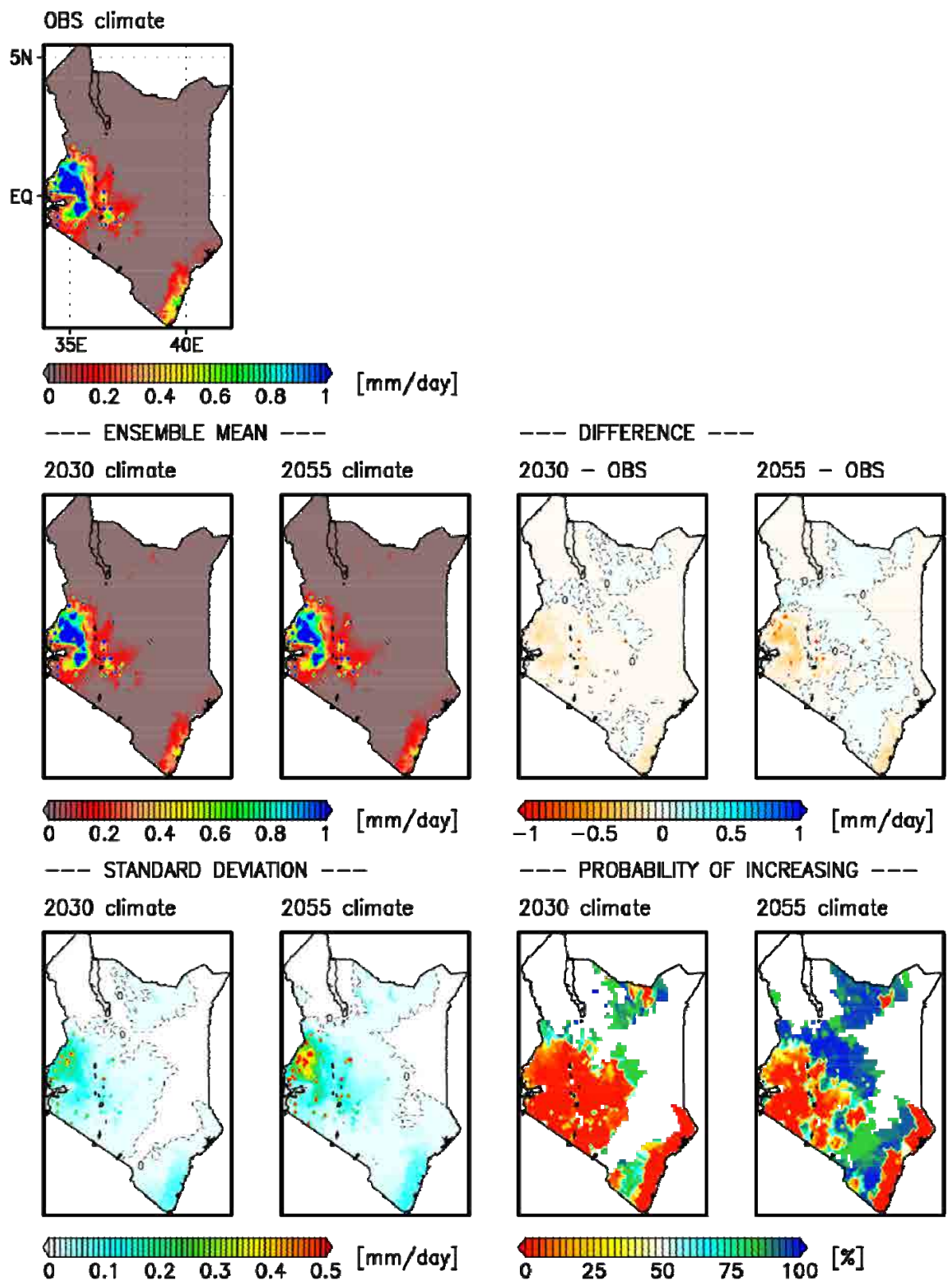


Source: JICA Study Team

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Figure 5.5.30
Spatial Distribution of
Mean Seasonal Groundwater Recharge
(MAM, FAO Penman – Monteith
Method)

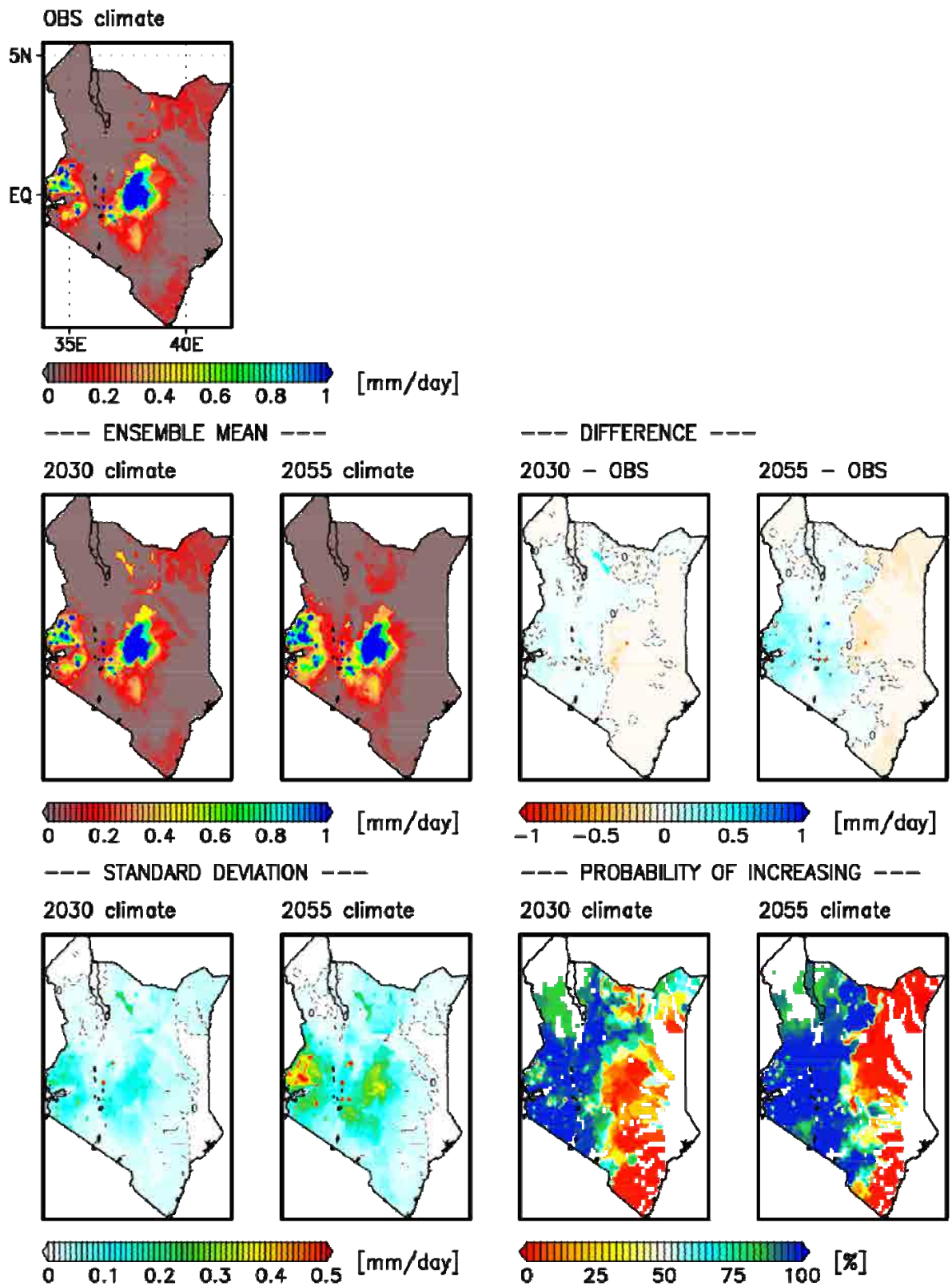


Source: JICA Study Team

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Figure 5.5.31
Spatial Distribution of Mean Seasonal
Groundwater Recharge
(JJA, FAO Penman – Monteith Method)

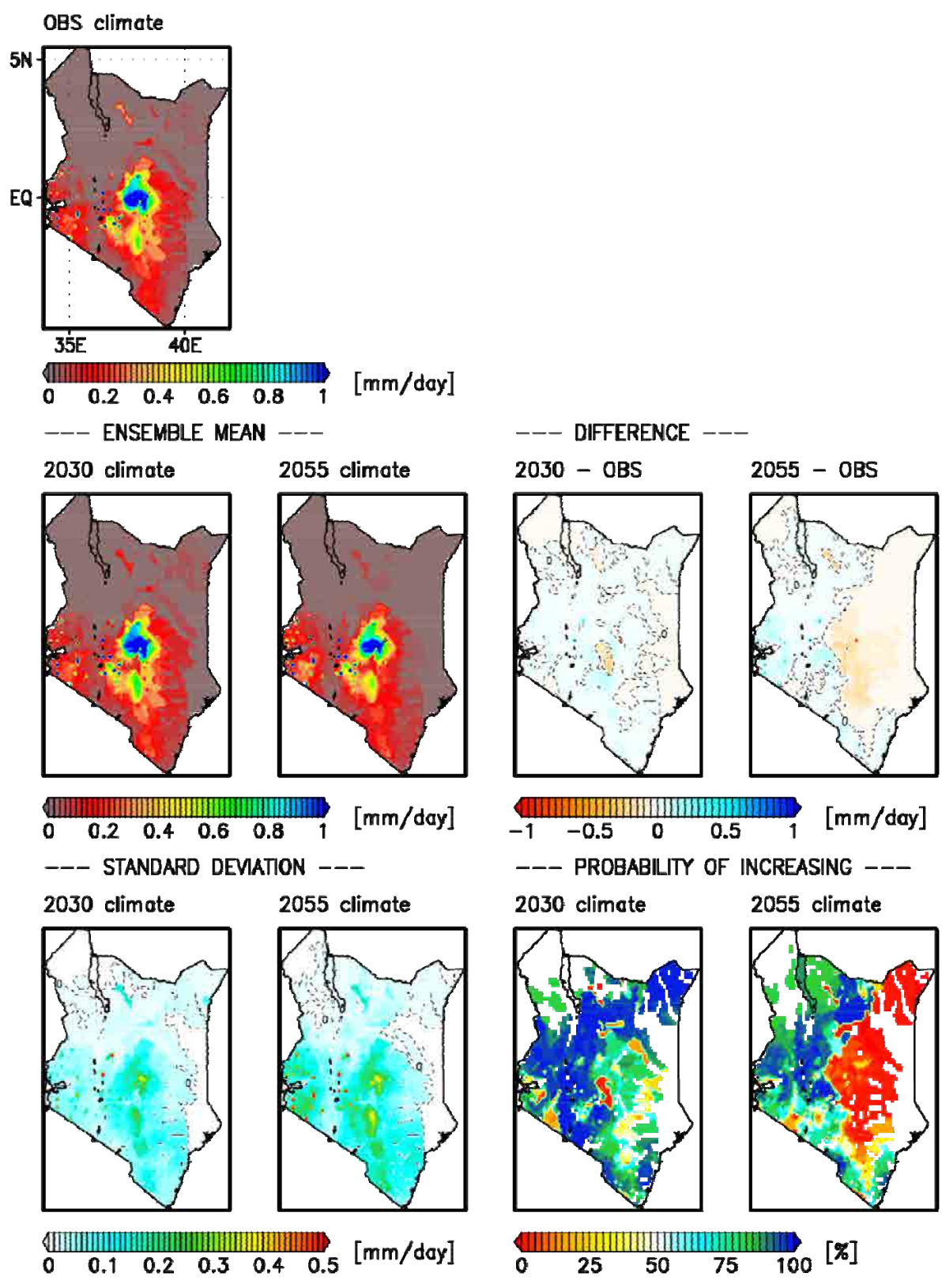


Source: JICA Study Team

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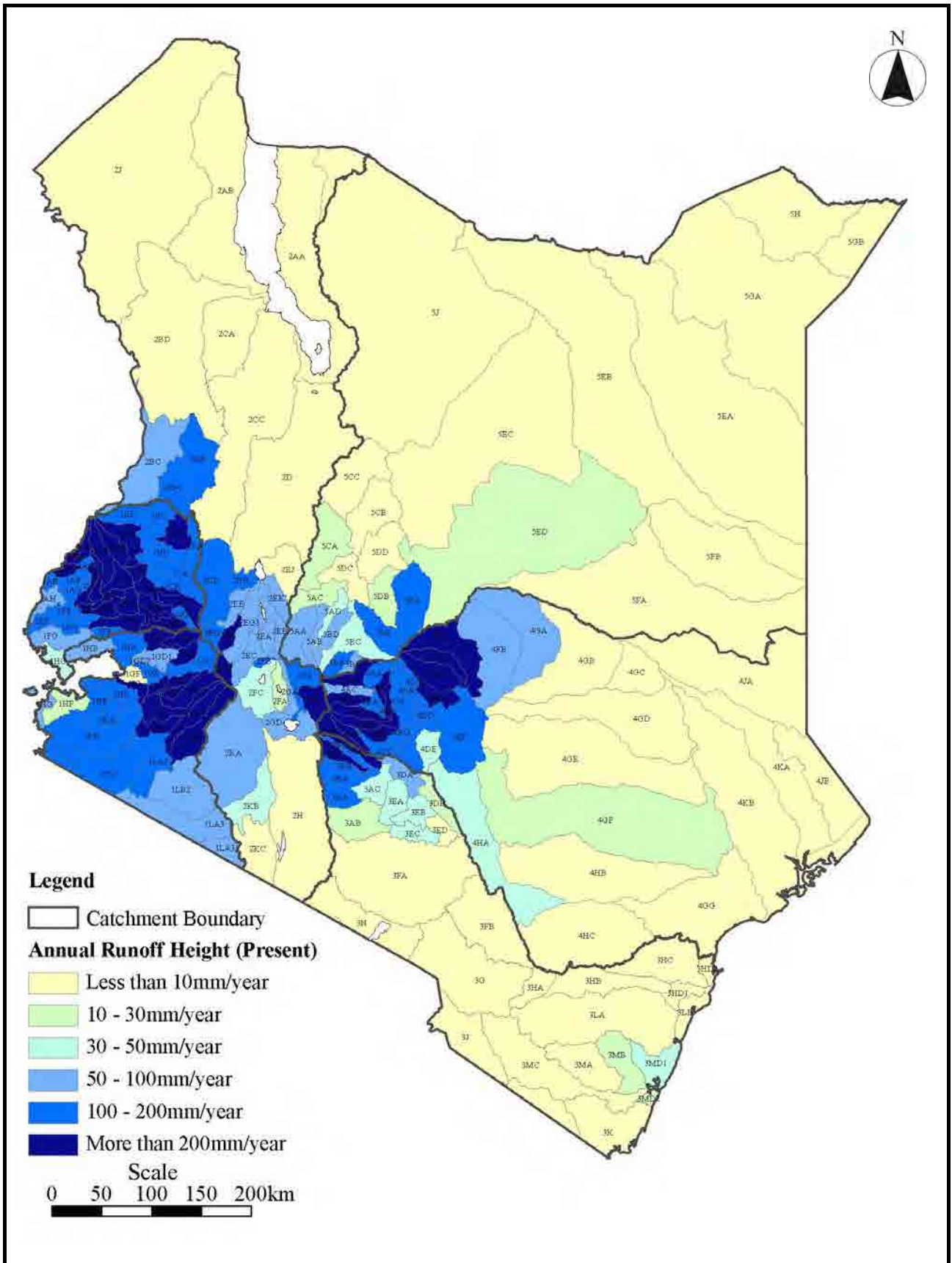
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Figure 5.5.32
Spatial Distribution of Mean Seasonal
Groundwater Recharge (SON, FAO
Penman – Monteith Method)



Source: JICA Study Team

Figure 5.5.33
Spatial Distribution of
Mean Seasonal Groundwater Recharge
(DJF, FAO Penman – Monteith Method)

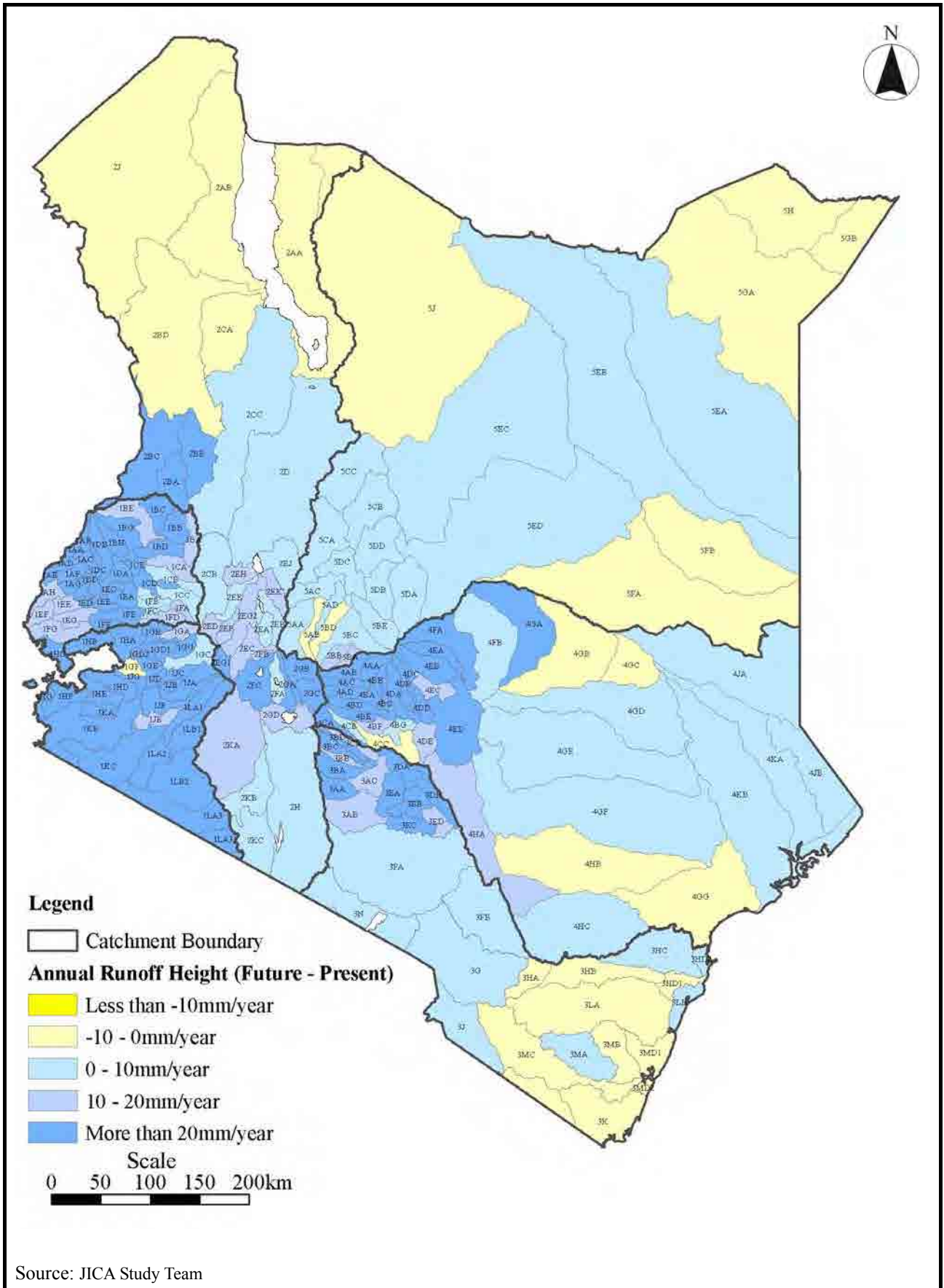


Source: JICA Study Team

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**Figure 5.6.1
Specific Renewable Surface Water
Resources by Sub Basin in Present
Climatology**

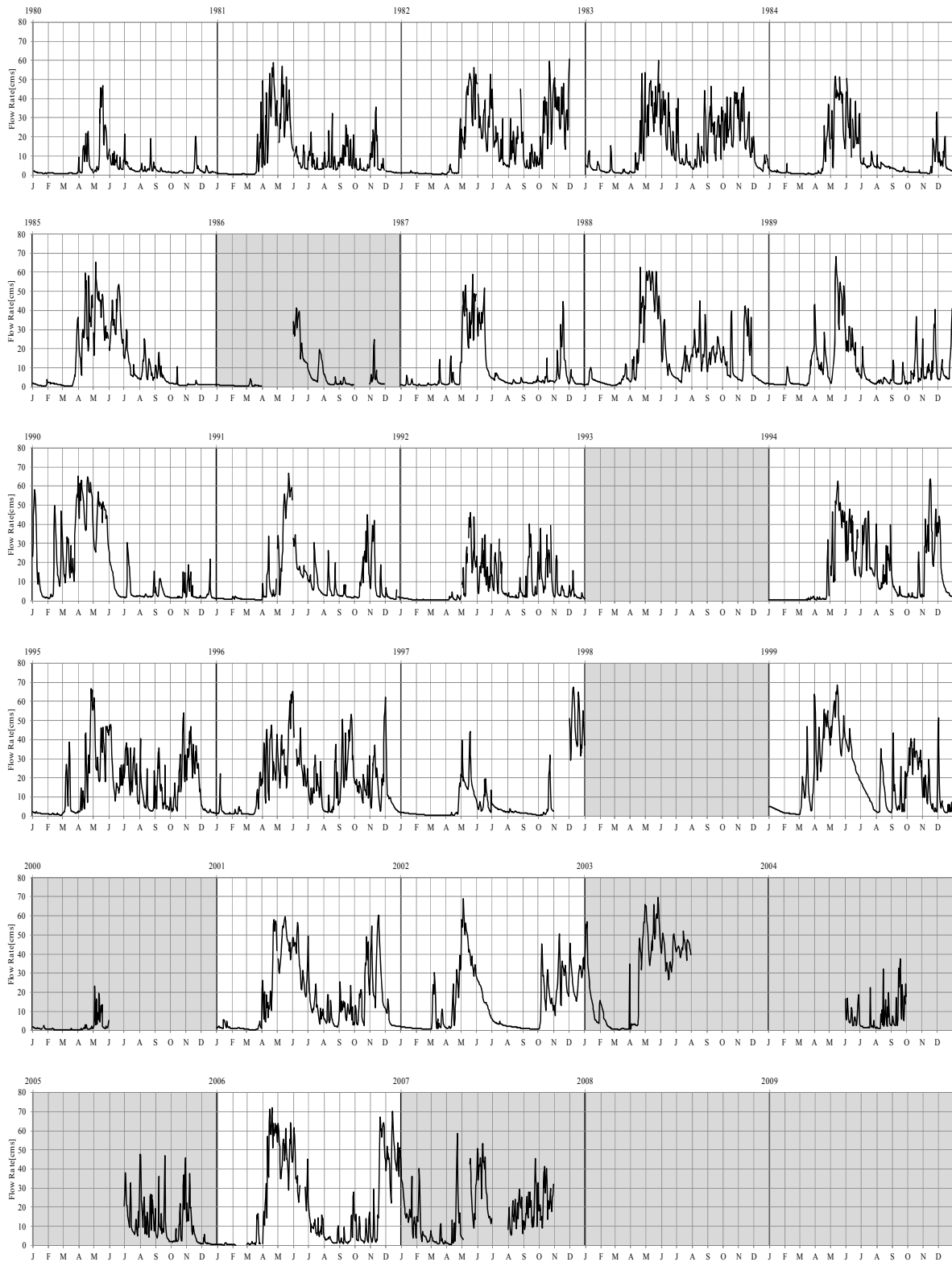


Source: JICA Study Team

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Figure 5.6.2
Difference of Future Annual Runoff and
Present Annual Runoff by Sub Basin



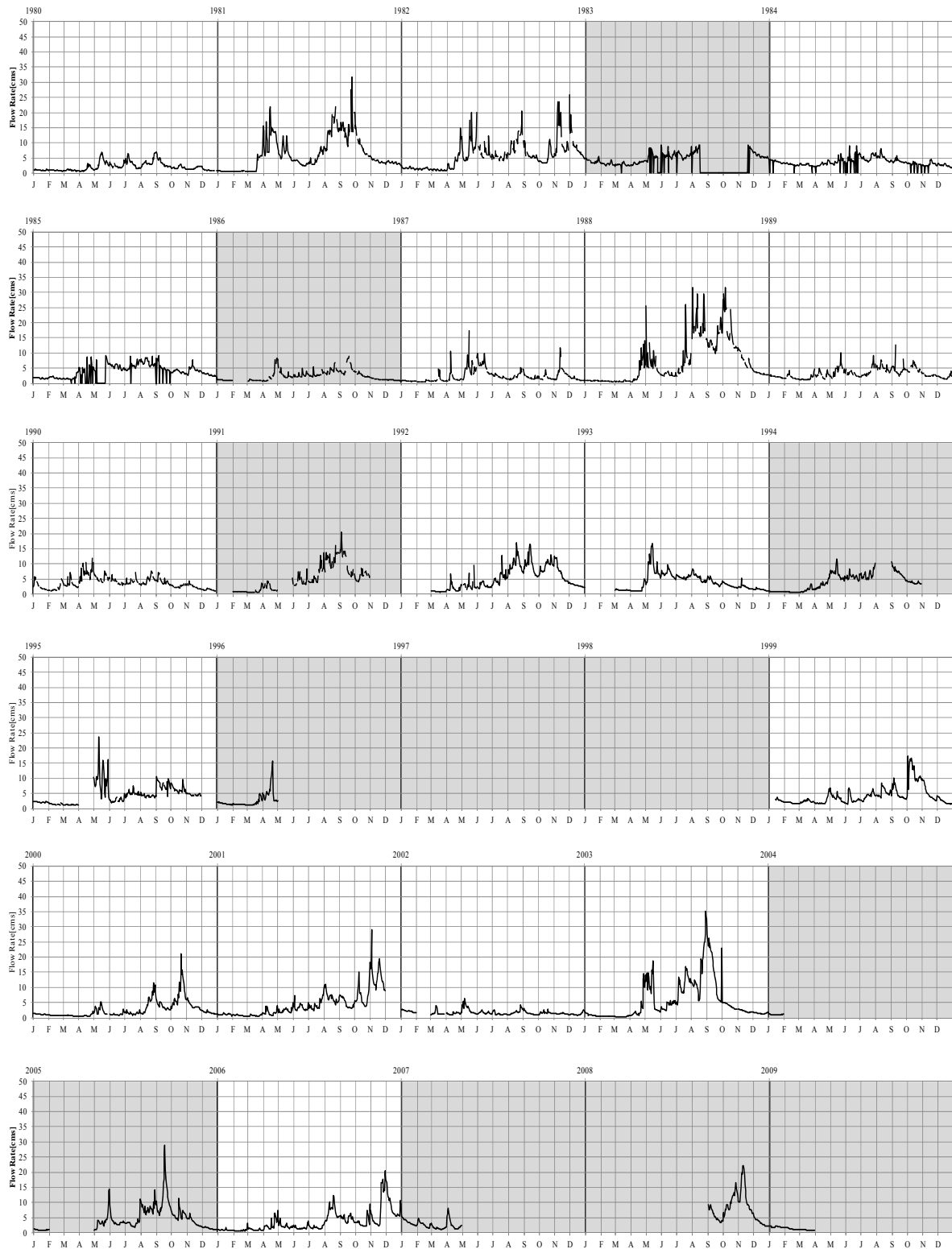
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.1
Availability of Observed River Flow
(1AH01,Sio)**



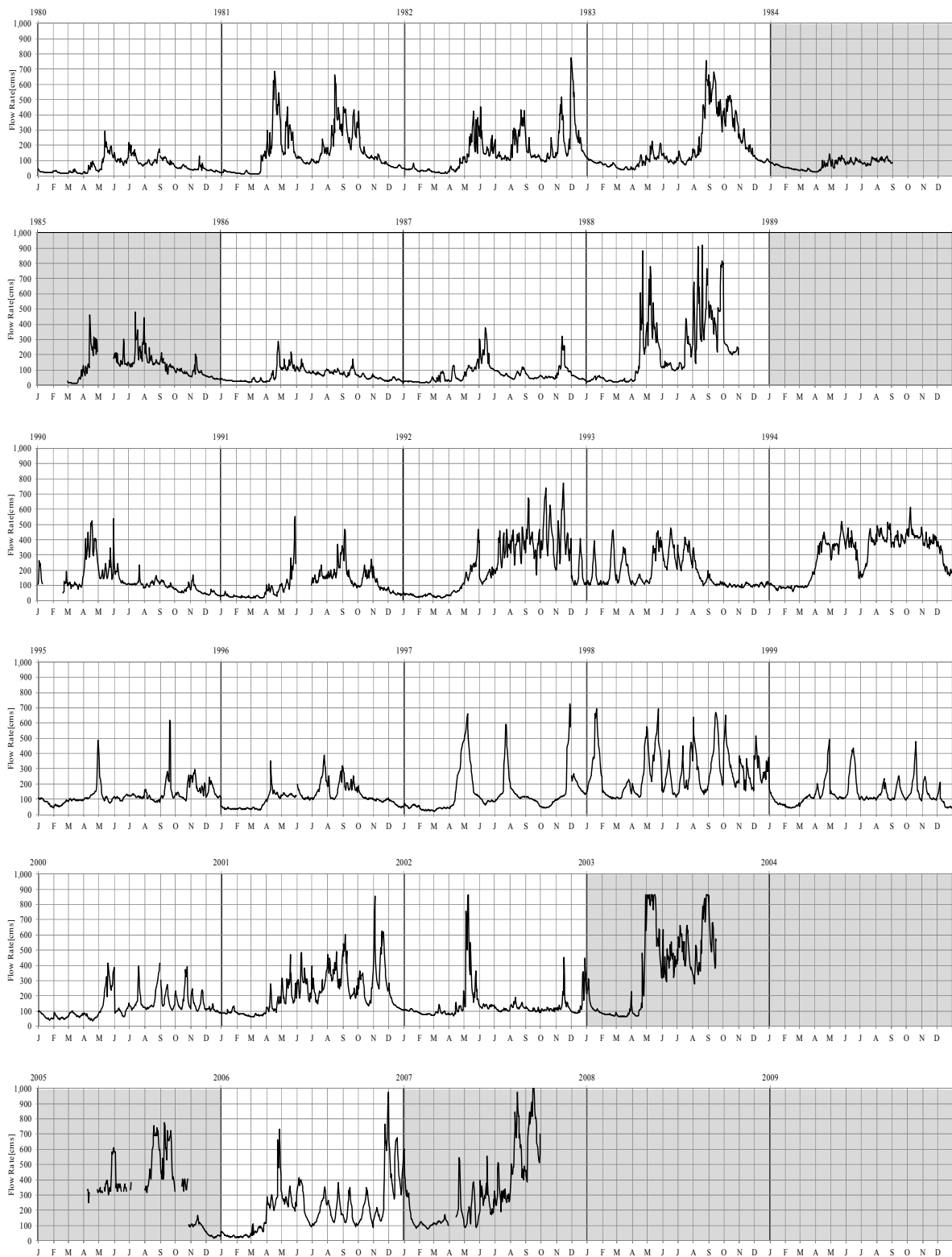
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.2
Availability of Observed River Flow
(1BG07, Rongai)**



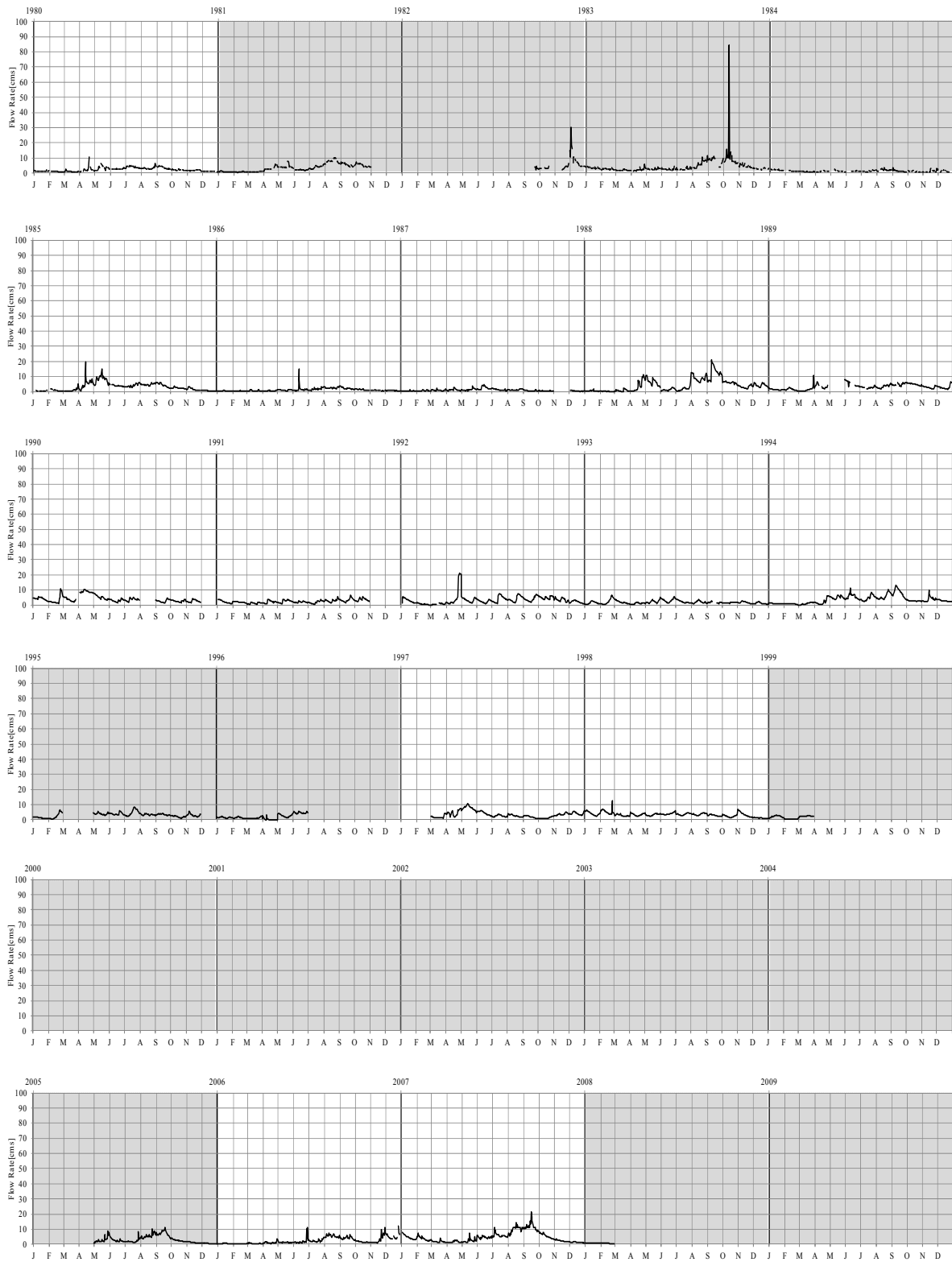
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.3
Availability of Observed River Flow
(1EF01, Nzoia at Ruambwa)**



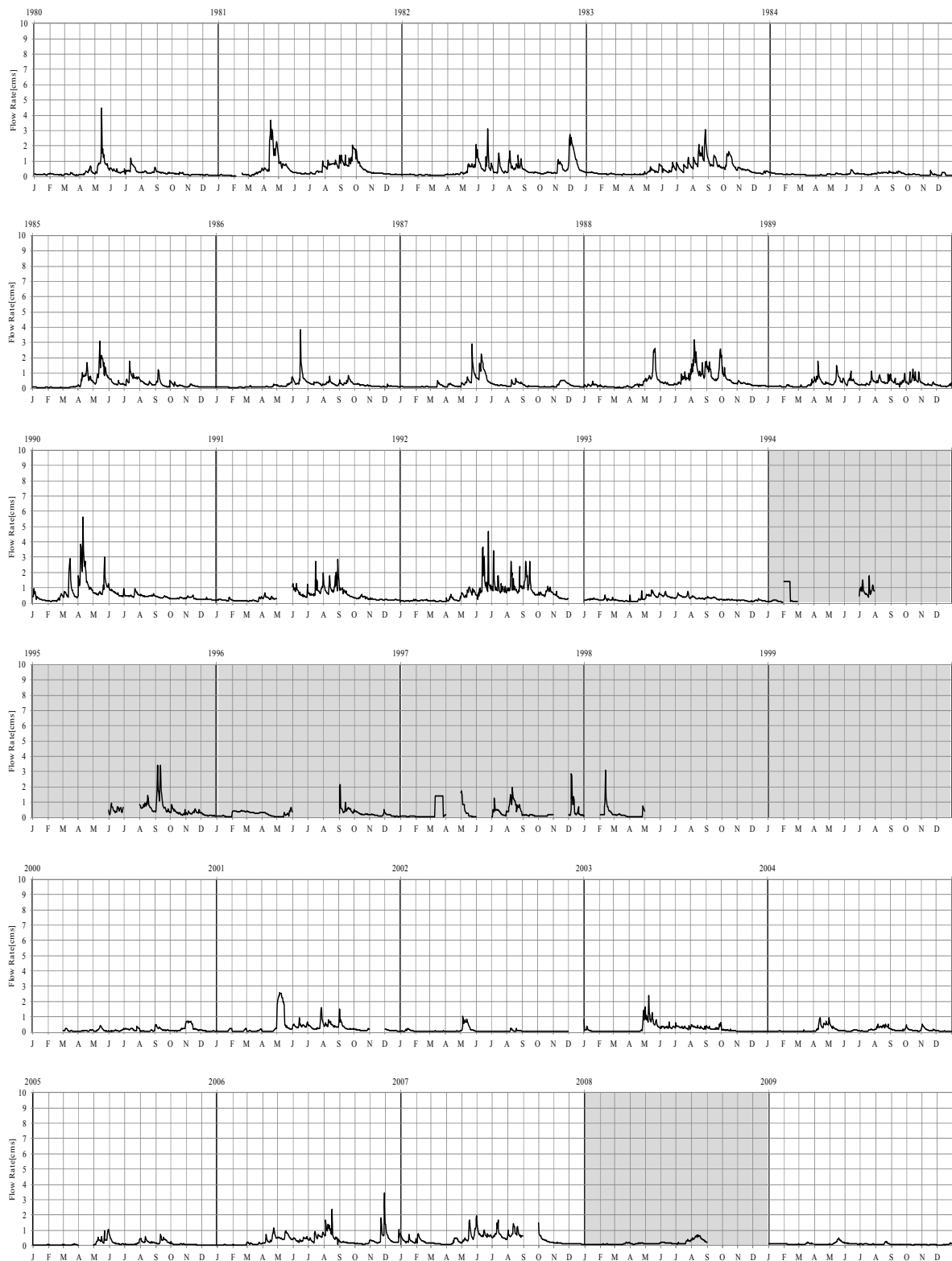
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.4
Availability of Observed River Flow
(1GB05, Ainamatua)**



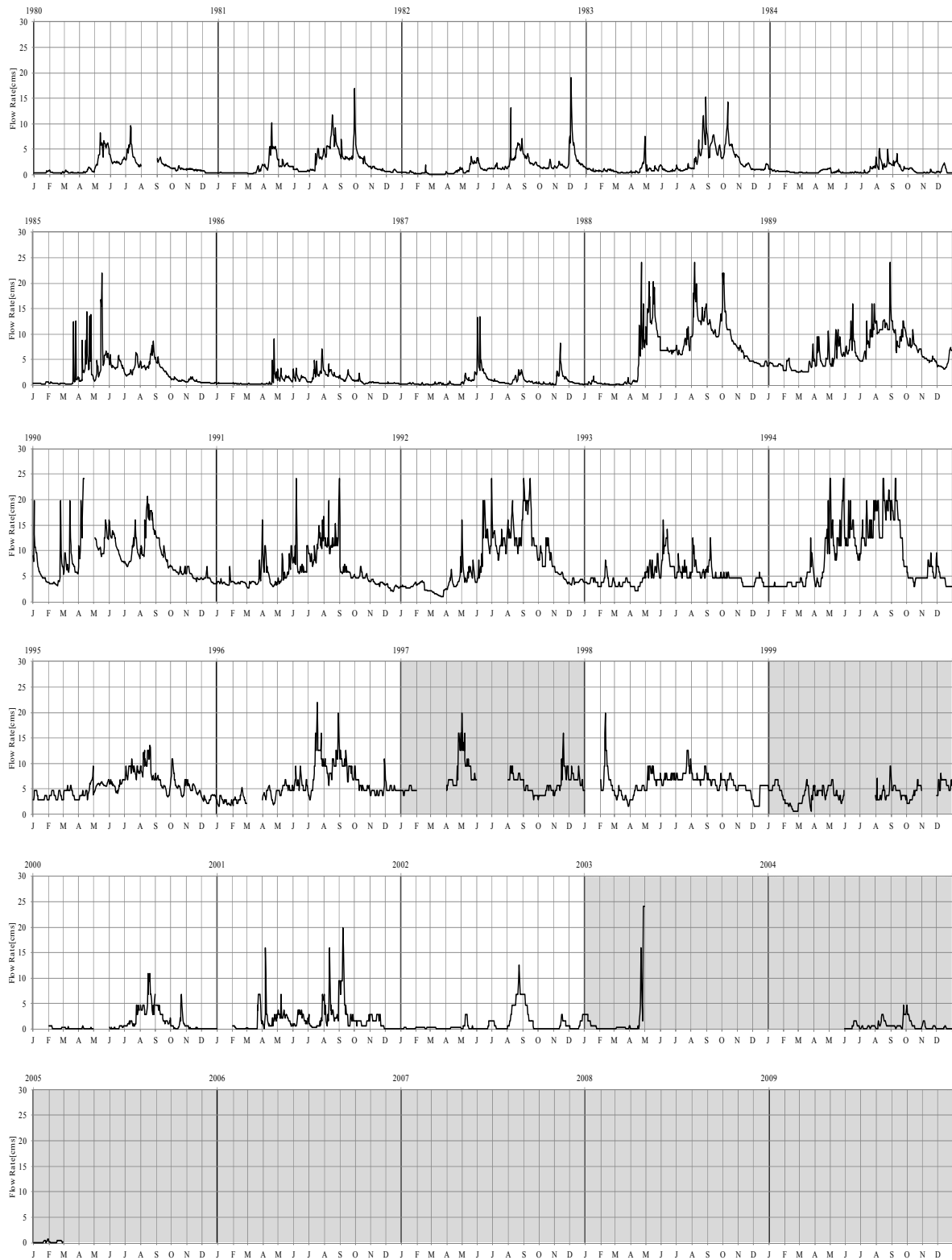
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.5
Availability of Observed River Flow
(1GC04, Tugenon)**



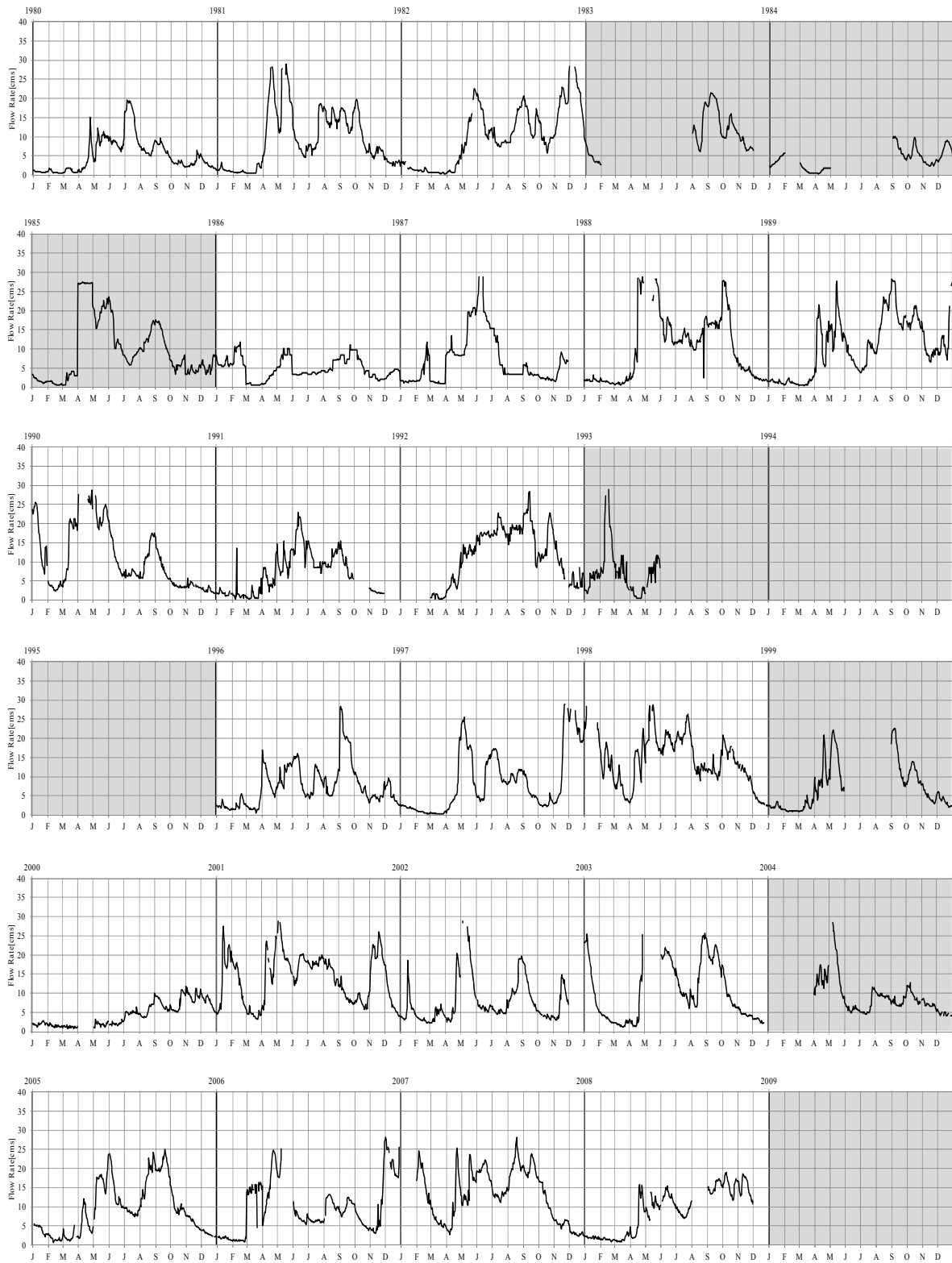
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.6
Availability of Observed River Flow
(1GG01, Namuting)**



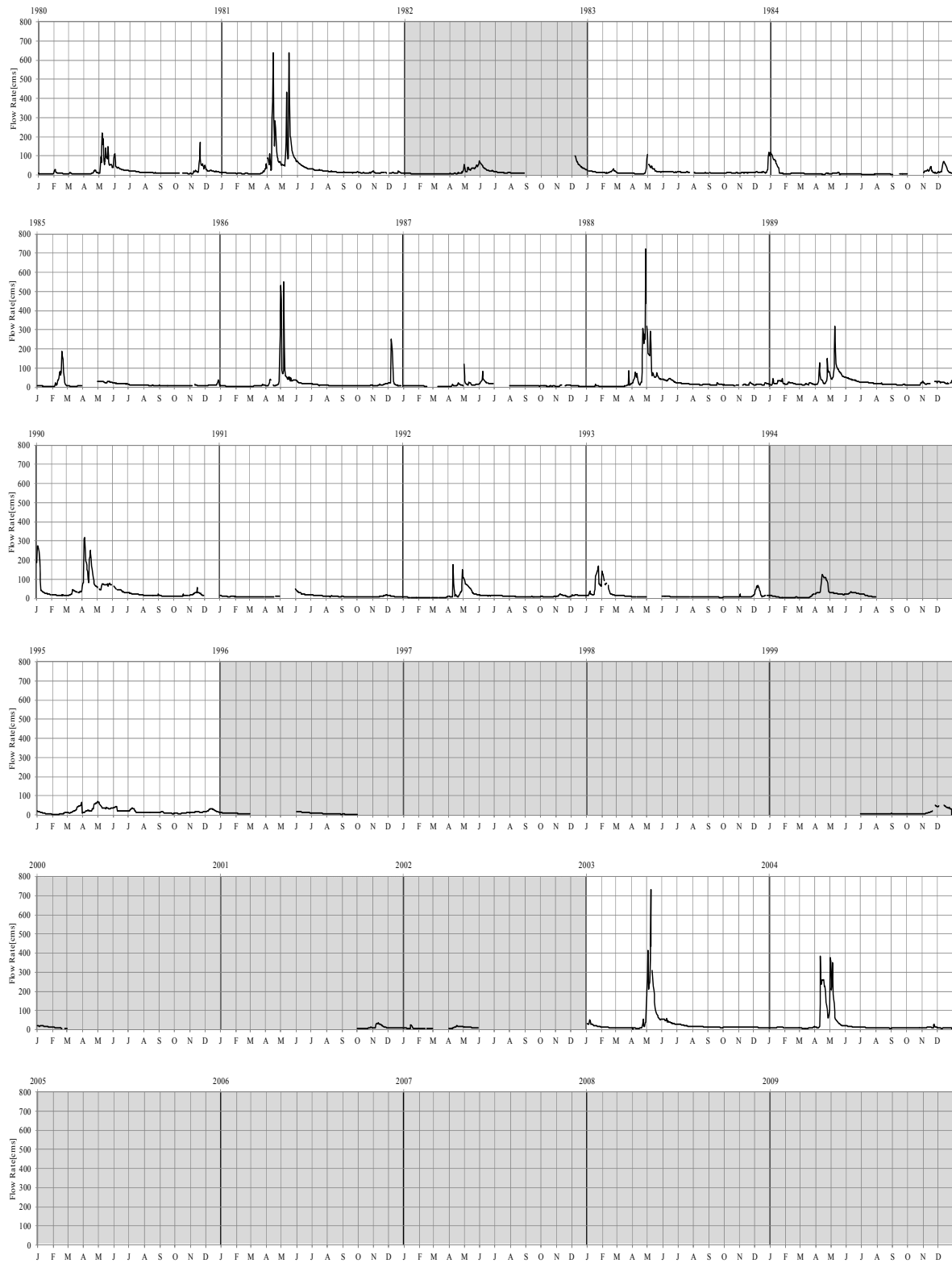
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.7
Availability of Observed River Flow
(1LA03, Nyangores)**



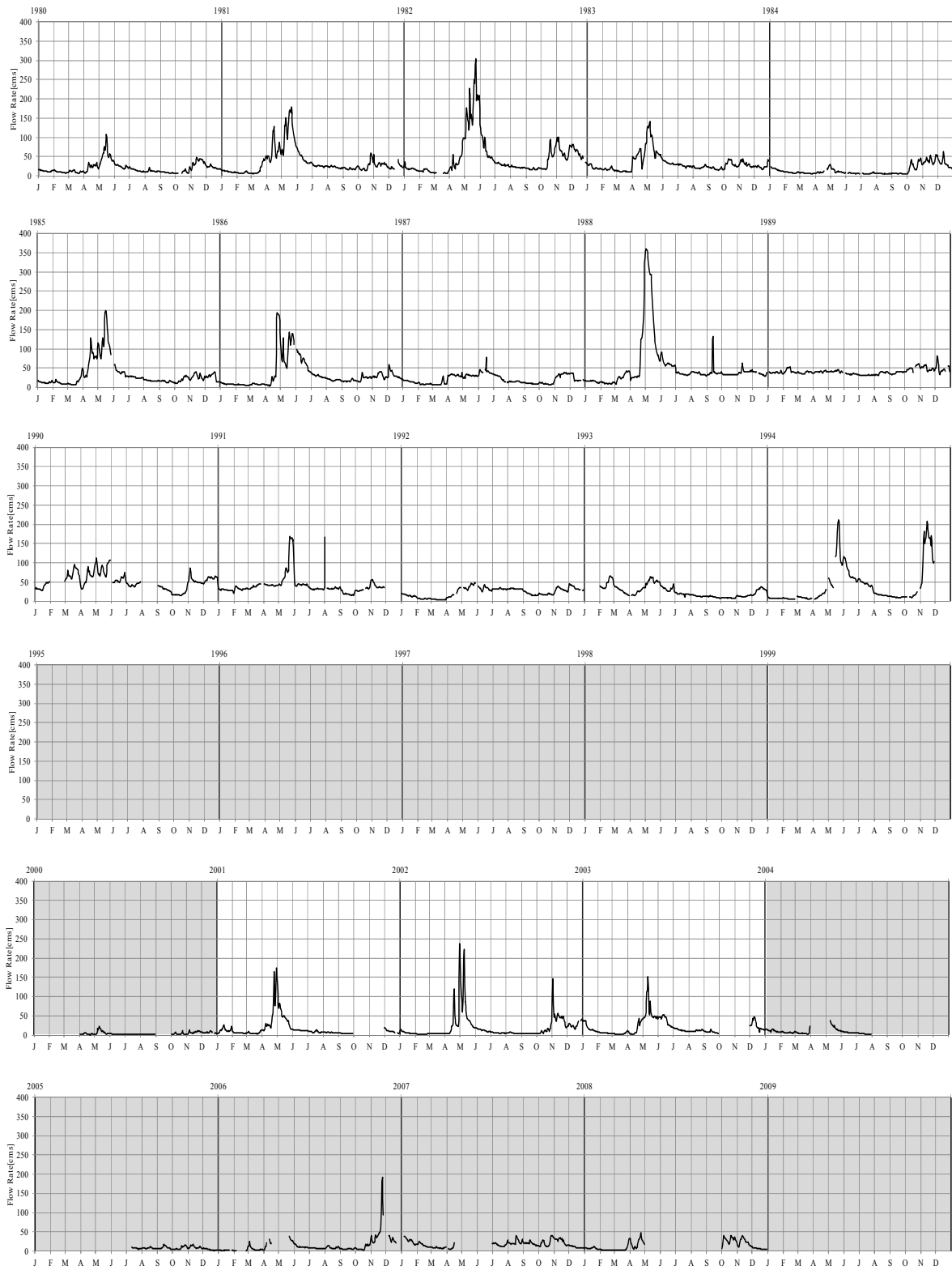
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.8
Availability of Observed River Flow
(3DA02, Athi Munyu)**



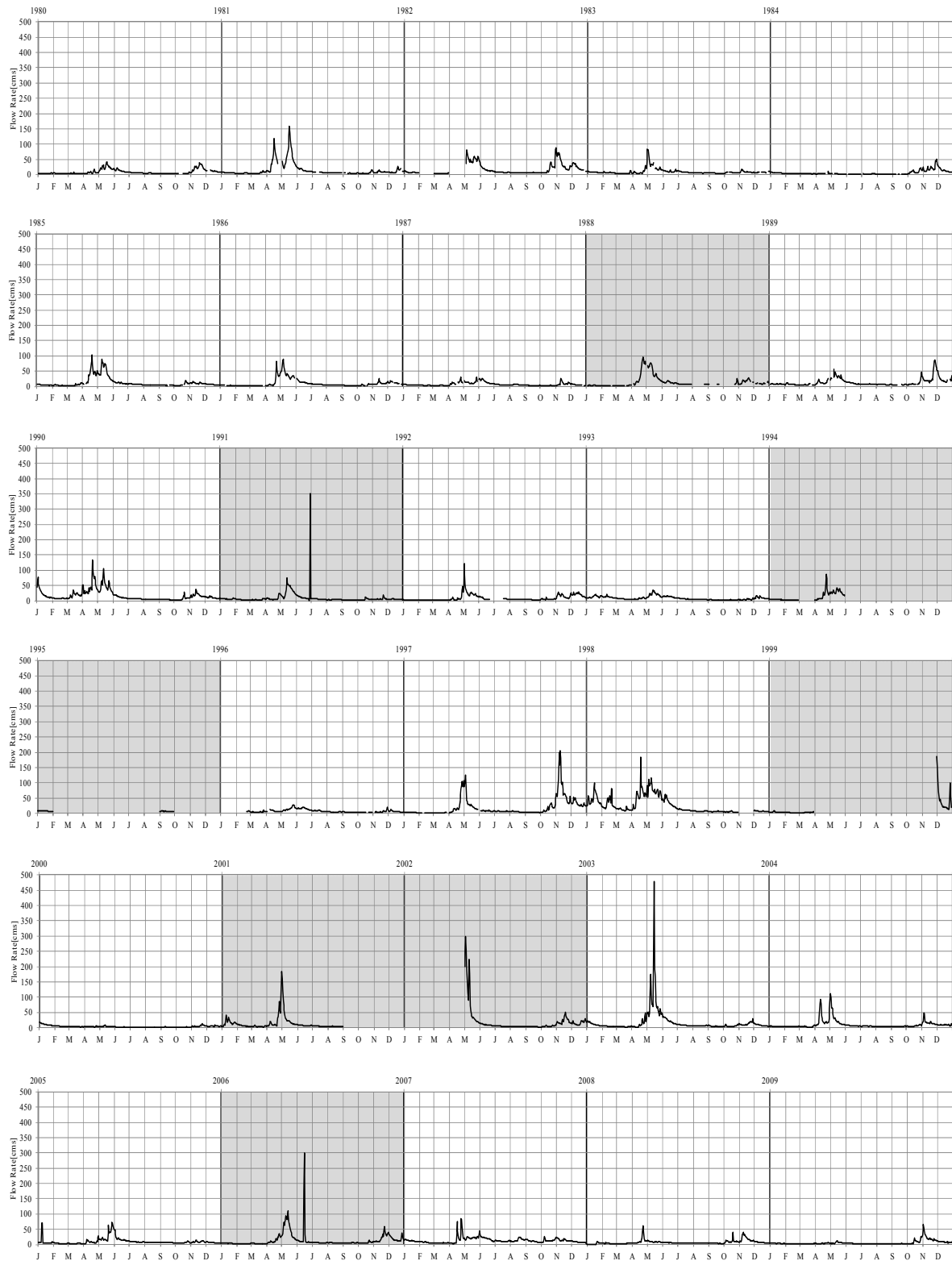
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.9
Availability of Observed River Flow
(4BC02, Tana Sagana)**



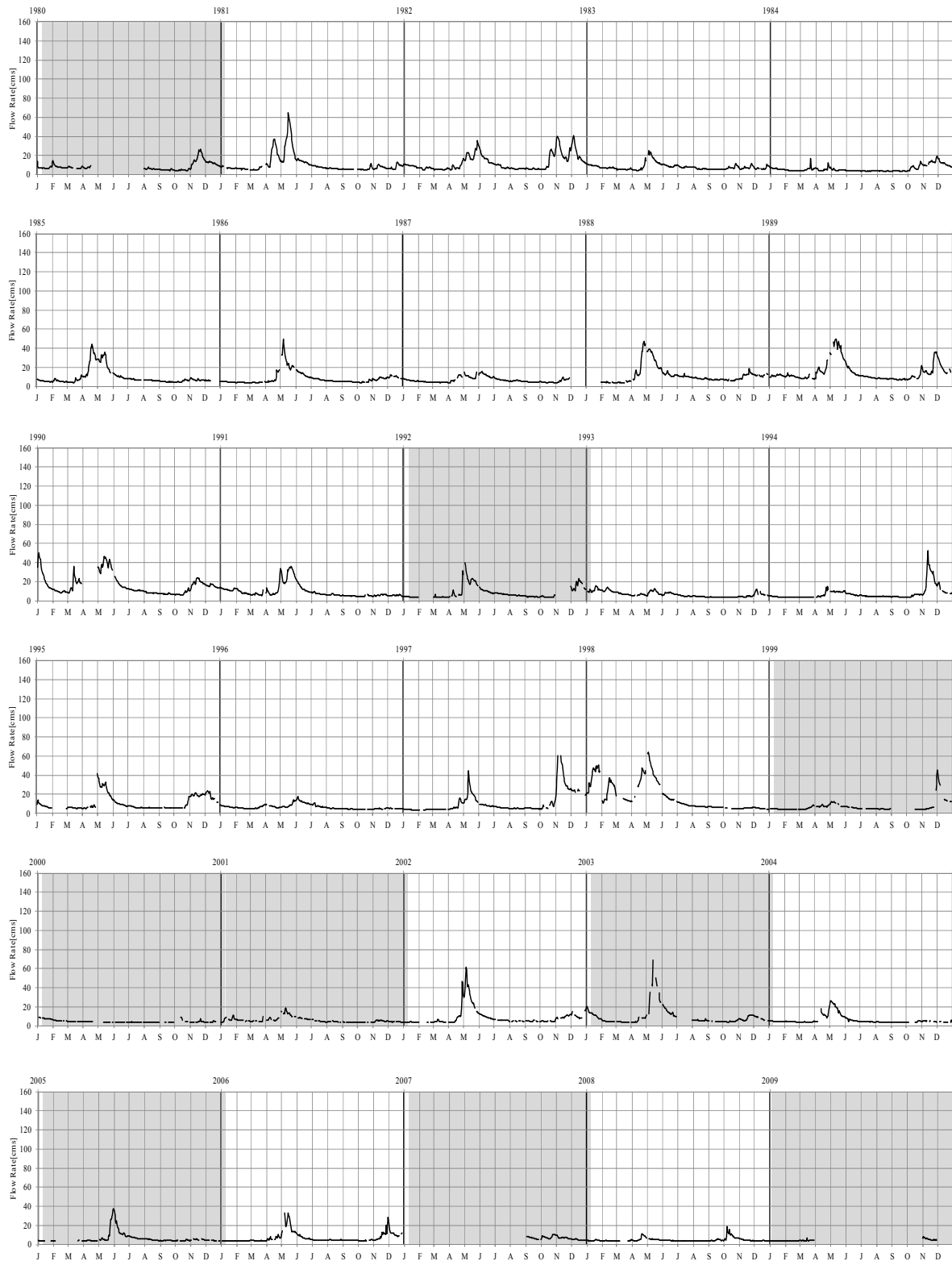
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.10
Availability of Observed River Flow
(4BE01, Maragua)**



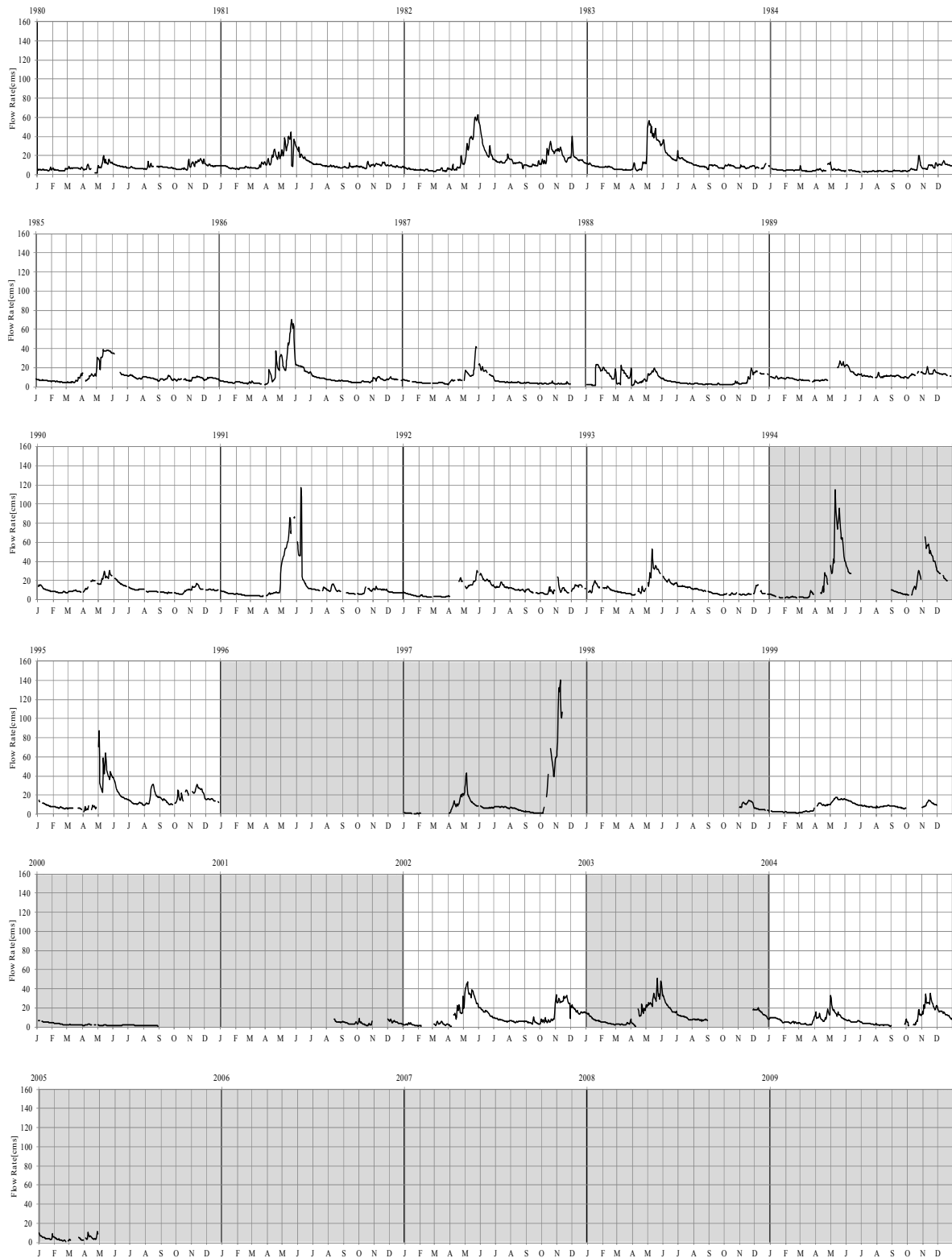
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.11
Availability of Observed River Flow
(4CB04, Thika)**



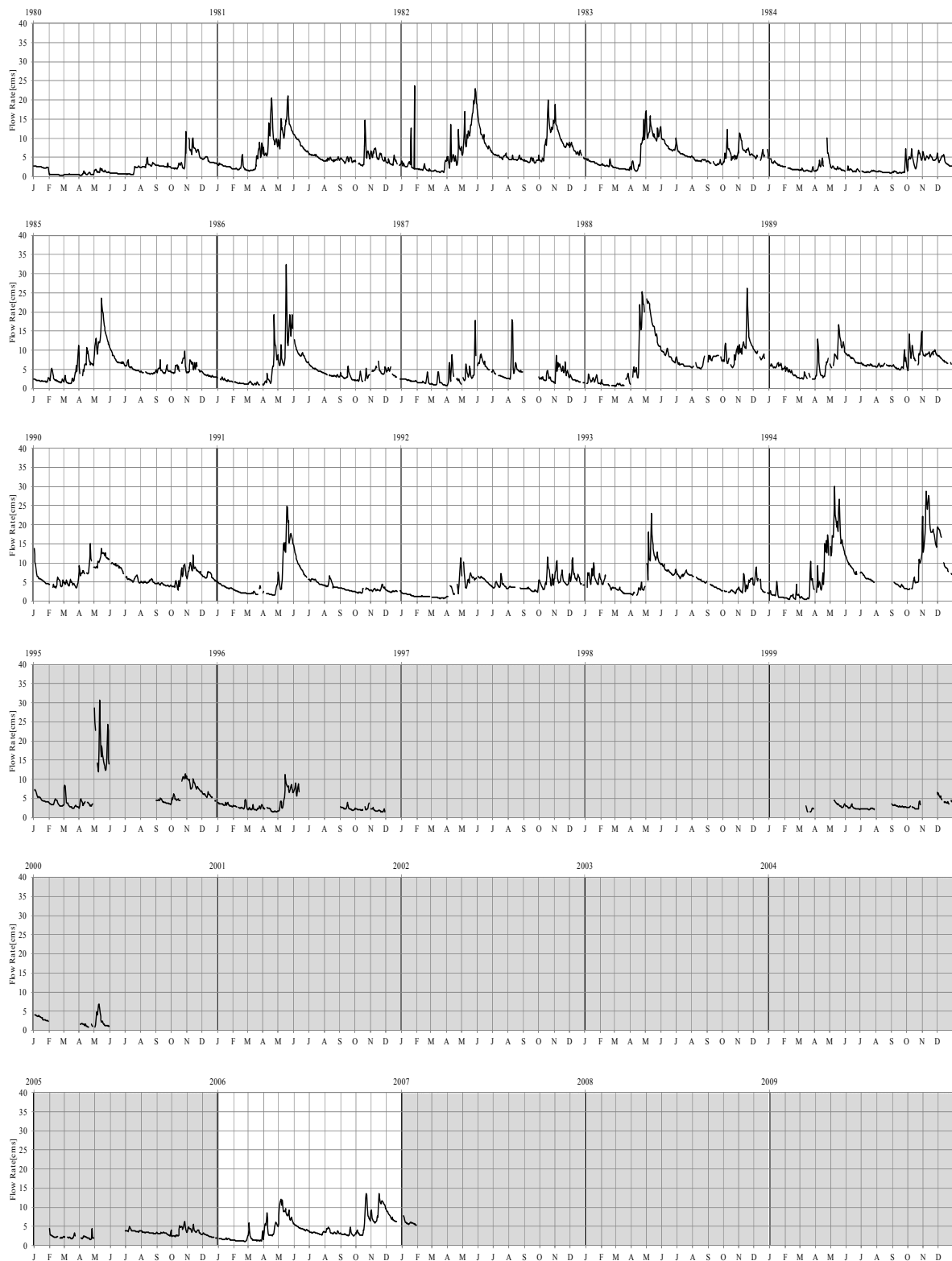
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.12
Availability of Observed River Flow
(4DA10, Thiba)**



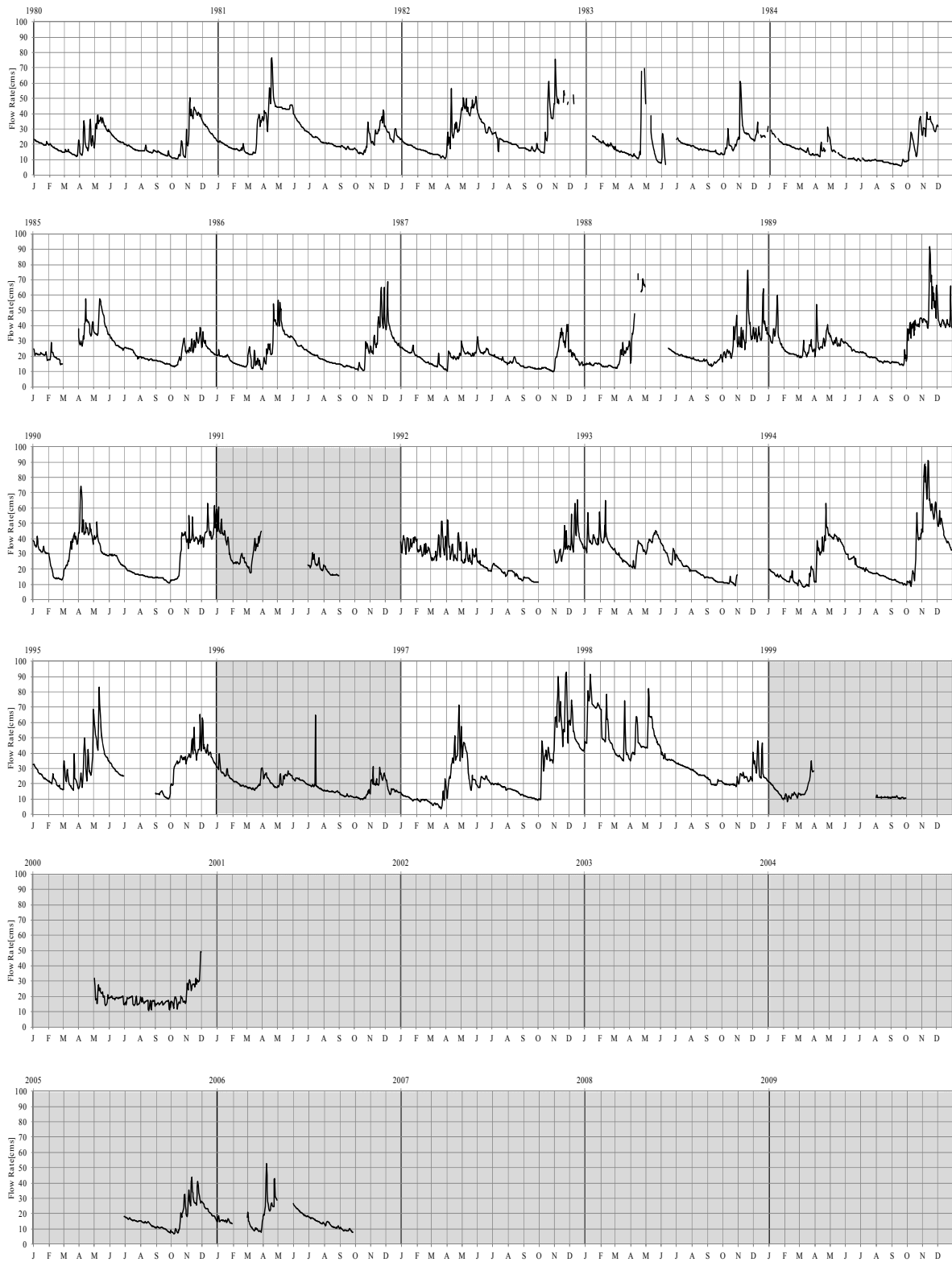
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.13
Availability of Observed River Flow
(4DC03, Rупingazi)**



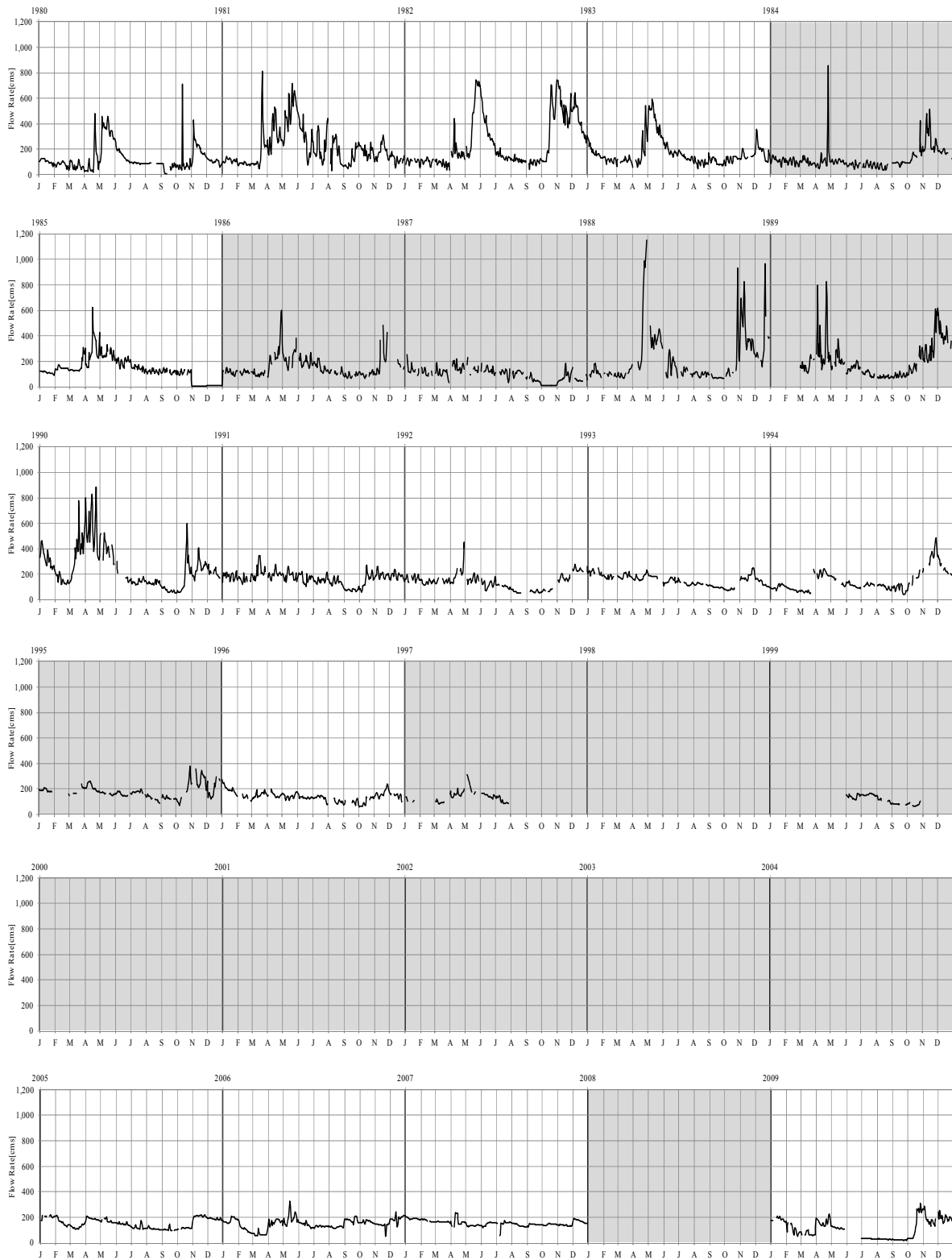
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.14
Availability of Observed River Flow
(4EA07, Mutonga)**



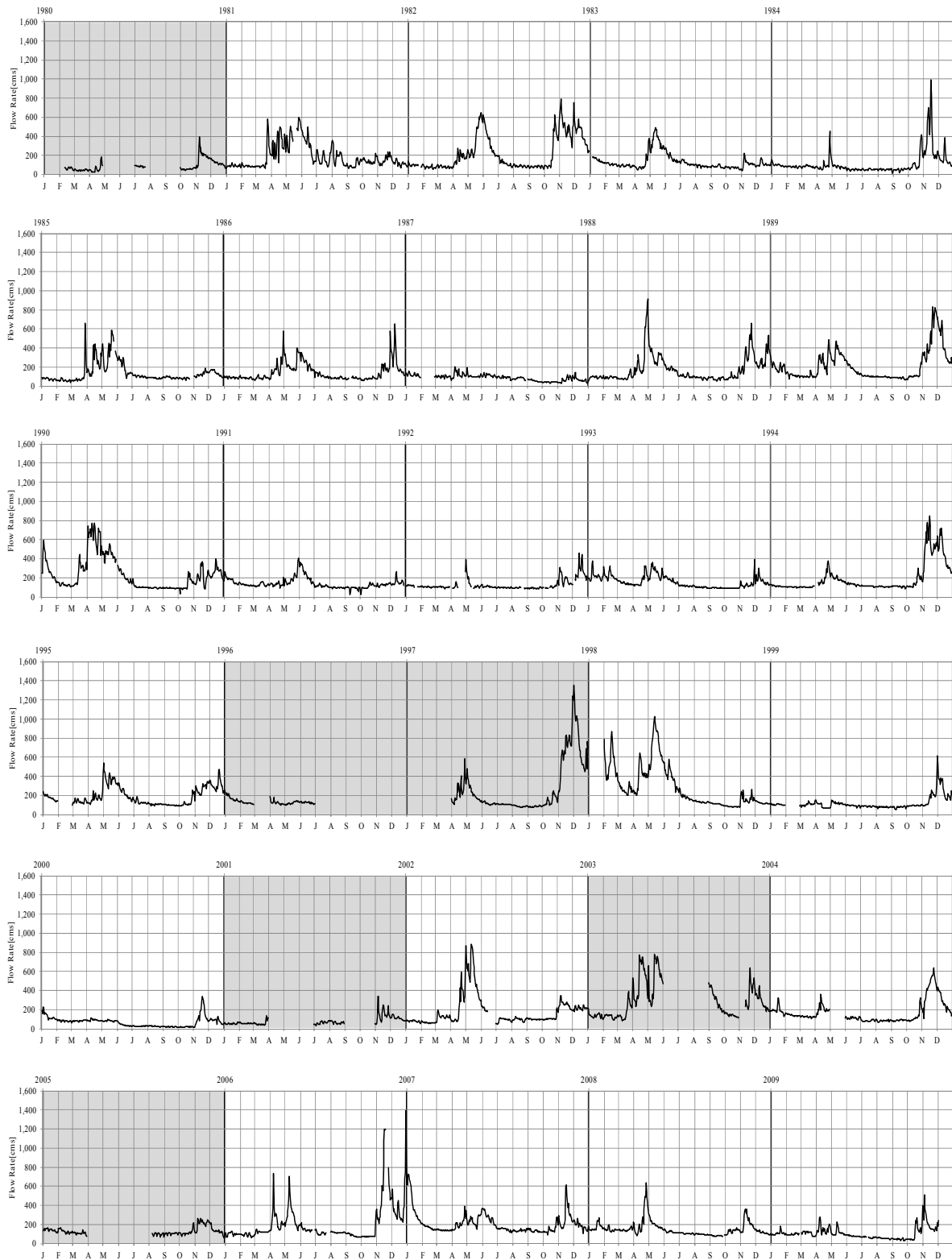
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.15
Availability of Observed River Flow
(4F13, Grand Falls)**



Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.16
Availability of Observed River Flow
(4G01, Garissa)**



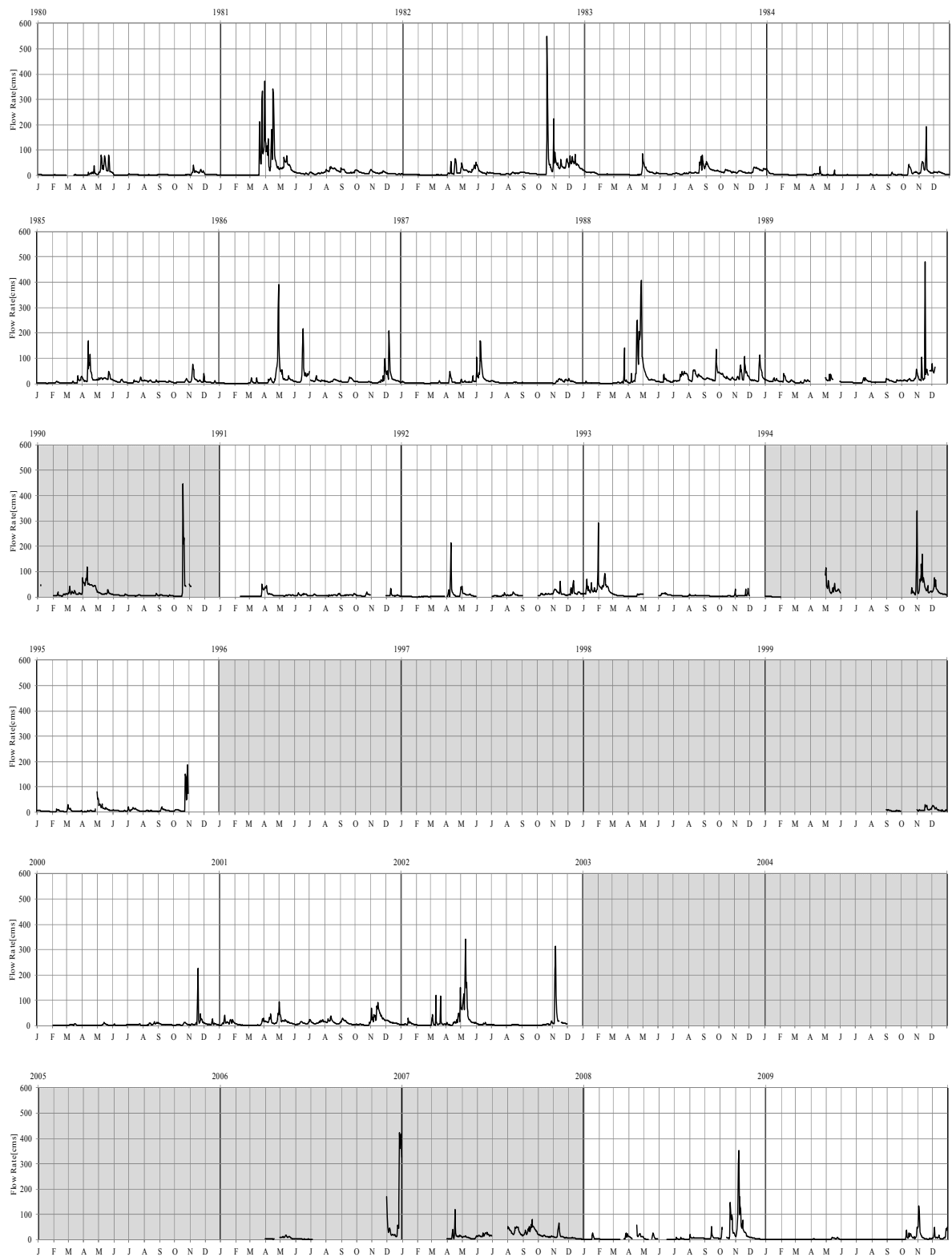
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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**Figure 6.2.17
Availability of Observed River Flow
(5BB02, Ewaso Ng'iro)**



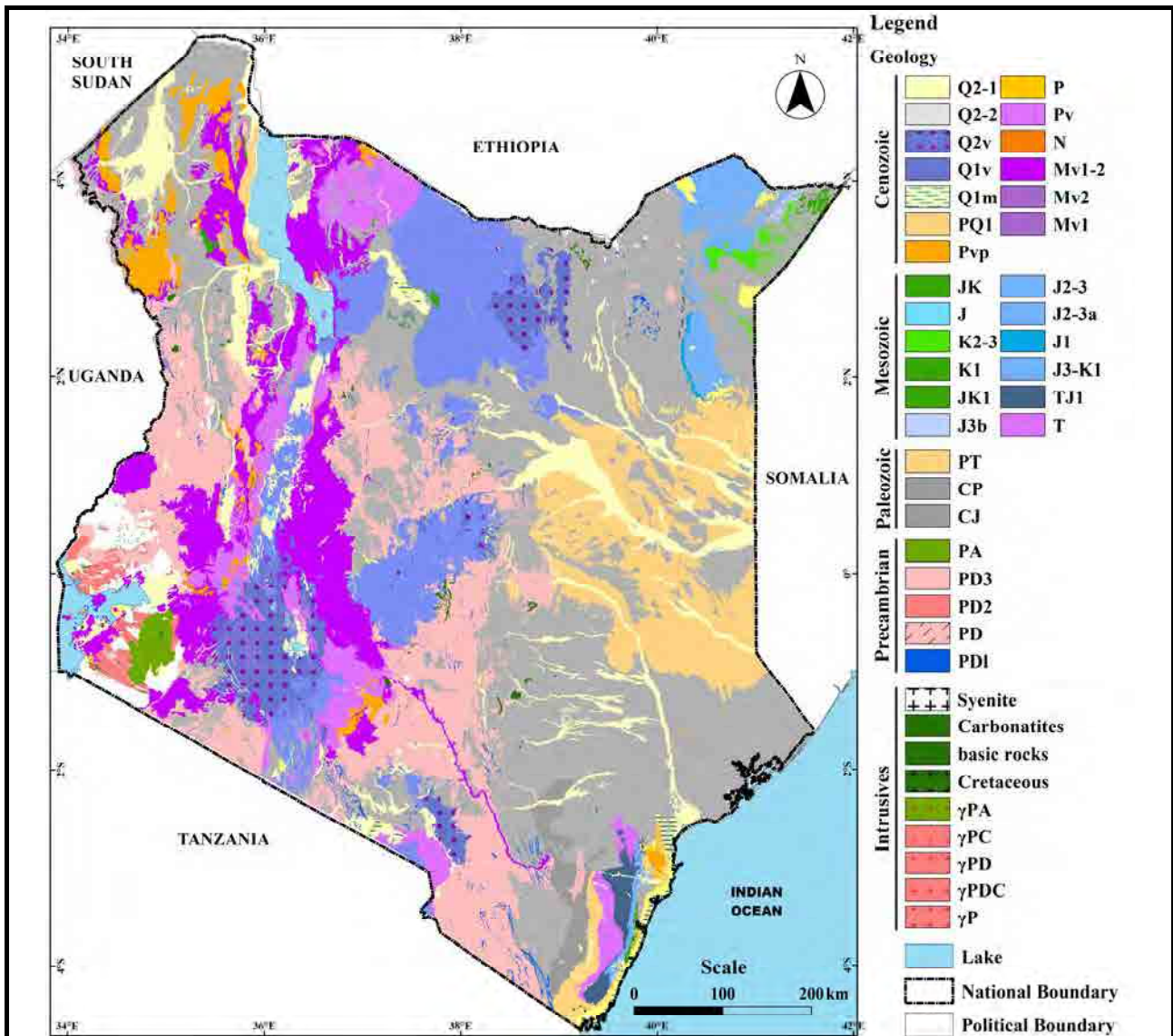
Source: MWI and WRMA

Note: The grayed years are excluded for the frequency analysis due to the lack of the data availability.

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Figure 6.2.18
Availability of Observed River Flow
(5E03, Ewaso Ng'iro at Archers' Post)



Period	Geology	Description
Cenozoic	Q2-1	Holocene. Alluvium
	Q2-2	Holocene. Colluvial deposits, pebble sheets and red soils
	Q2v	Holocene. Basalt flows, pyroclastics, volcanic soils
	Q1v	Pleistocene. Trachytes, basalts and pyroclastics
	Q1m	Pleistocene. Sands, marine deposits
	PQ1	Plio-Pleistocene. Sediments of Turkana area
	Pvp	Pliocene. Trachytes, phonolites, basalts, rhyolites
	P	Pliocene. Sandstones, sands
	Pv	Pliocene. Trachyte, phonolite, basalts
	N	Neogene. Undifferentiated sediments, interbedded in volcanic, sands, shales, tuffs
Mesozoic	M ₁ , M ₂	Miocene Phonolites, trachytes and olivine basalts
	JK	Jurassic-Cretaceous. Turkana Grits
	J	Jurassic. Condensate undifferentiated sequence of sandstones, limestones
	K ₂₋₃	Cenomanian to Maastrichtian. Marehan series. Sandstones, shales with marine limestones
	K ₁	Neocomian. Shales and limestone
	JK ₁	Tithonian to Neocomian. Mandra Series. Dolomites, shales, sandstones
	J _{3b}	Kimmeridgian-Tithonian. Dense limestone with an intermediate shale member
	J ₂₋₃	Bajocian-Upper Jurassic. Posidona shales and Kambe oolitic limestone

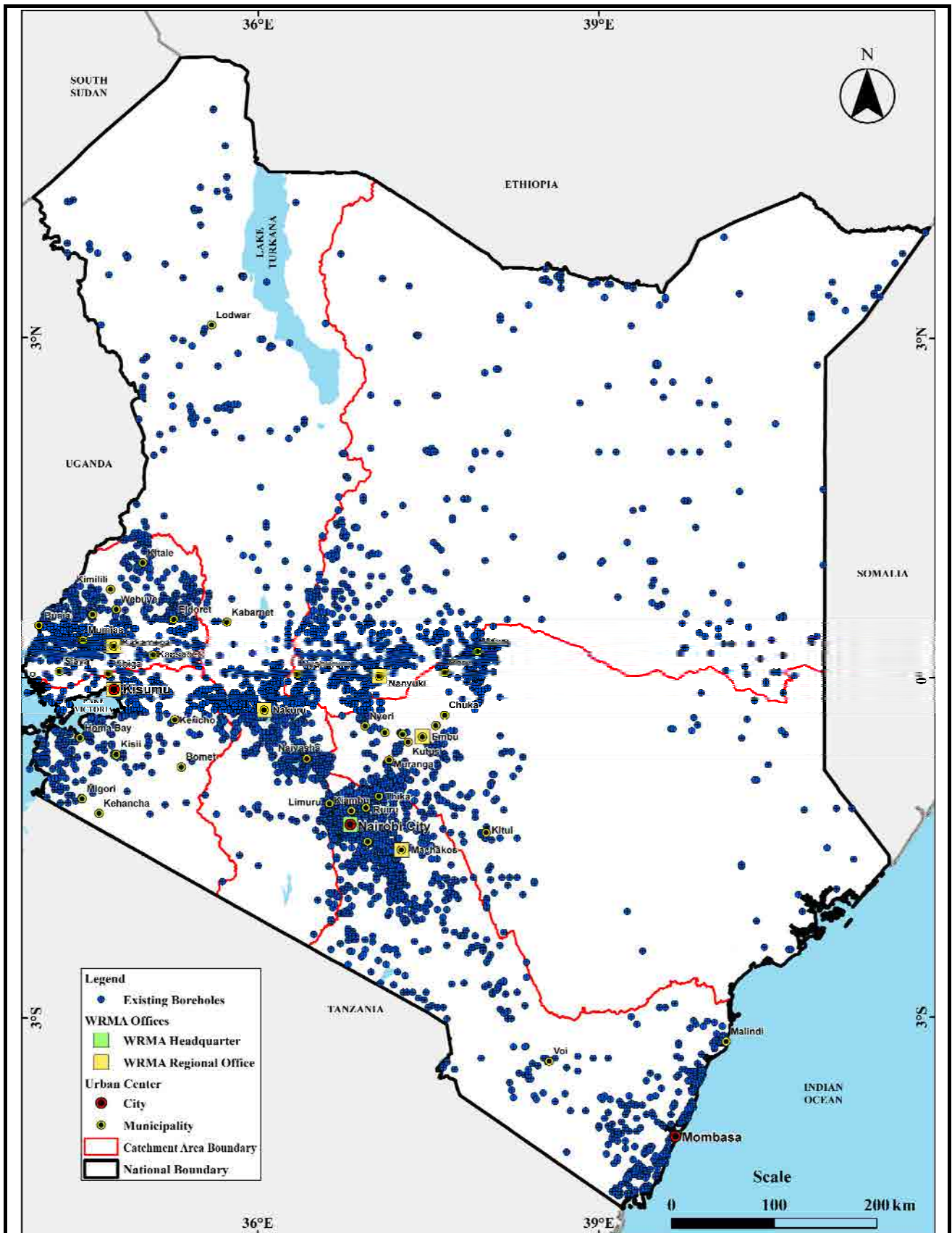
Period	Geology	Description
Mesozoic	J _{2-3a}	Bajocian to Oxfordian. Mainly limestones oolitic or not with shale sans sandstones
	J ₁	Toarcian. Didimtu. Non oolitic limestone
	TJ ₁	Upper Triassic-Lower Lias. Coarse grained sandstones
	T	Triassic. Mariakani. Sandstones, shales
Paleozoic	PT	Permian-Lower Triassic. Maji-ya-Chumvi. Shales, siltstones
	CP	Upper Carboniferous-Lower Permian. Taru Grits. Tillites, grits, shales
	CJ	Duruma Series of undifferentiated Karoo
Precambrian	PA	Precambrian A. Bukoban. Quartzites and volcanics
	PD ₃	Precambrian D ₃ . Kavironidian, Embu. Grits and mudstones
	PD ₂	Precambrian D ₂ . Nyanzian. Rhyolites, andesites, basalts and greywackes
	PD	Precambrian D. Mozambique belt. Quartzites, micaschists, biotite and hornblende gneiss, granitoid gneiss, amphibolites, migmatites, syntectonic granites
Intrusive	PD ₁	Crystalline limestones, intercalations in PD
	γ PA	Precambrian A
	γ PC	Precambrian C
	γ PD	Precambrian D
	γ PDC	Precambrian DC
γ P	Undifferentiated Precambrian	

Source: Ministry of Energy and Regional Development

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**Figure 7.2.1
Geological Map of Kenya**

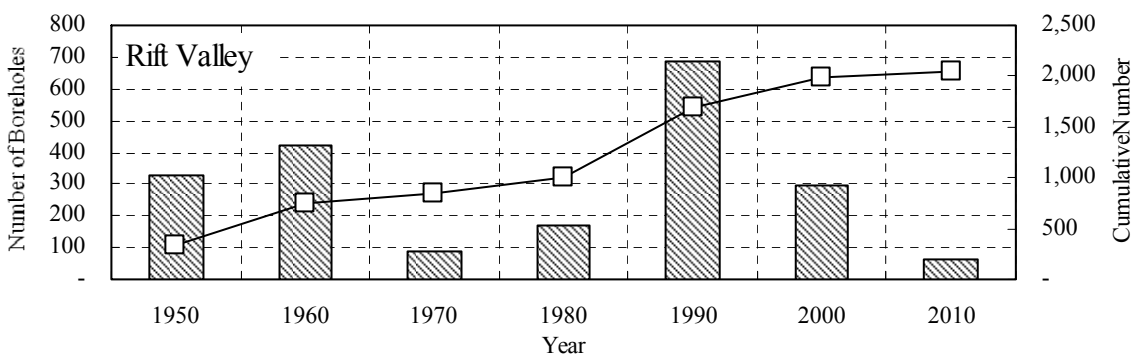
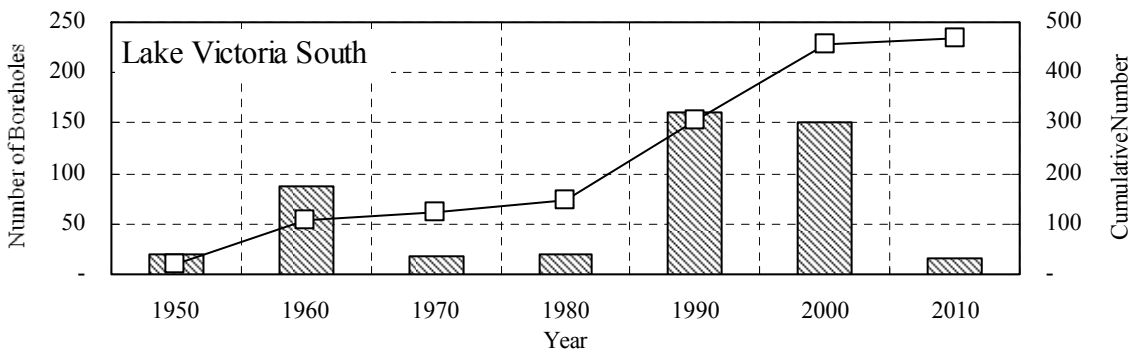
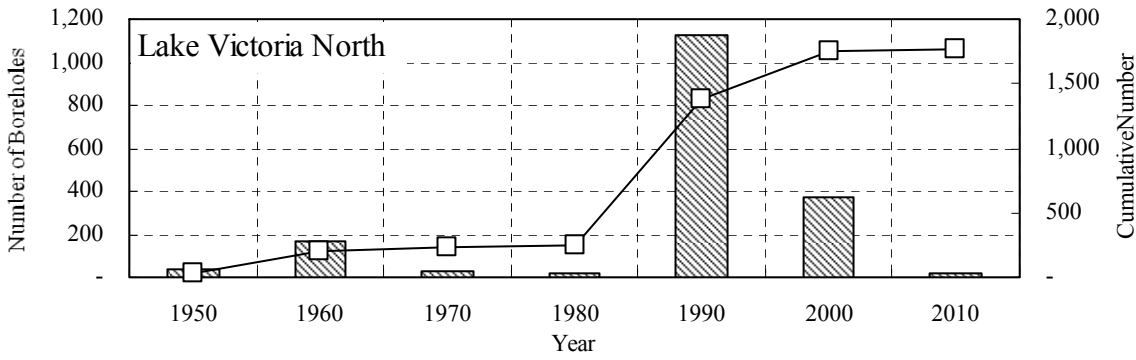
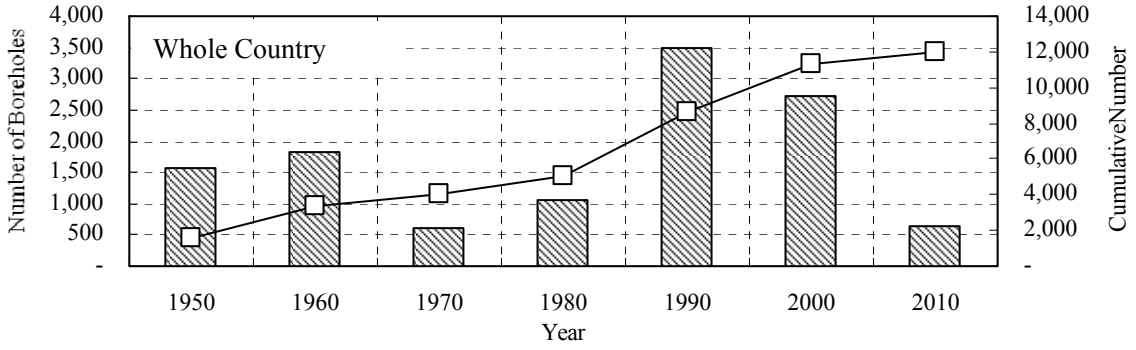


Source : JICA Study Team

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**Figure 7.3.1
Location of Existing Boreholes**

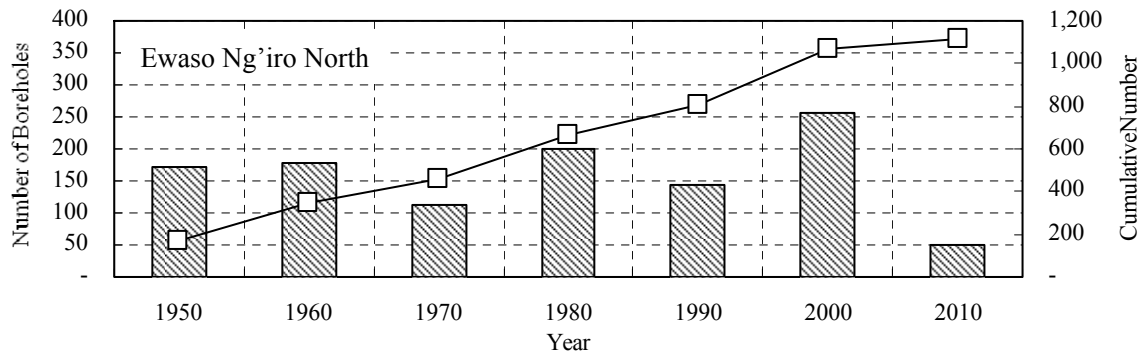
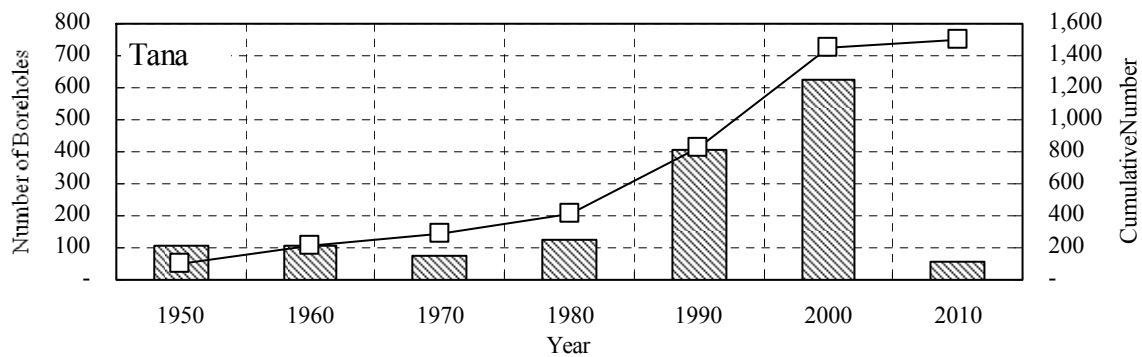
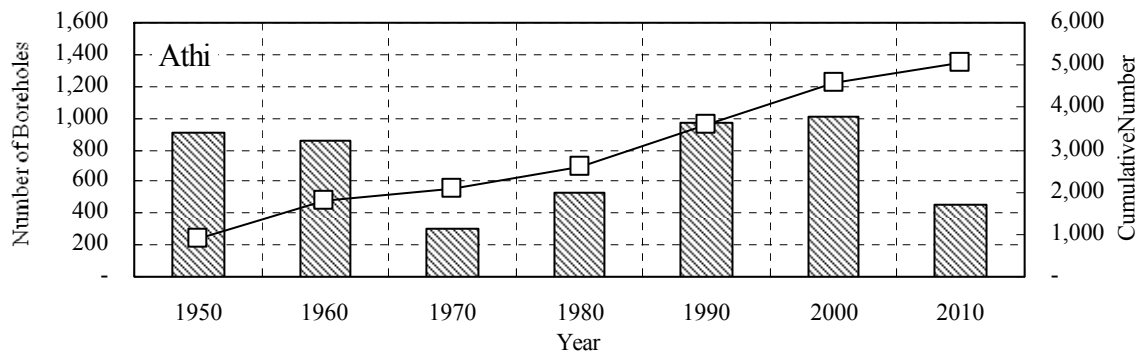


Source: MWI

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Figure 7.3.2
Histograms of Borehole Numbers by
Construction Year (1/2)

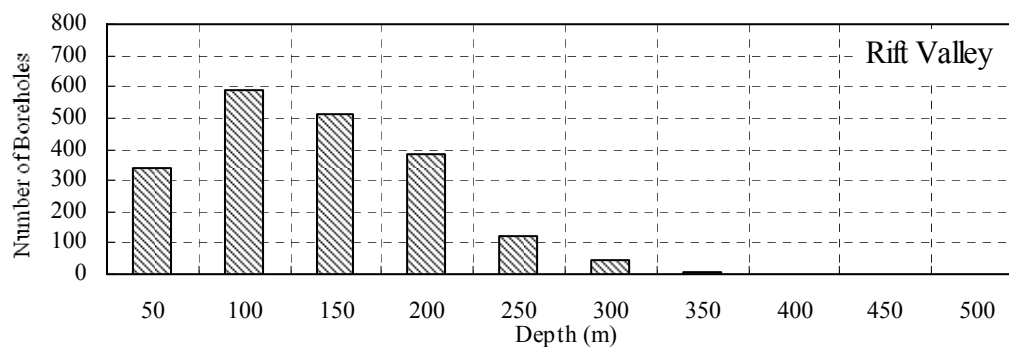
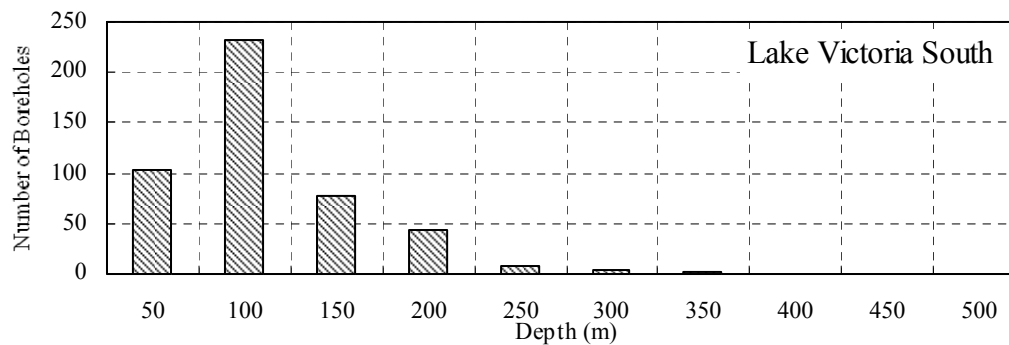
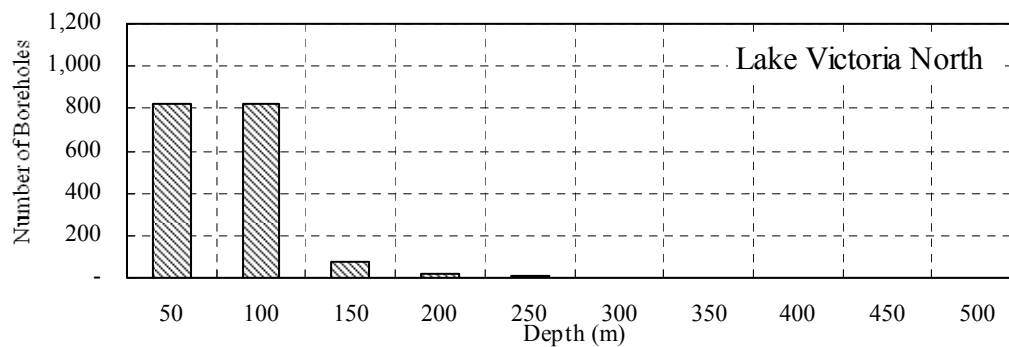
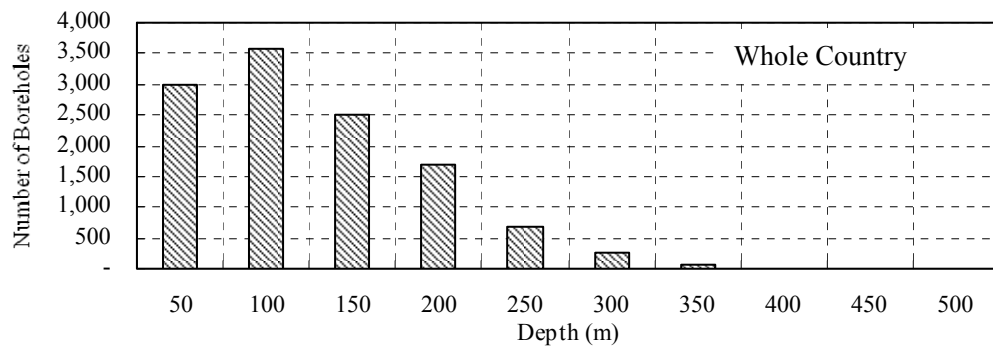


Source: MWI

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Figure 7.3.2
Histograms of Borehole Numbers by
Construction Year (2/2)

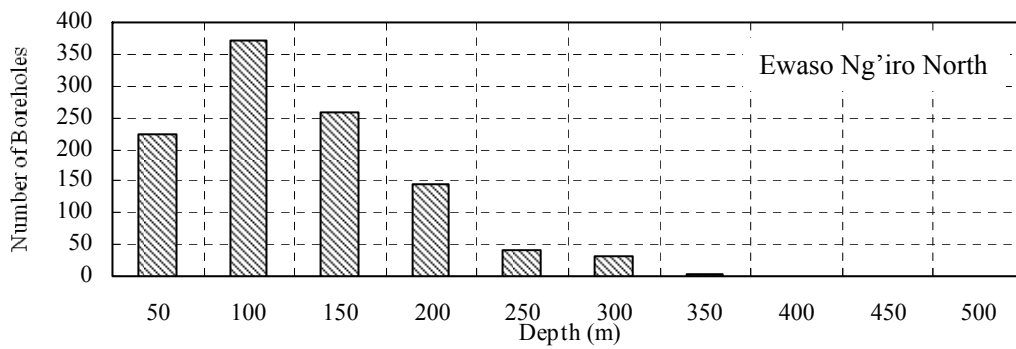
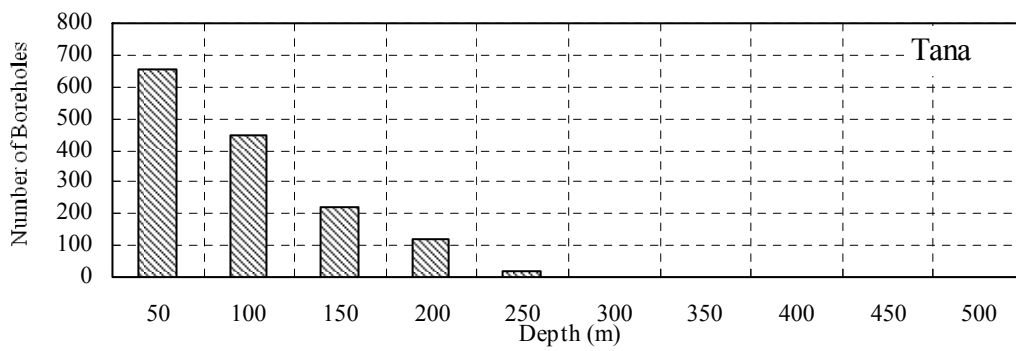
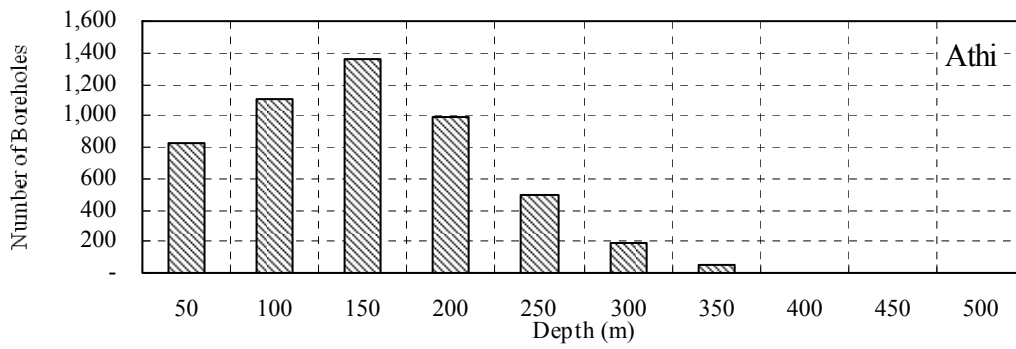


Source: MWI

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Figure 7.3.3
Histograms of Borehole Numbers by
Depth (1/2)

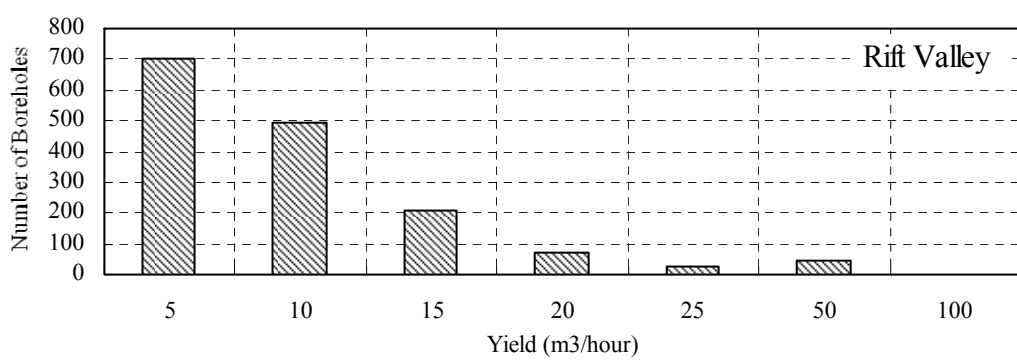
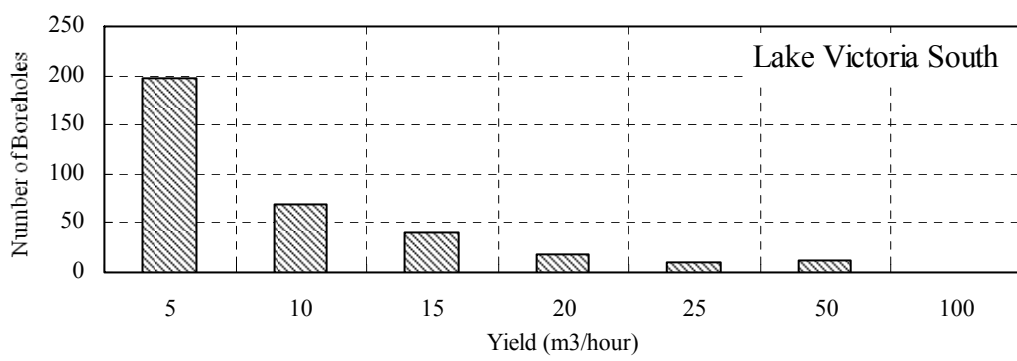
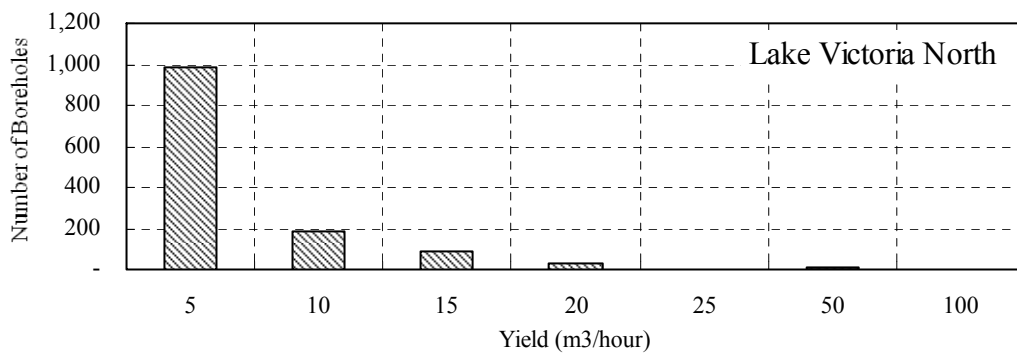
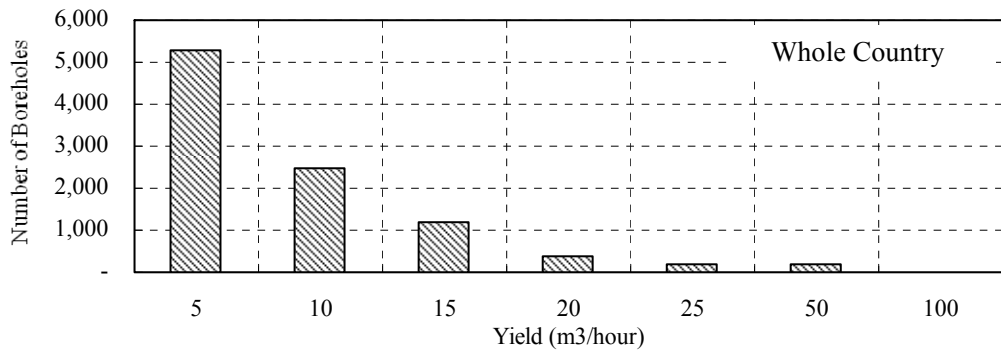


Source: MWI

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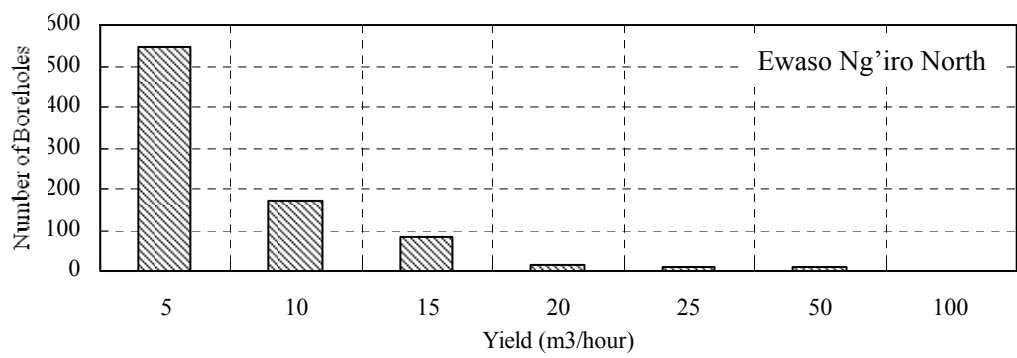
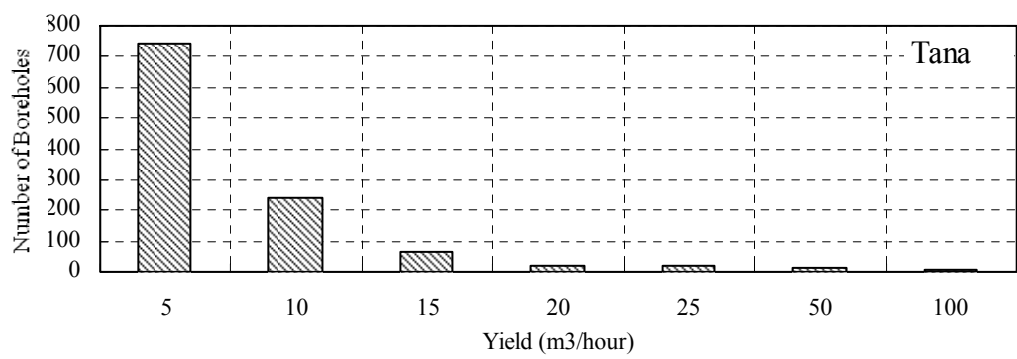
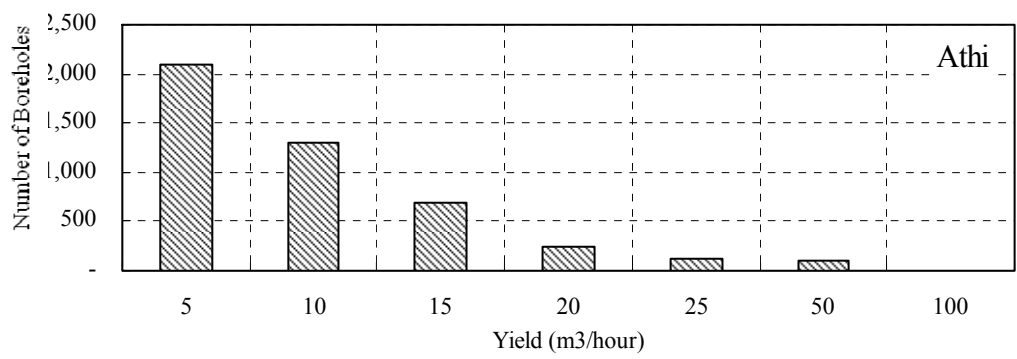
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Figure 7.3.3
Histograms of Borehole Numbers by
Depth (2/2)



Source : MWI

Figure 7.3.4
Histograms of Borehole Numbers by
Yield (1/2)

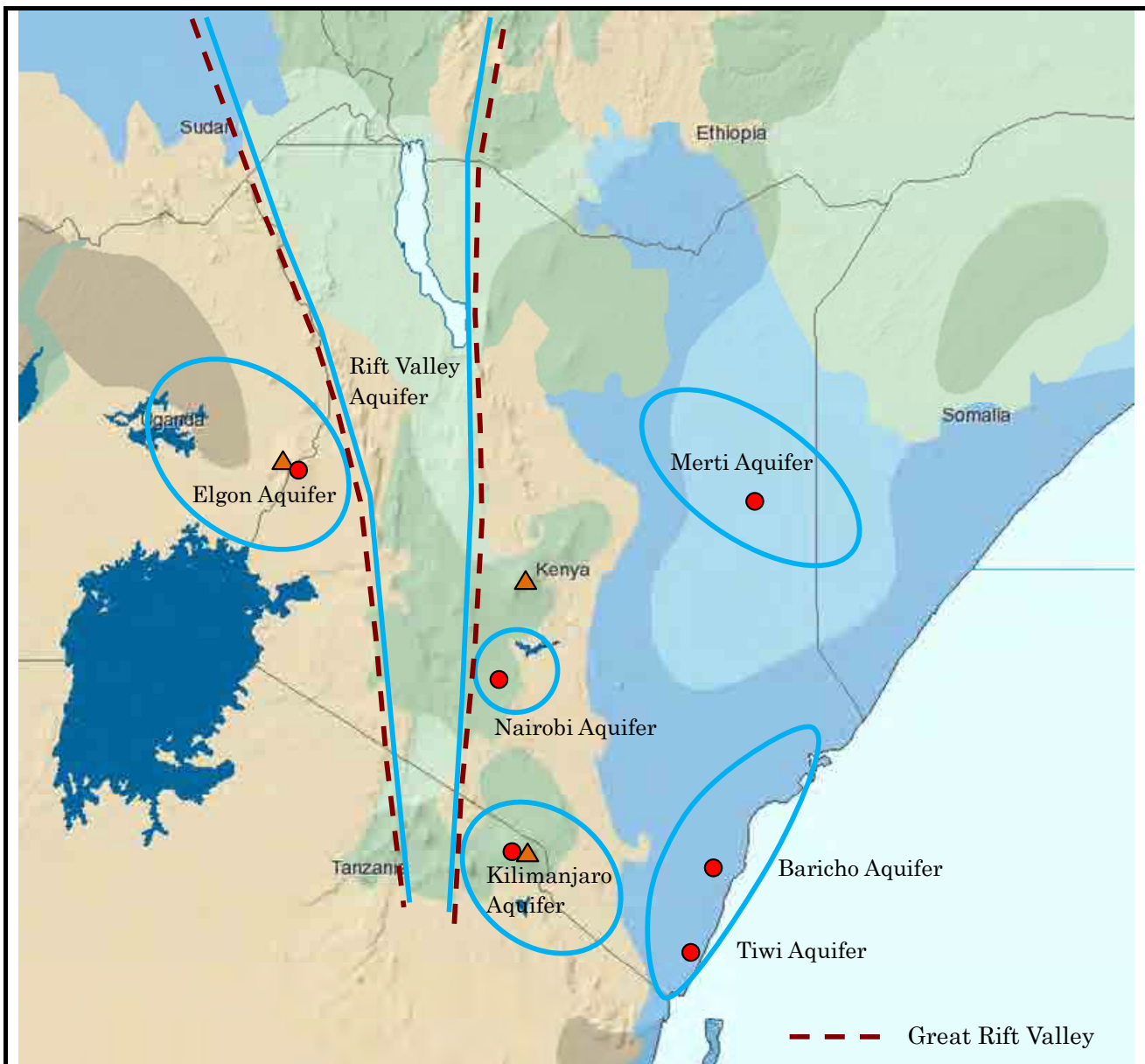


Source : MWI

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Figure 7.3.4
Histograms of Borehole Numbers by
Yield (2/2)



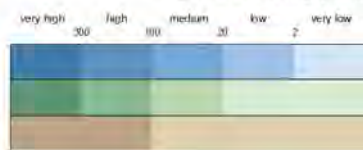
Groundwater resources

- in major groundwater basins
- in areas with complex hydrogeological structure
- in areas with local and shallow aquifers

Special groundwater features

- area of saline groundwater (> 5 g/l total dissolved solids)

groundwater recharge (mm/a)



Geography

- selected city
- selected city, largely dependent on groundwater
- country boundary
- major river
- large freshwater lake
- large saltwater lake

Source : Location of transboundary aquifers, JICA Study Team

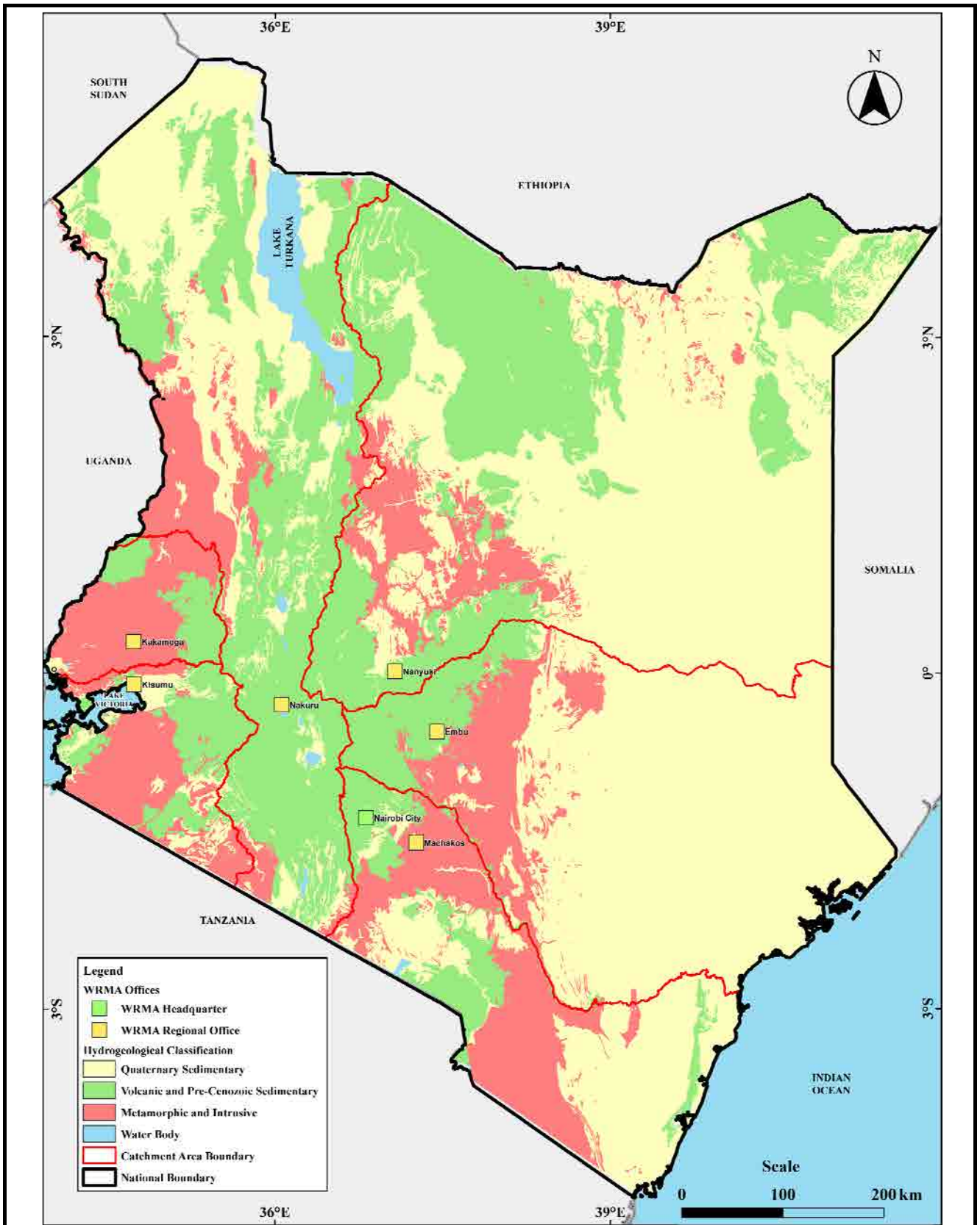
Base on Groundwater Resources of Africa, UNESCO (2008), trimmed focused on Kenya

The site reference to : http://www.whymap.org/whymap/EN/Home/whymap_node.html

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**Figure 7.4.1
Groundwater Resources Map of Kenya
(UNESCO)**

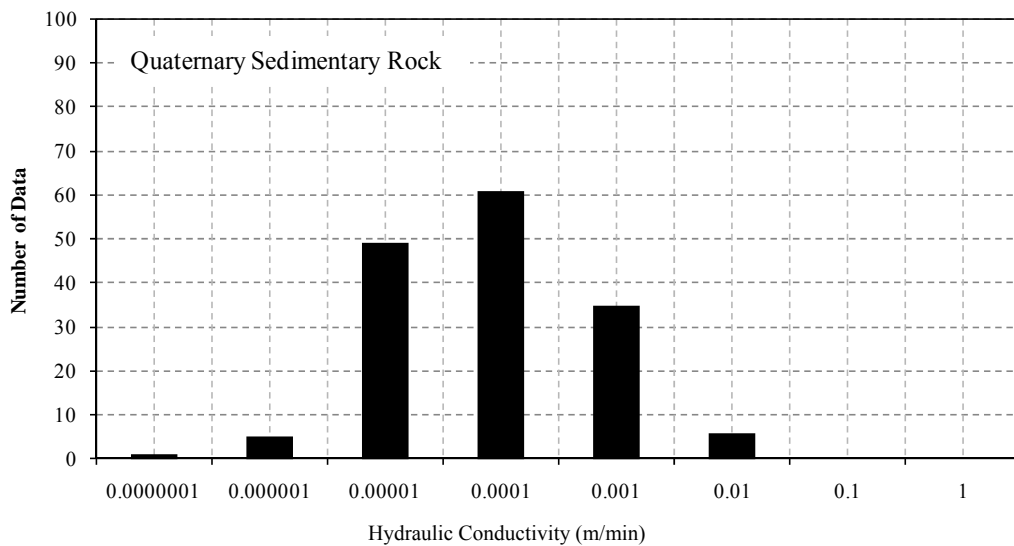
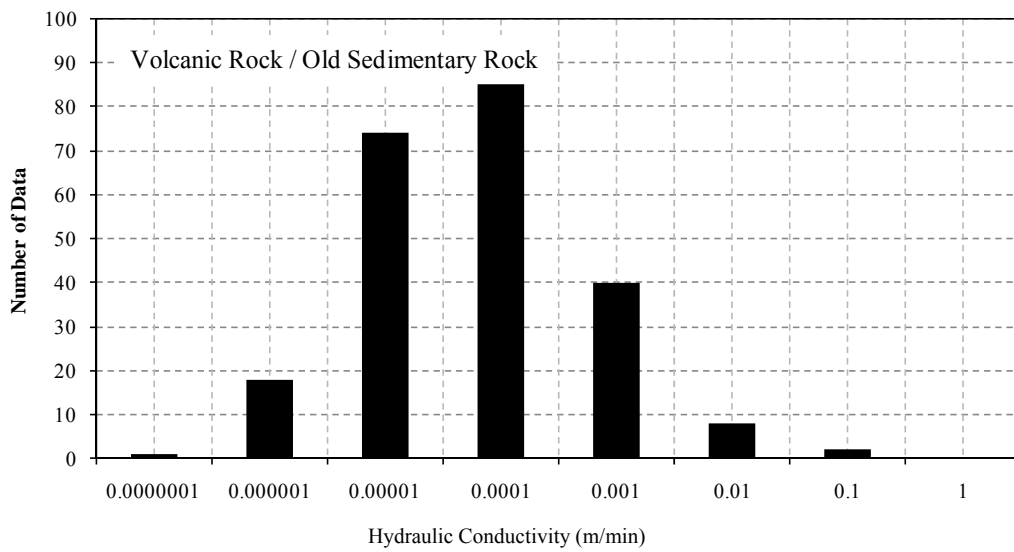
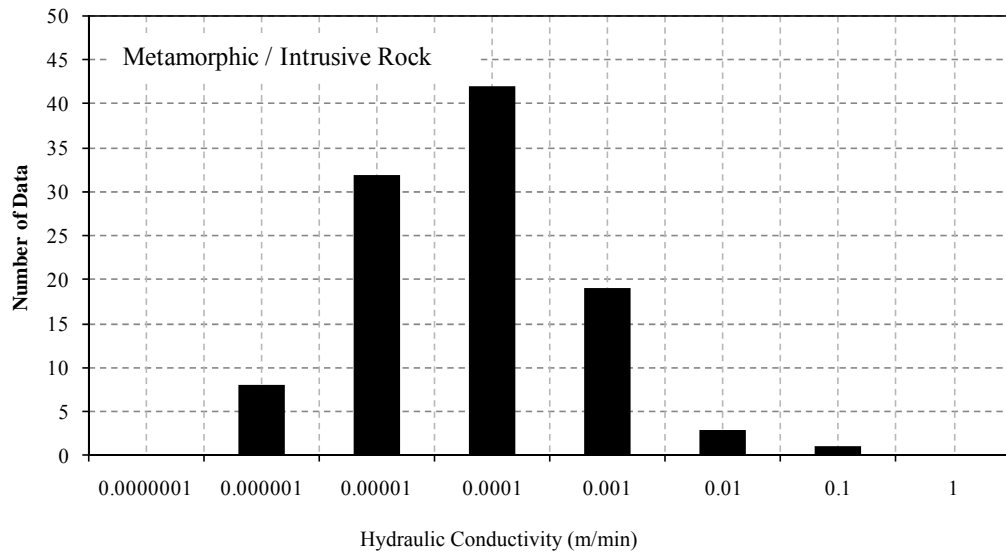


Note: The conductivities used for this study are determined based on the observed records.
 Source : JICA Study Team

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**Figure 7.5.1
 Hydrogeological Classification**

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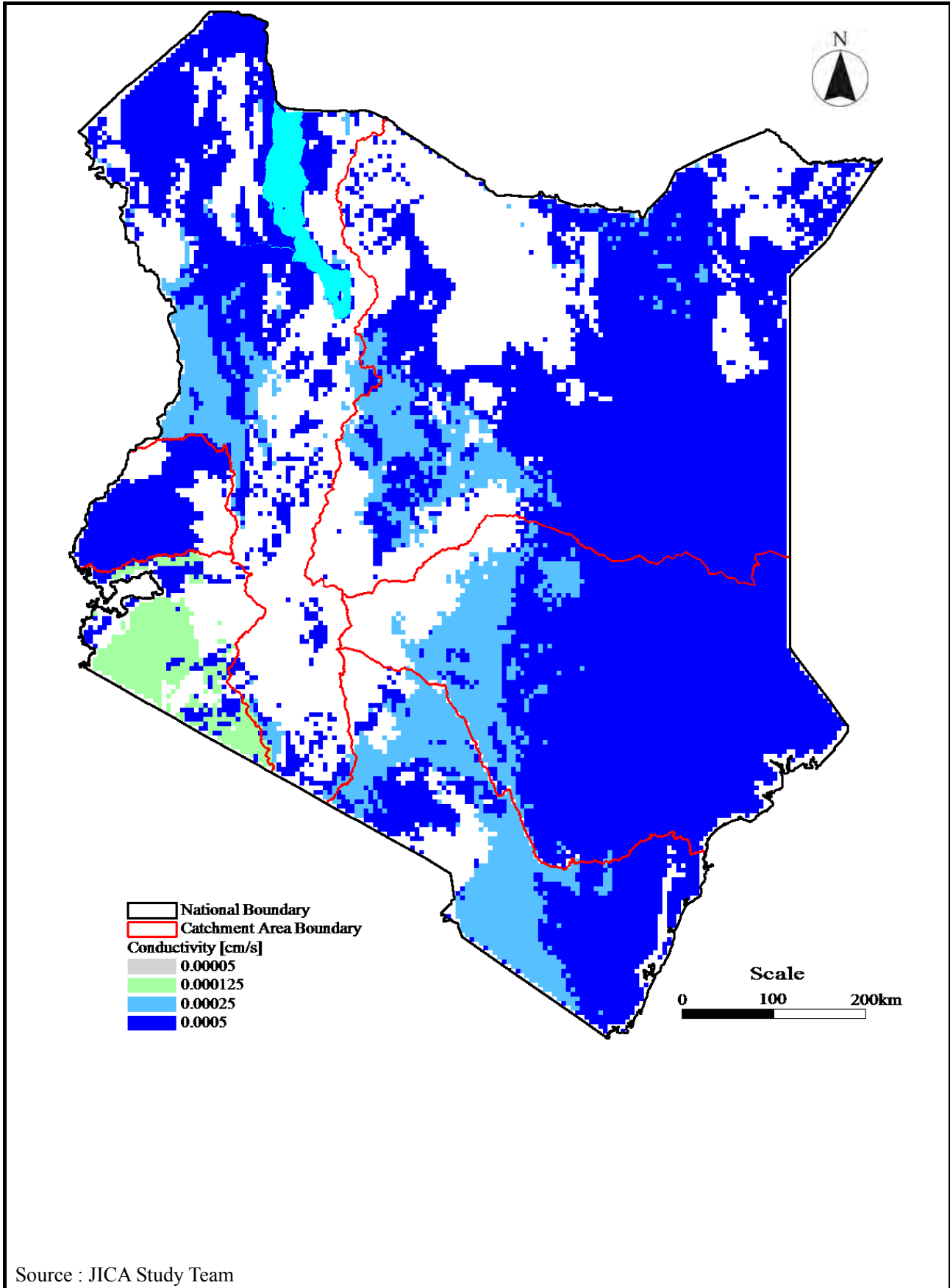


Source : NWMP (1992)

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Figure 7.5.2
Histograms of Hydraulic Conductivity by
Hydrogeological Classification

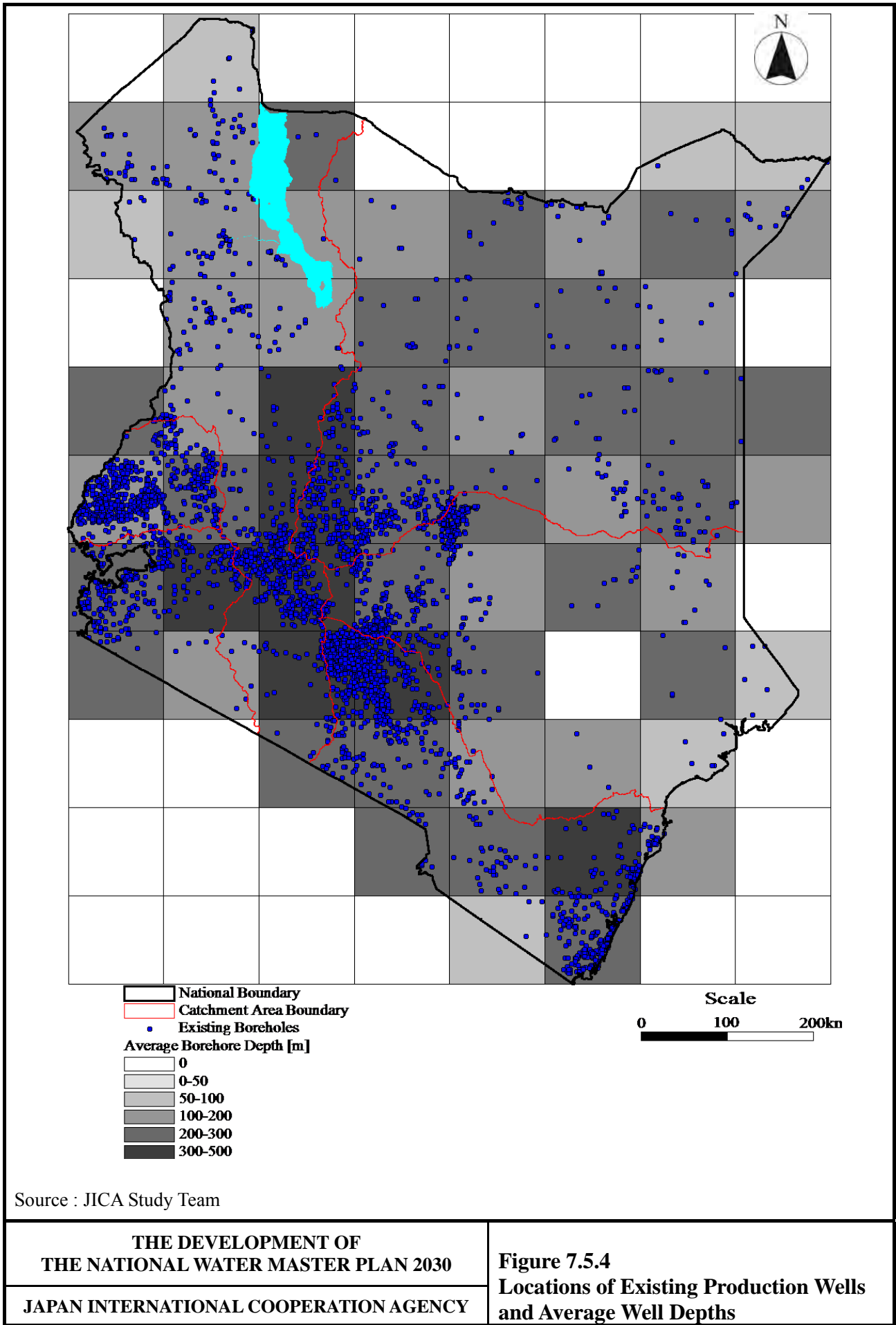


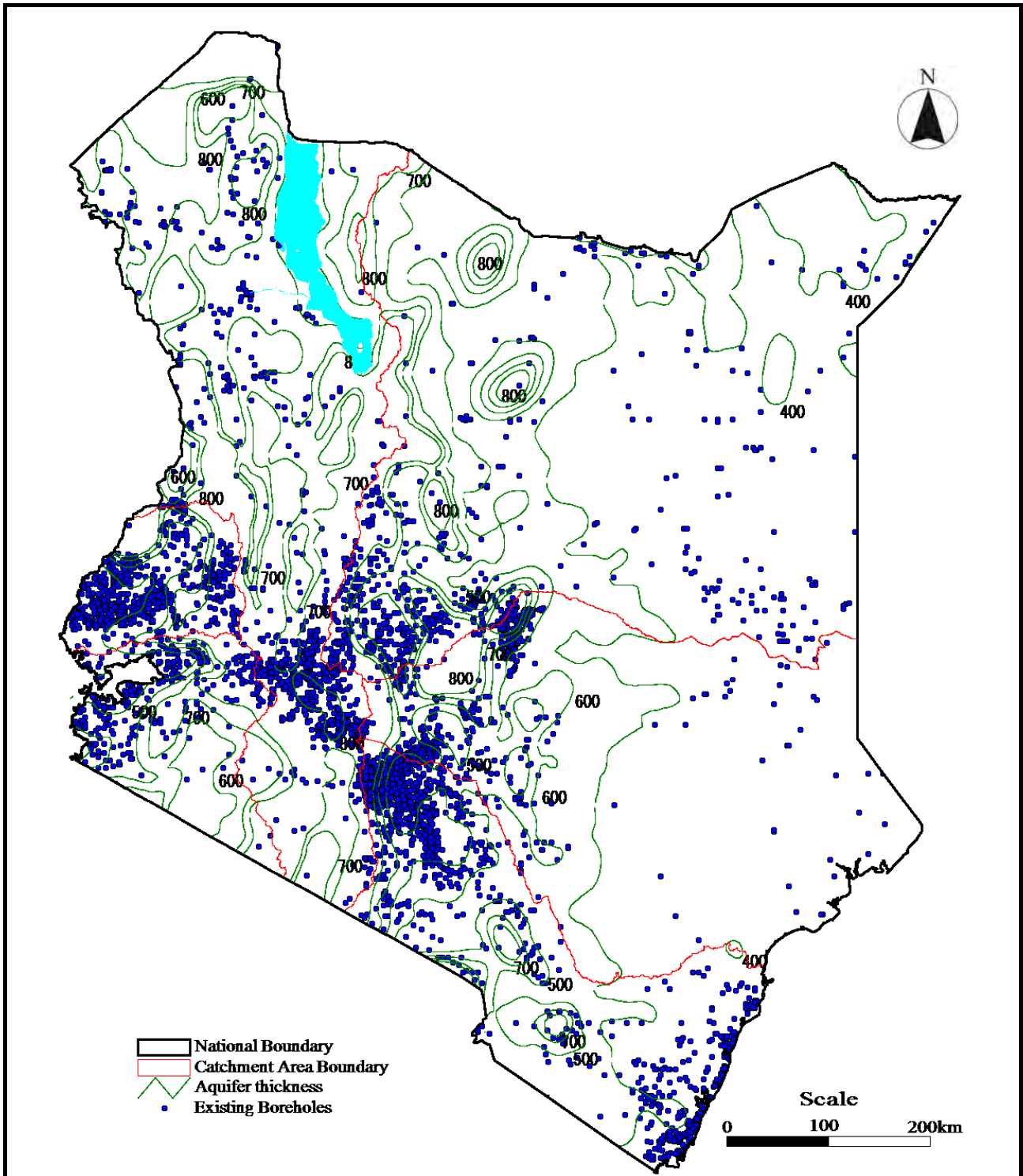
Source : JICA Study Team

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Figure 7.5.3
Spatial Distribution of Hydraulic
Conductivity



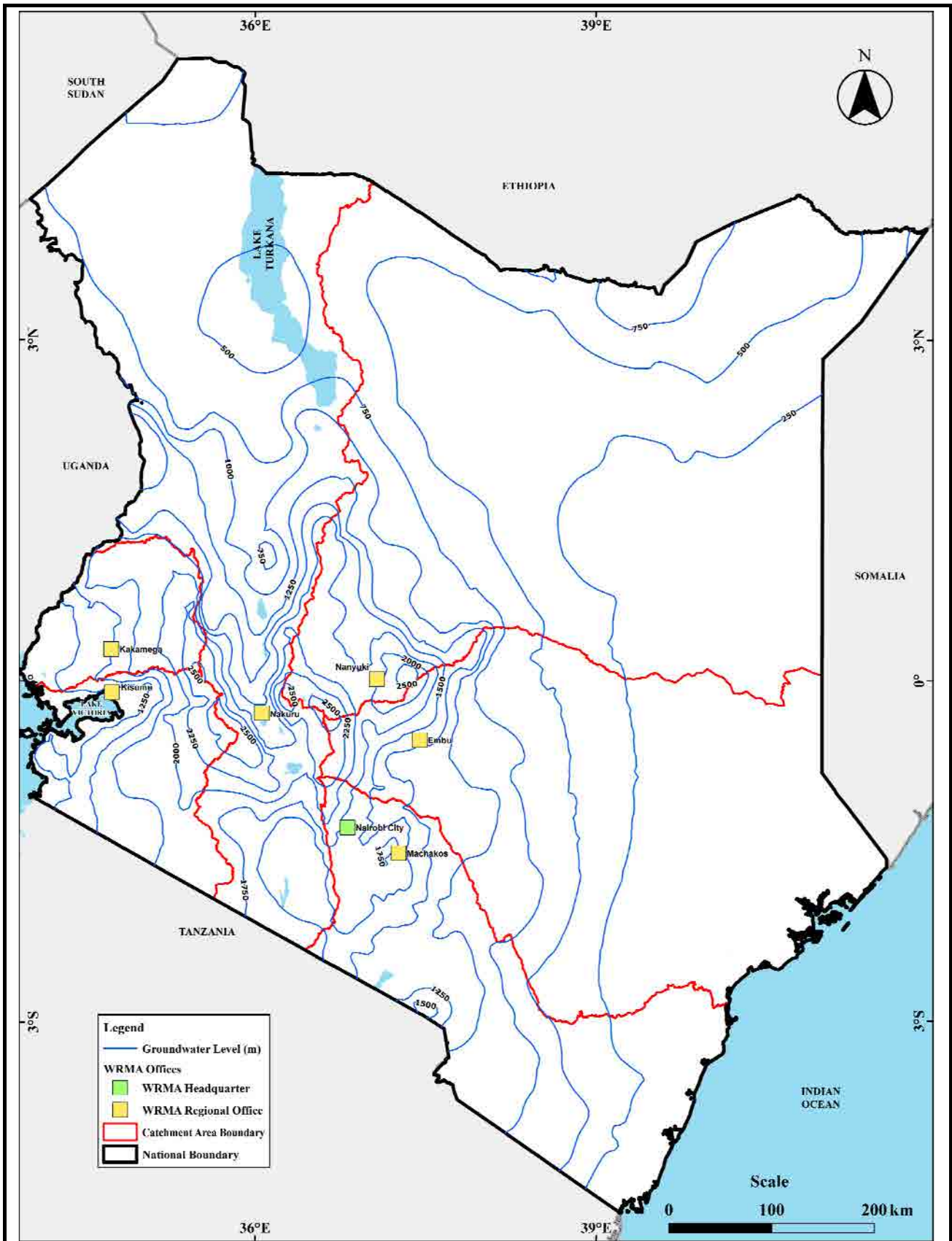


Source : JICA Study Team

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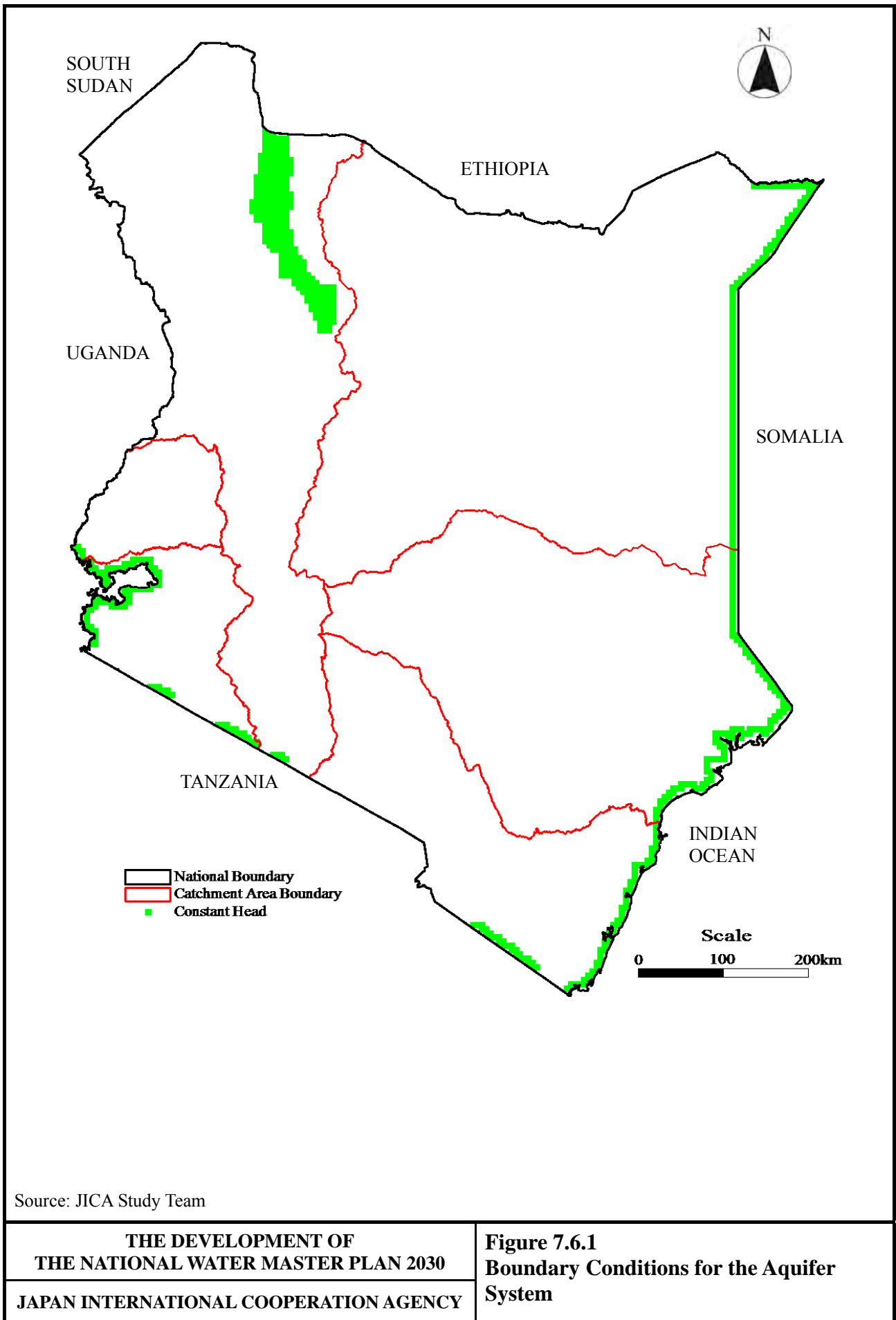
Figure 7.5.5
Thickness of the Main Aquifer

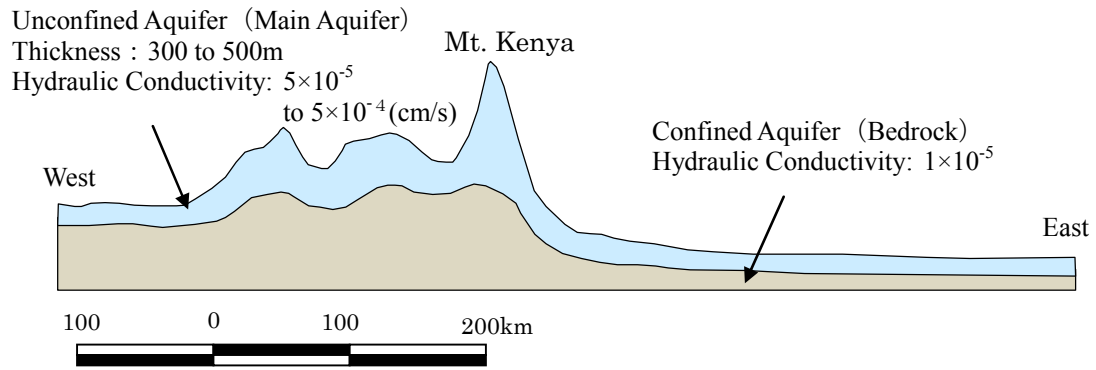


Source : JICA Study Team

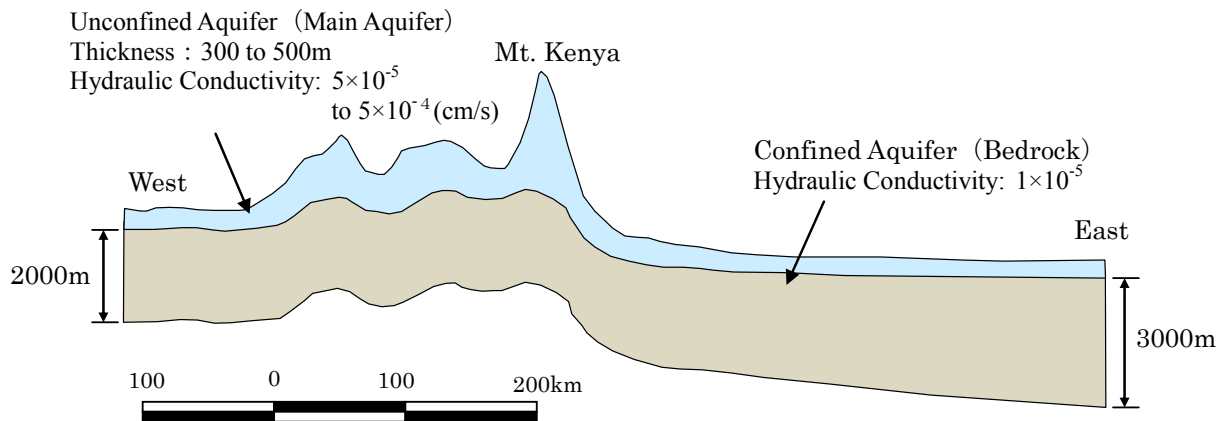
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**Figure 7.5.6
Groundwater Level Contour Map**

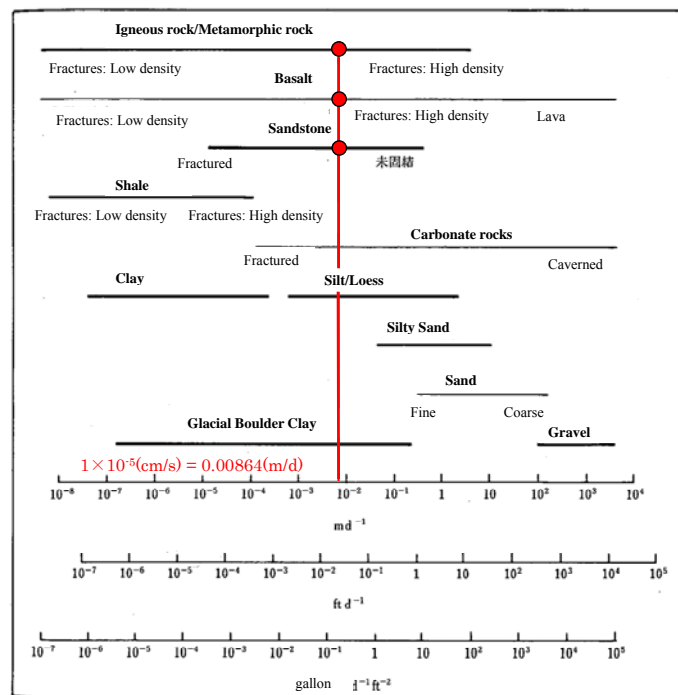




Case A



Case B

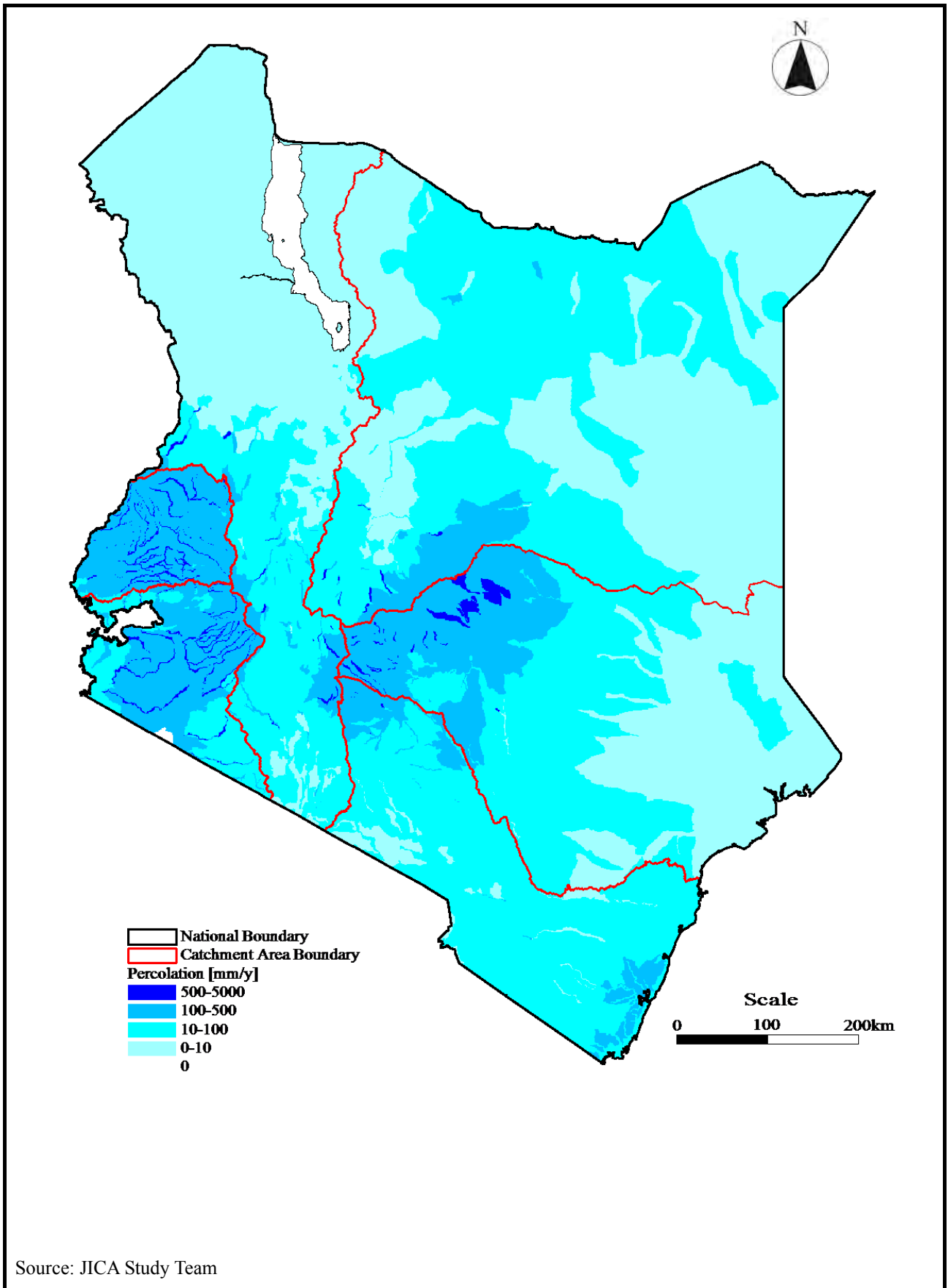


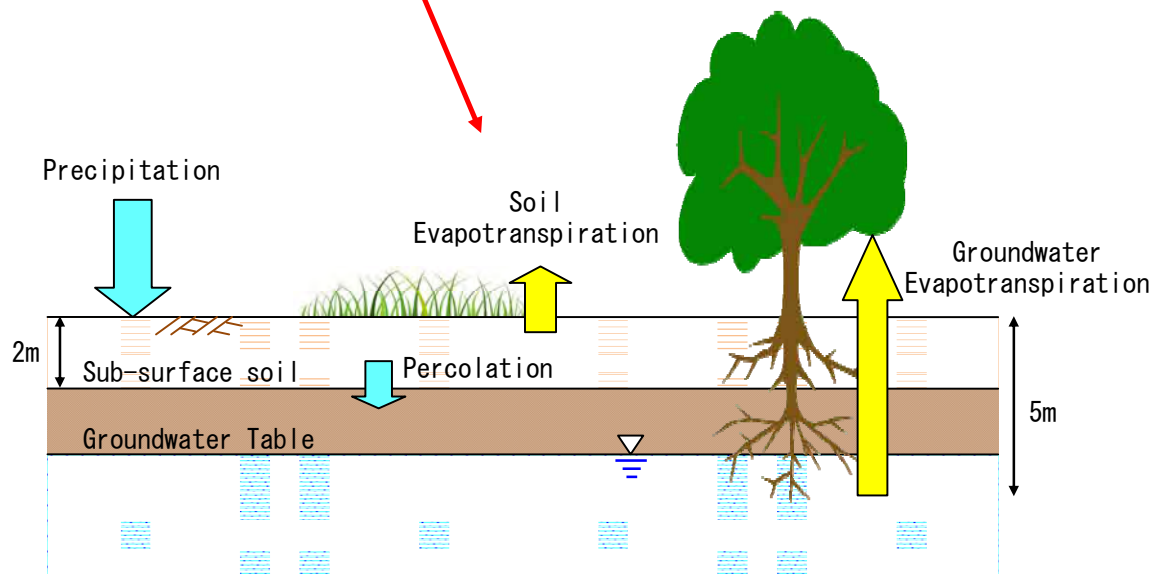
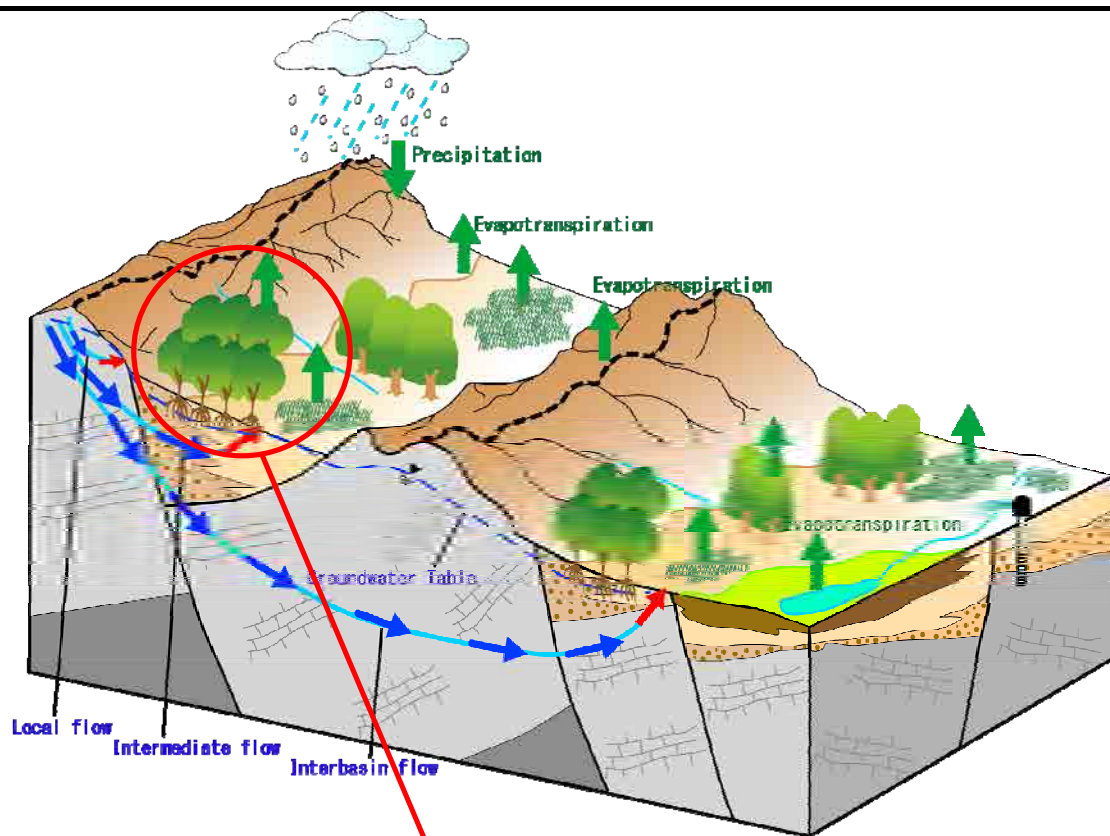
Source: JICA Study Team
 M. P. Anderson and W. W. Woessner. Applied Groundwater Modeling: Simulation of flow and Advective Transport

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Figure 7.6.2
 Structure of the Aquifer and Hydraulic Conductivities



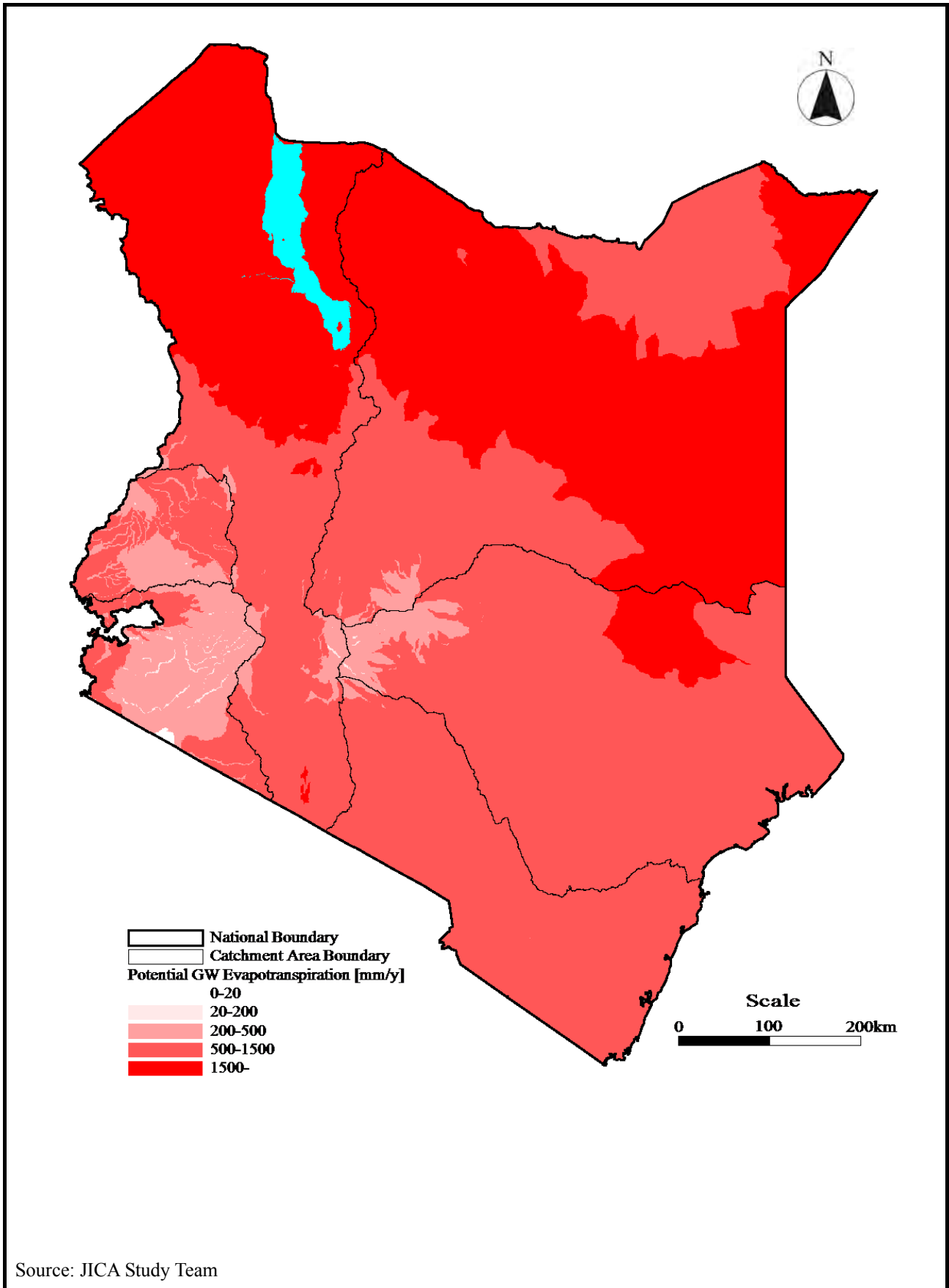


Source: JICA Study Team Based on U.S. Geological Survey, 2010. Groundwater Resources Program Conceptual Model of the Great Basin Carbonate and Alluvial Aquifer System. Scientific Investigations Report

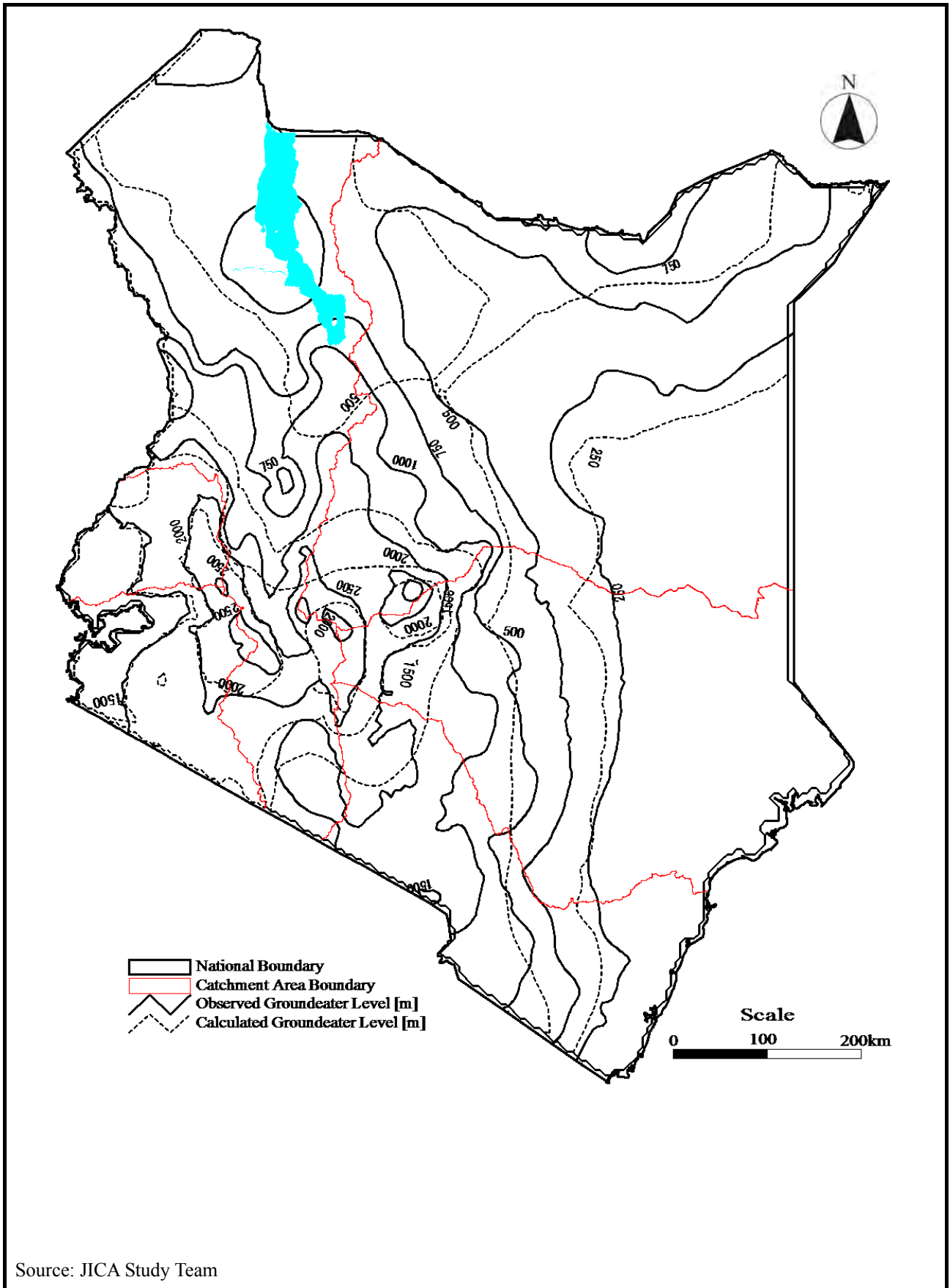
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Figure 7.6.4
Water Budget near the Ground Surface
and Groundwater Evapotranspiration



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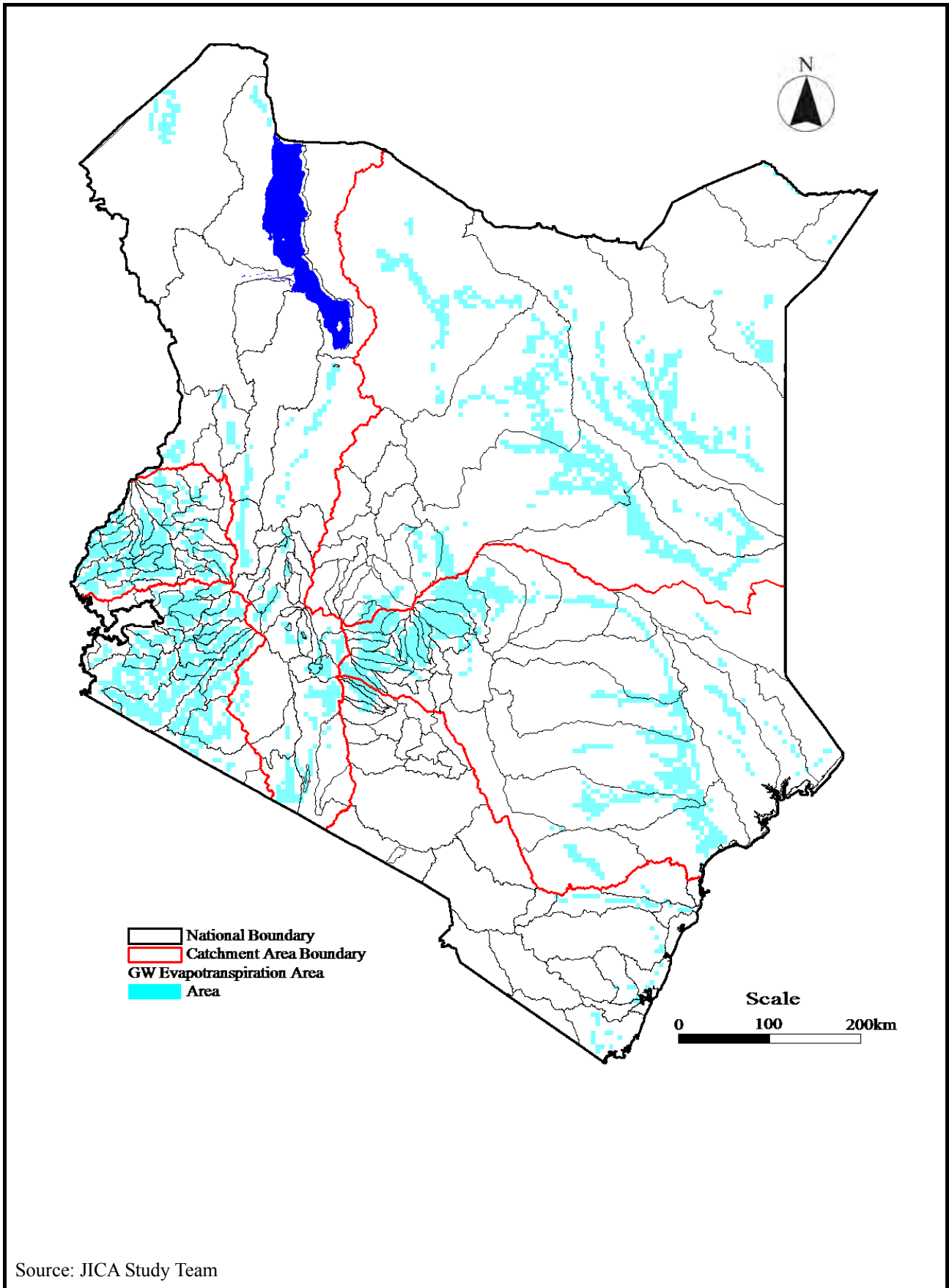


Source: JICA Study Team

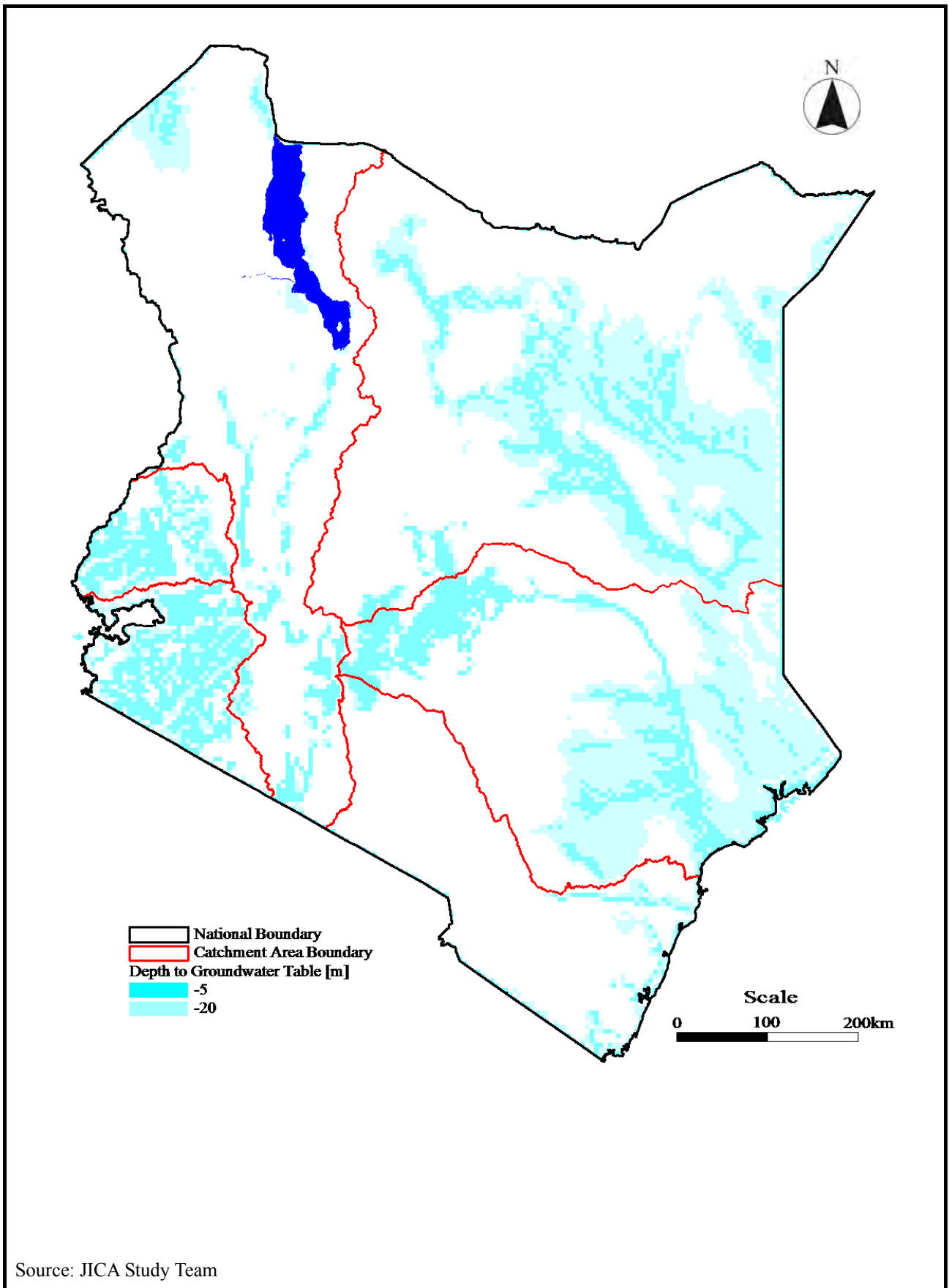
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**Figure 7.6.6
Groundwater Contour Map Estimated
and Observed Contours**



<p>THE DEVELOPMENT OF THE NATIONAL WATER MASTER PLAN 2030 JAPAN INTERNATIONAL COOPERATION AGENCY</p>	<p>Figure 7.6.7 Spatial Distribution of Groundwater Evapotranspiration</p>
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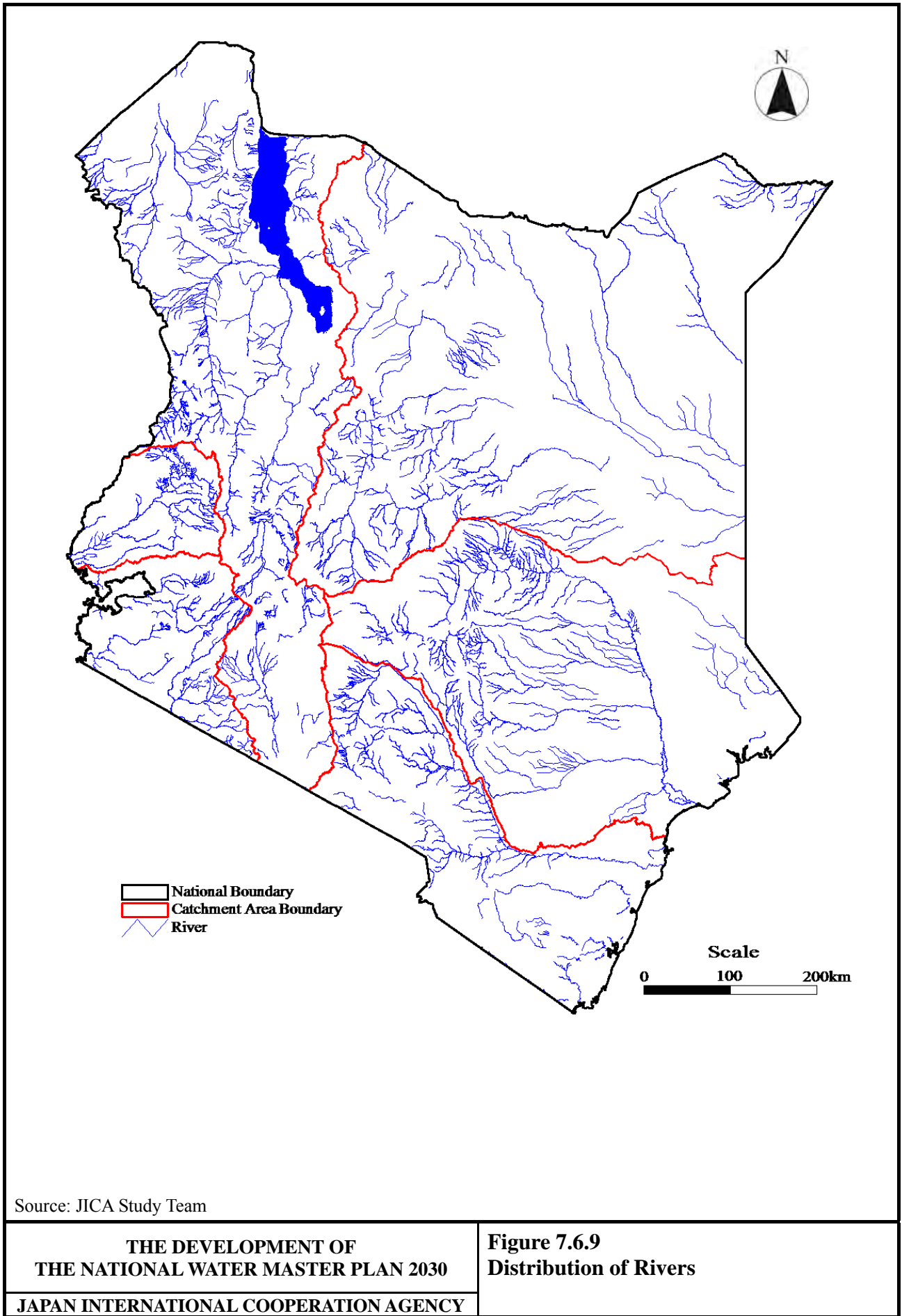


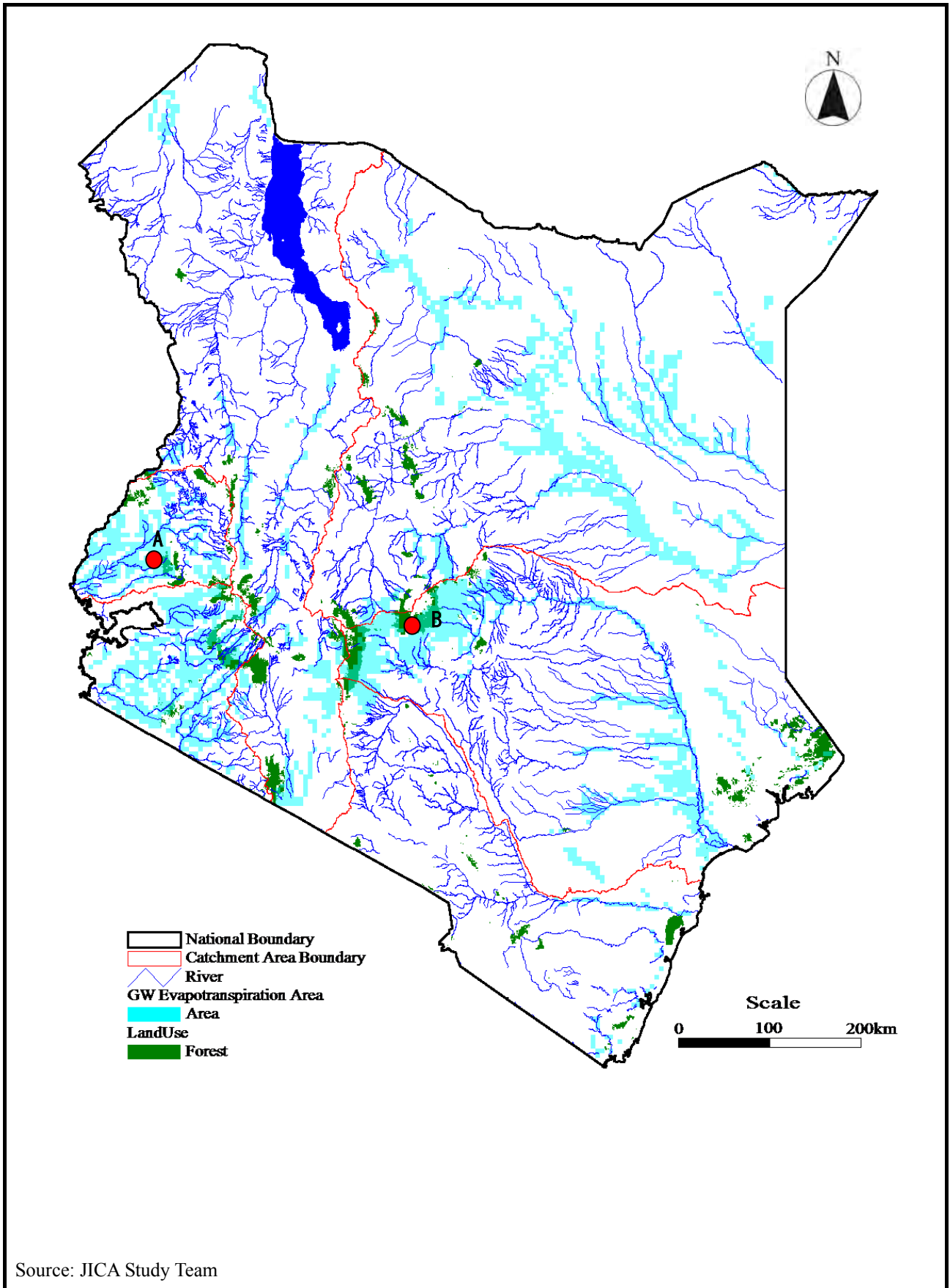
Source: JICA Study Team

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**Figure 7.6.8
Groundwater Tables within 5m and 20m
Depths below Ground Surface**





Source: JICA Study Team

<p style="text-align: center;">THE DEVELOPMENT OF THE NATIONAL WATER MASTER PLAN 2030</p> <p style="text-align: center;">JAPAN INTERNATIONAL COOPERATION AGENCY</p>	<p>Figure 7.6.10 Locations of Groundwater Evapotranspiration in Forest Land (1/2)</p>
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A



Tree roots along the river

B

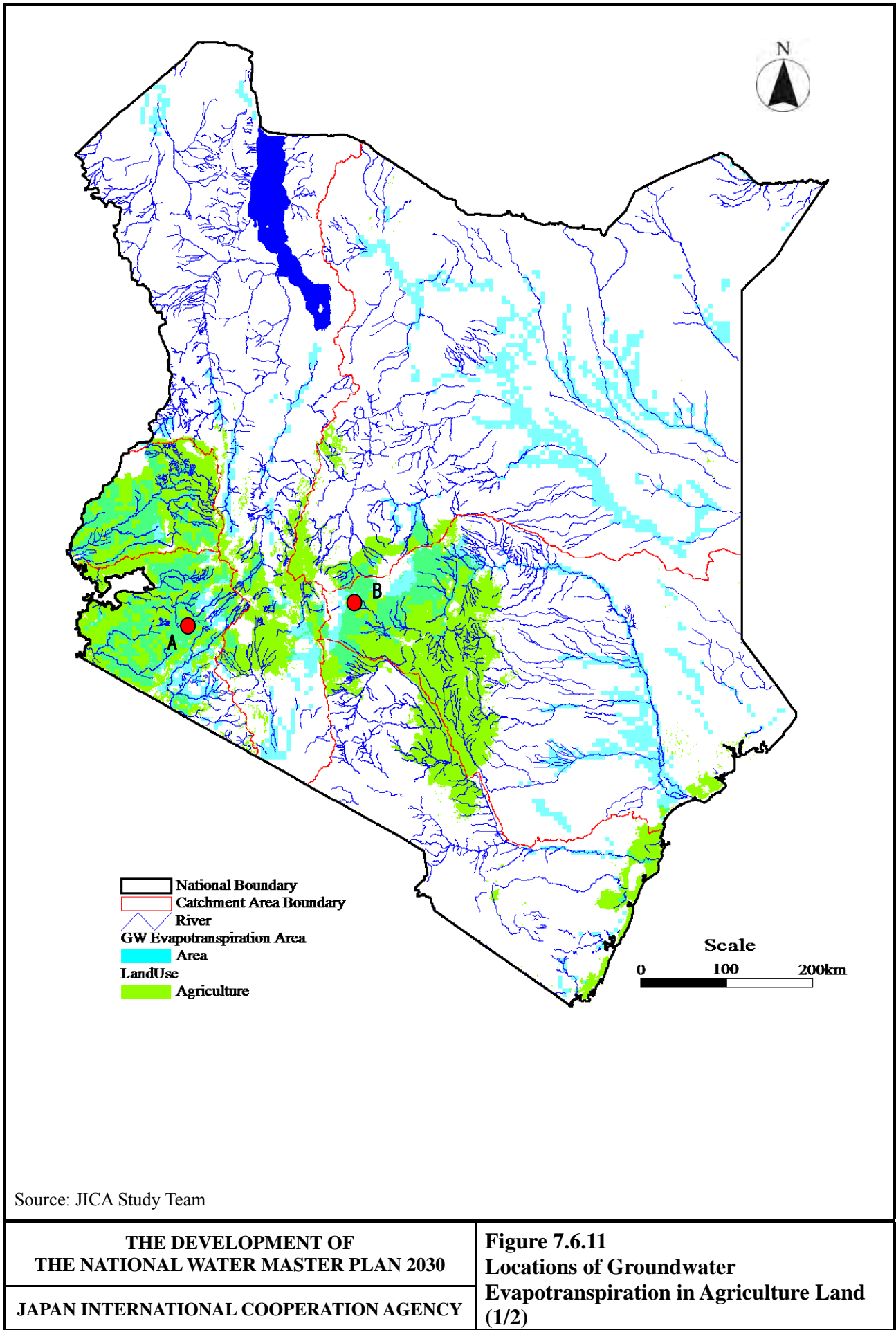


Source: JICA Study Team

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Figure 7.6.10
Locations with Shallow Groundwater in
in Forest Land (2/2)



Source: JICA Study Team

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Figure 7.6.11
Locations of Groundwater
Evapotranspiration in Agriculture Land
(1/2)

A



Dense trees along the river

B

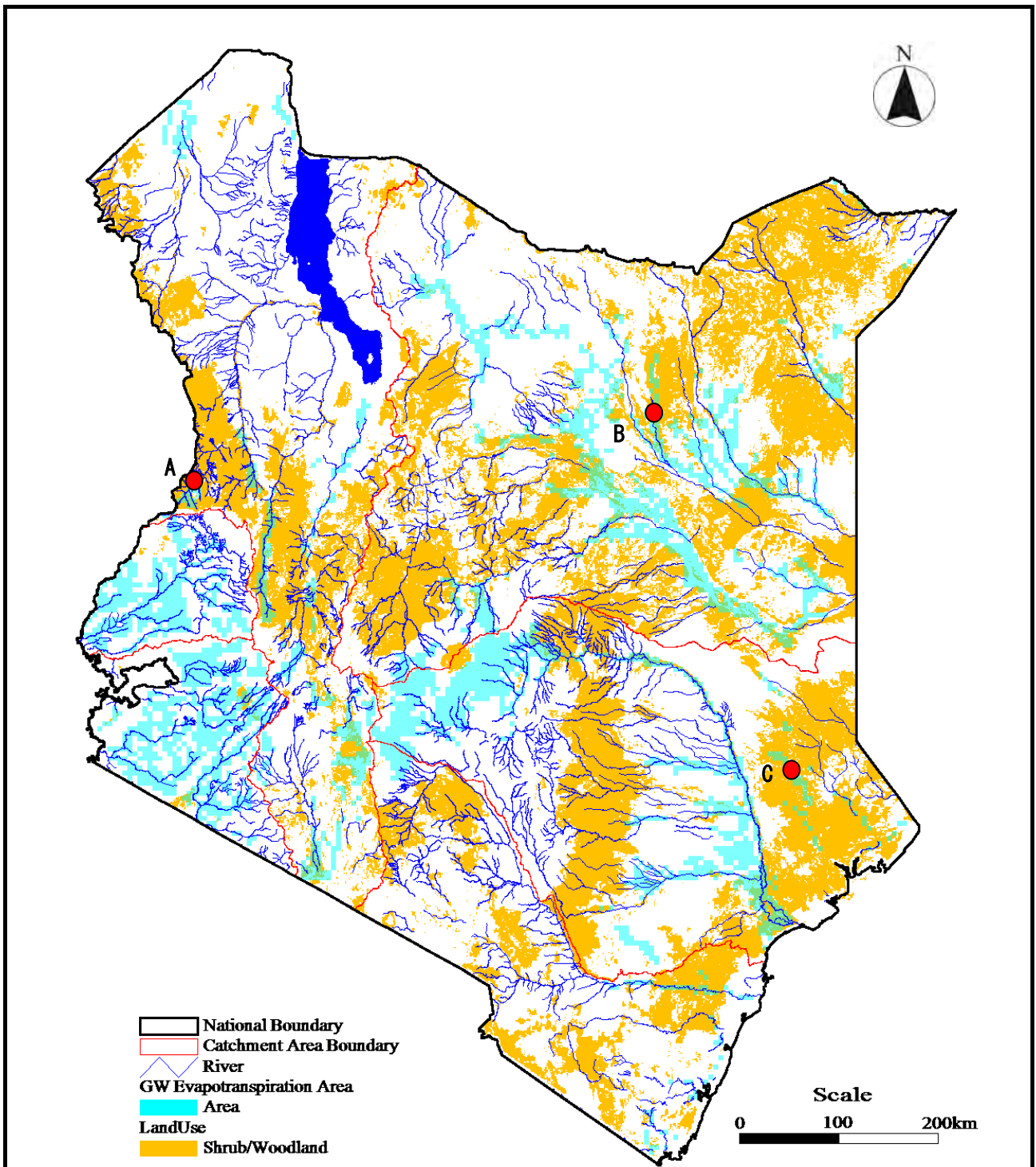


Source: JICA Study Team

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**Figure 7.6.11
Locations with Shallow Groundwater in
in Agriculture Land (2/2)**



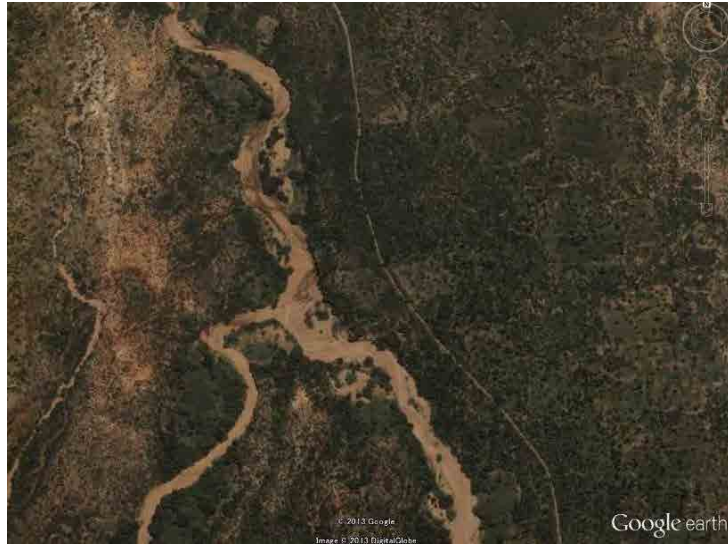
Source: JICA Study Team

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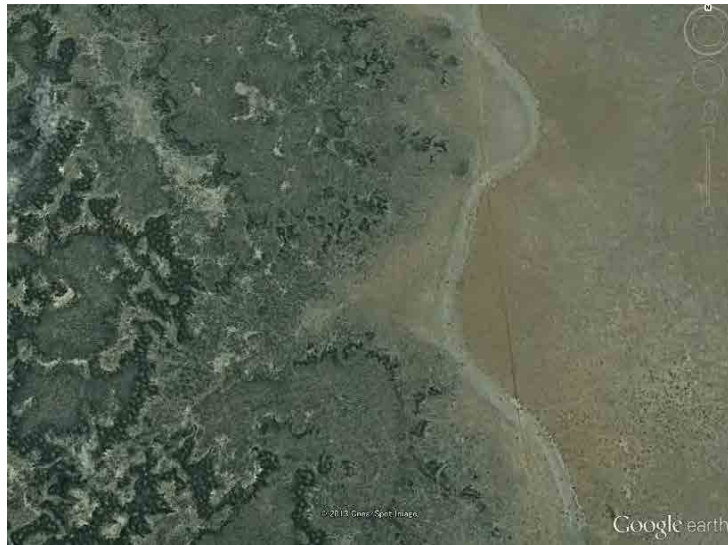
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**Figure 7.6.12
Locations of Groundwater
Evapotranspiration in Shrub/Woodland
Land (1/2)**

A



B



C

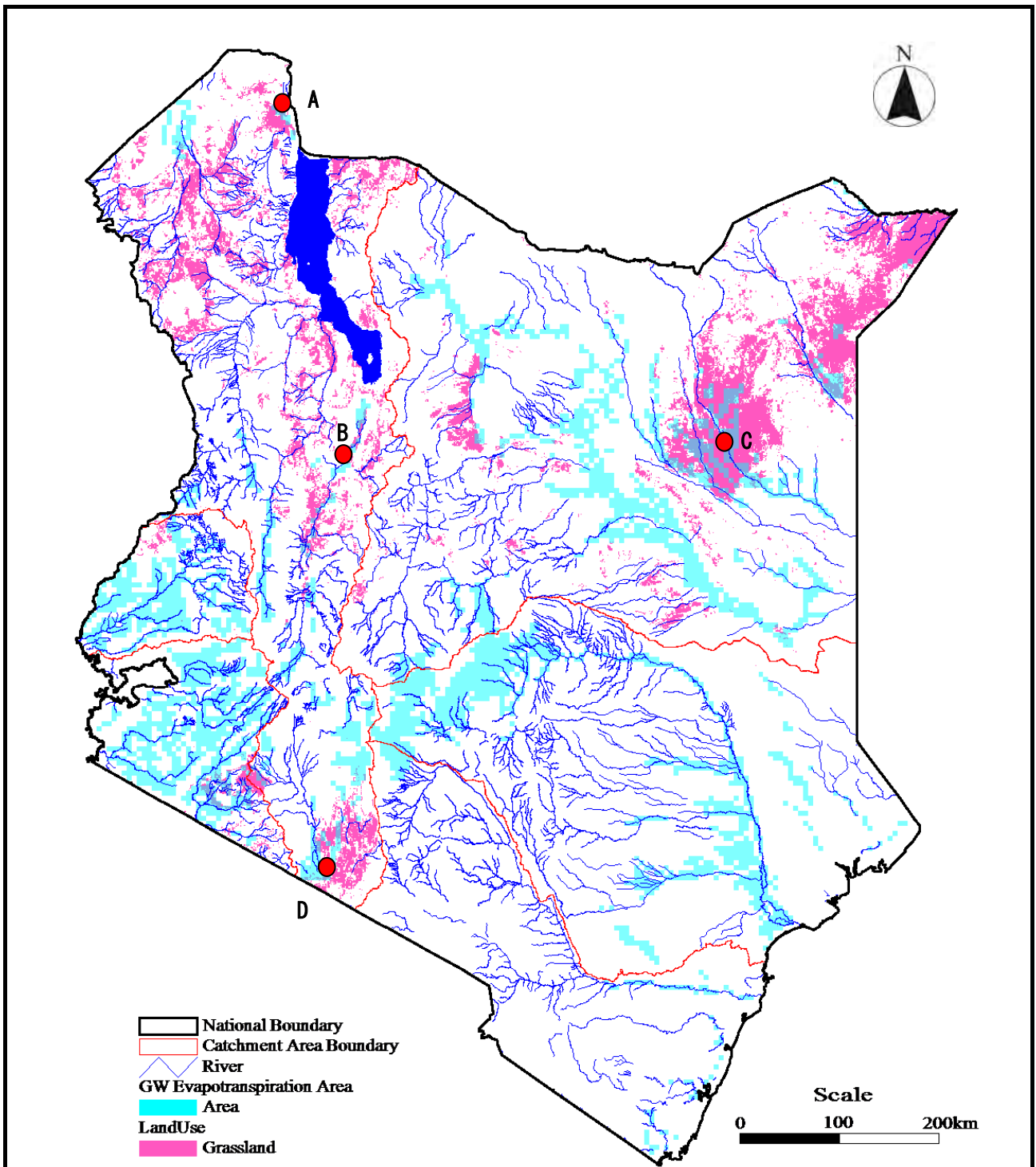


Source: JICA Study Team

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**Figure 7.6.12
Locations of Groundwater
Evapotranspiration in Shrub/Woodland
Land (2/2)**



Source: JICA Study Team

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Figure 7.6.13
Locations of Groundwater
Evapotranspiration in in Grass land (1/2)

A



B



C



D



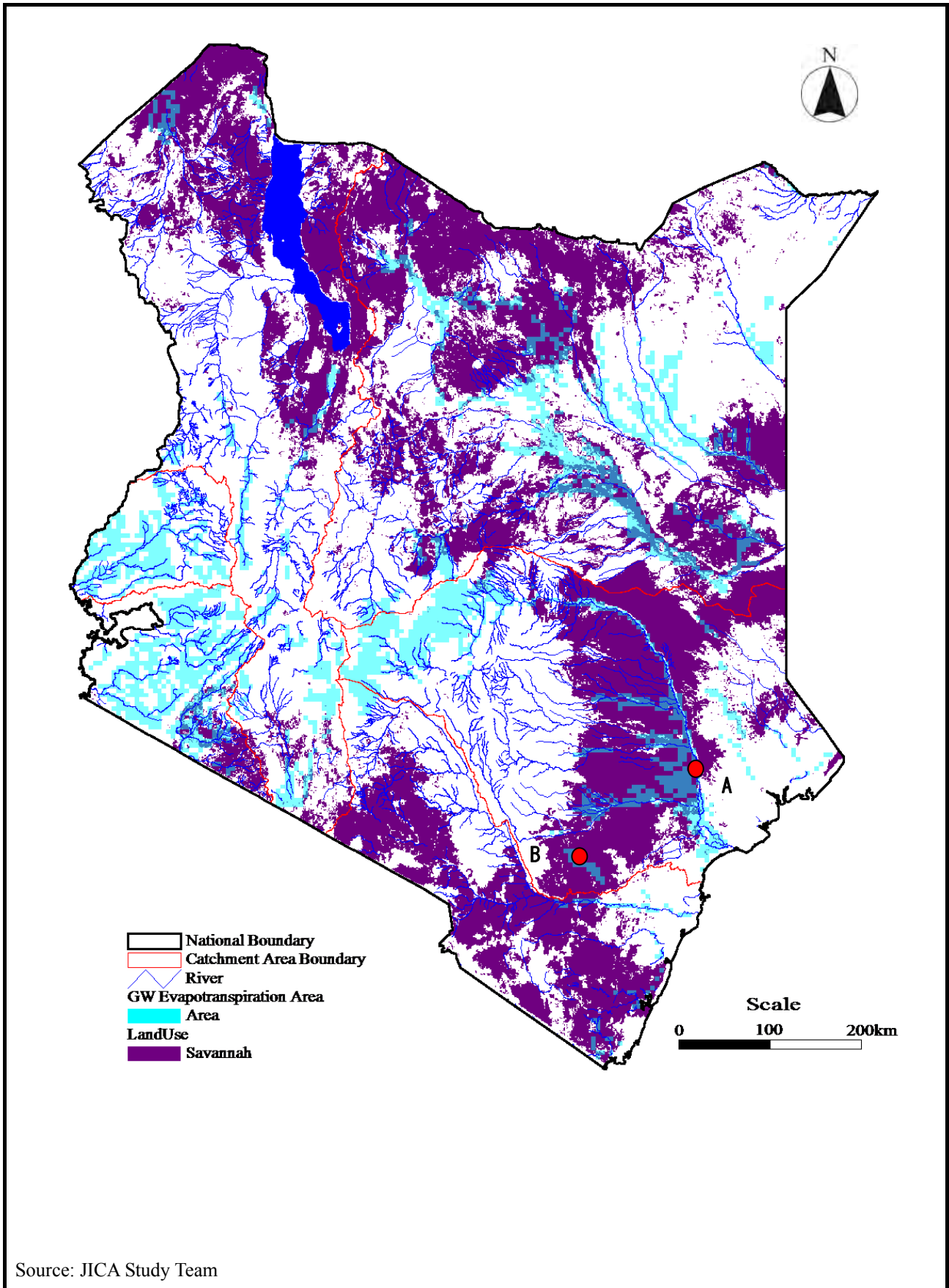
Sparse distribution of trees in the photograph on the left can be found, but locations with dense trees can be identified with satellite images with Google Earth.

Source: JICA Study Team

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**Figure 7.6.13
Locations of Groundwater
Evapotranspiration in in Grass land (2/2)**



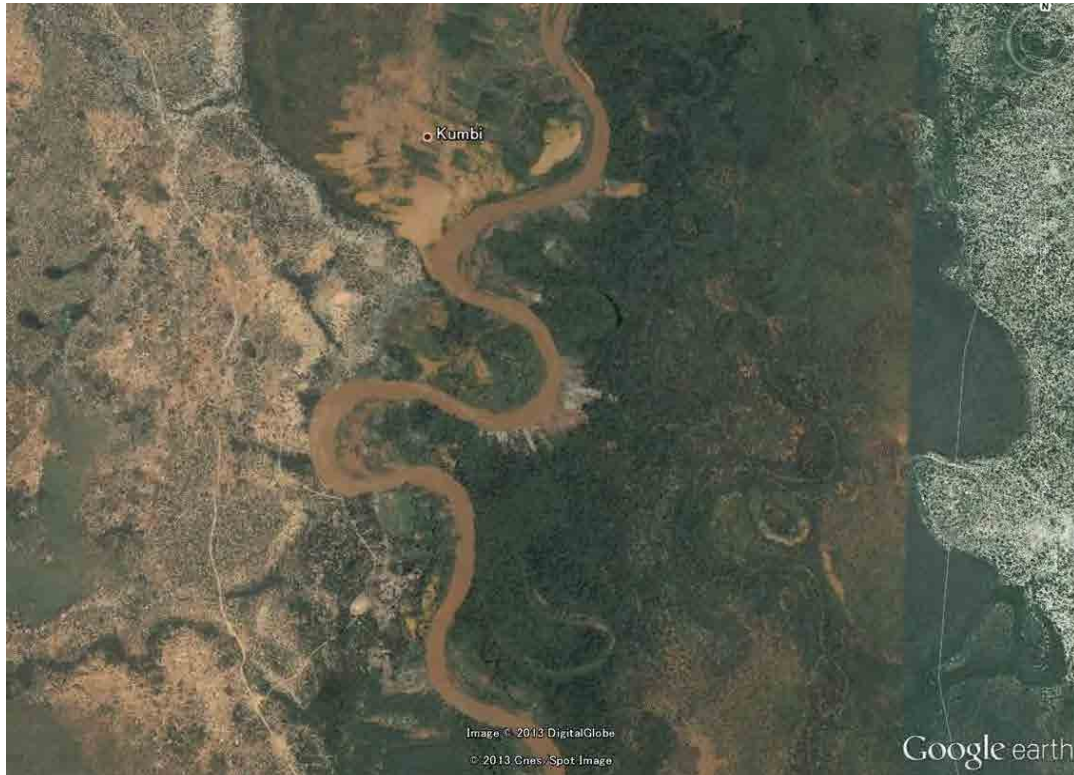
Source: JICA Study Team

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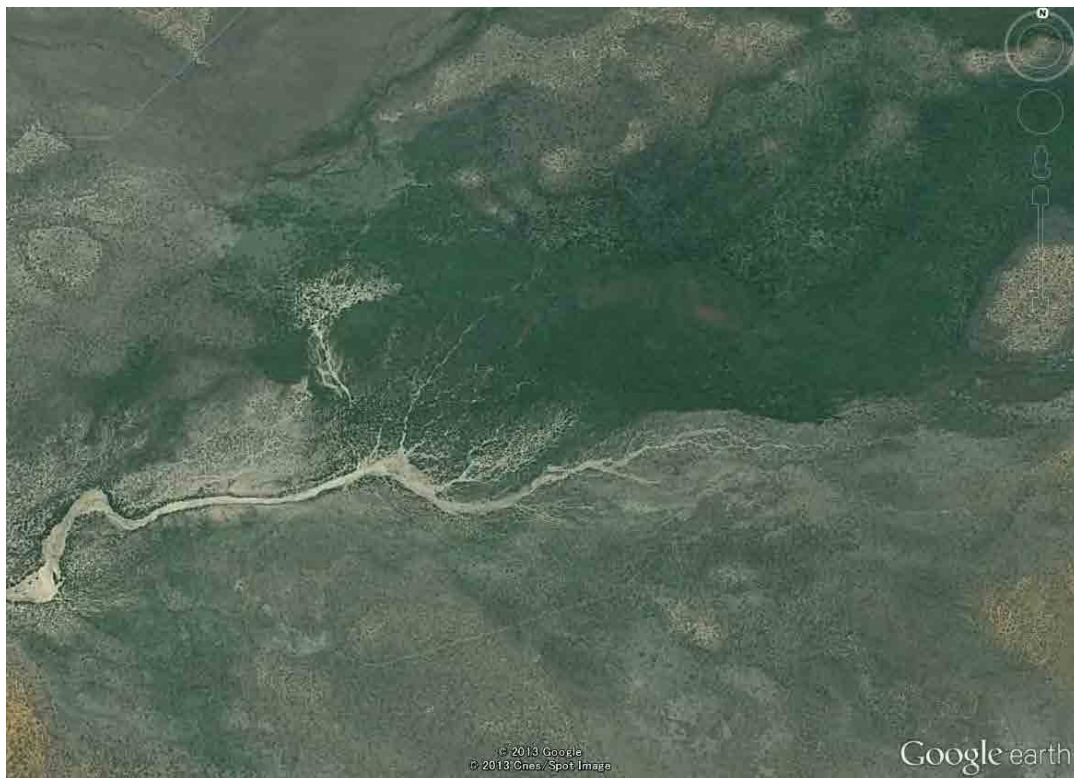
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Figure 7.6.14
Locations of Groundwater
Evapotranspiration in Savannah land
(1/2)

A



B

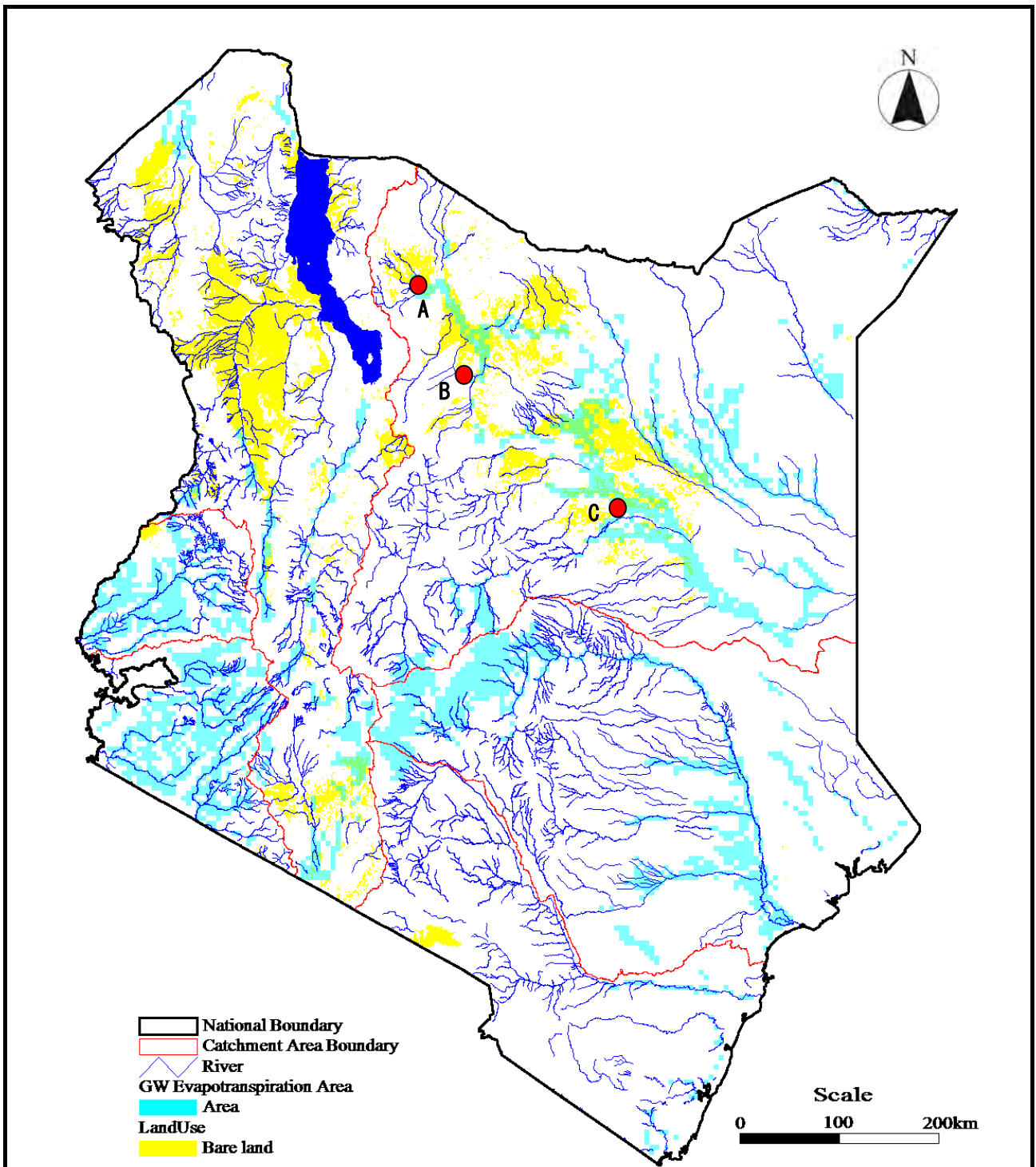


Source: JICA Study Team

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**Figure 7.6.14
Locations of Groundwater
Evapotranspiration in Savannah land
(2/2)**



Source: JICA Study Team

<p>THE DEVELOPMENT OF THE NATIONAL WATER MASTER PLAN 2030 JAPAN INTERNATIONAL COOPERATION AGENCY</p>	<p>Figure 7.6.15 Locations of Groundwater Evapotranspiration in Bare Land (1/2)</p>
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A



B



C

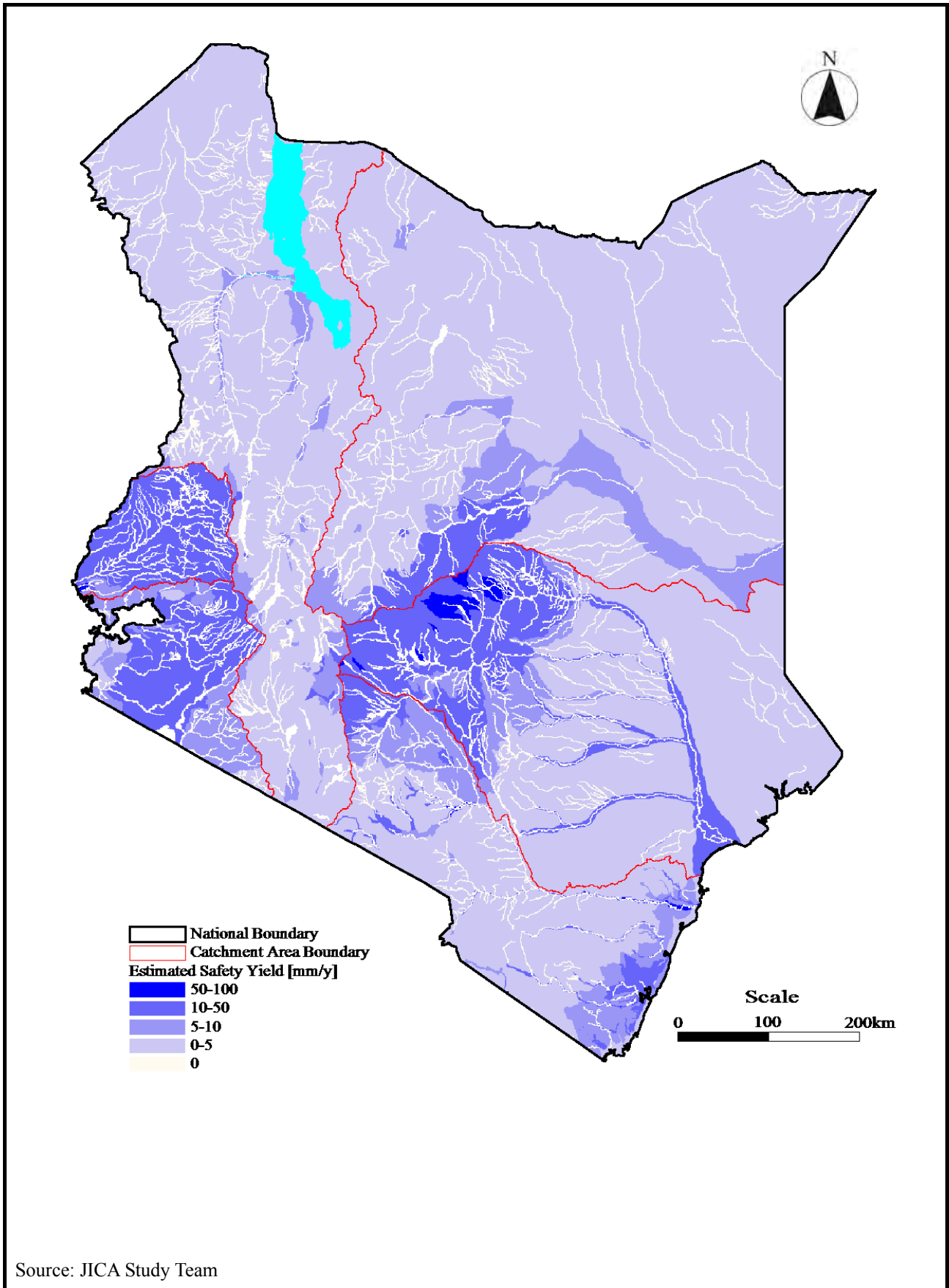


Source: JICA Study Team

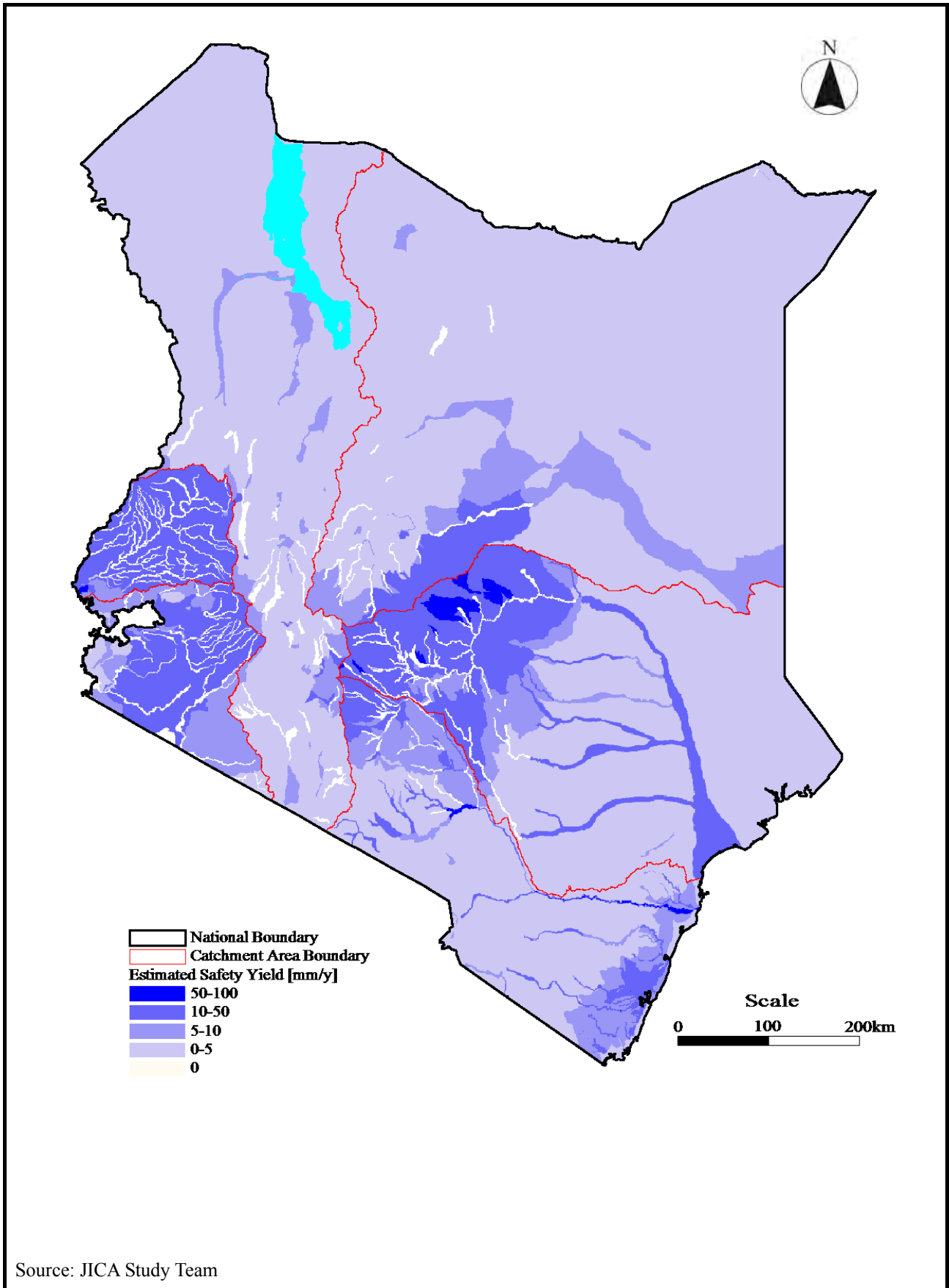
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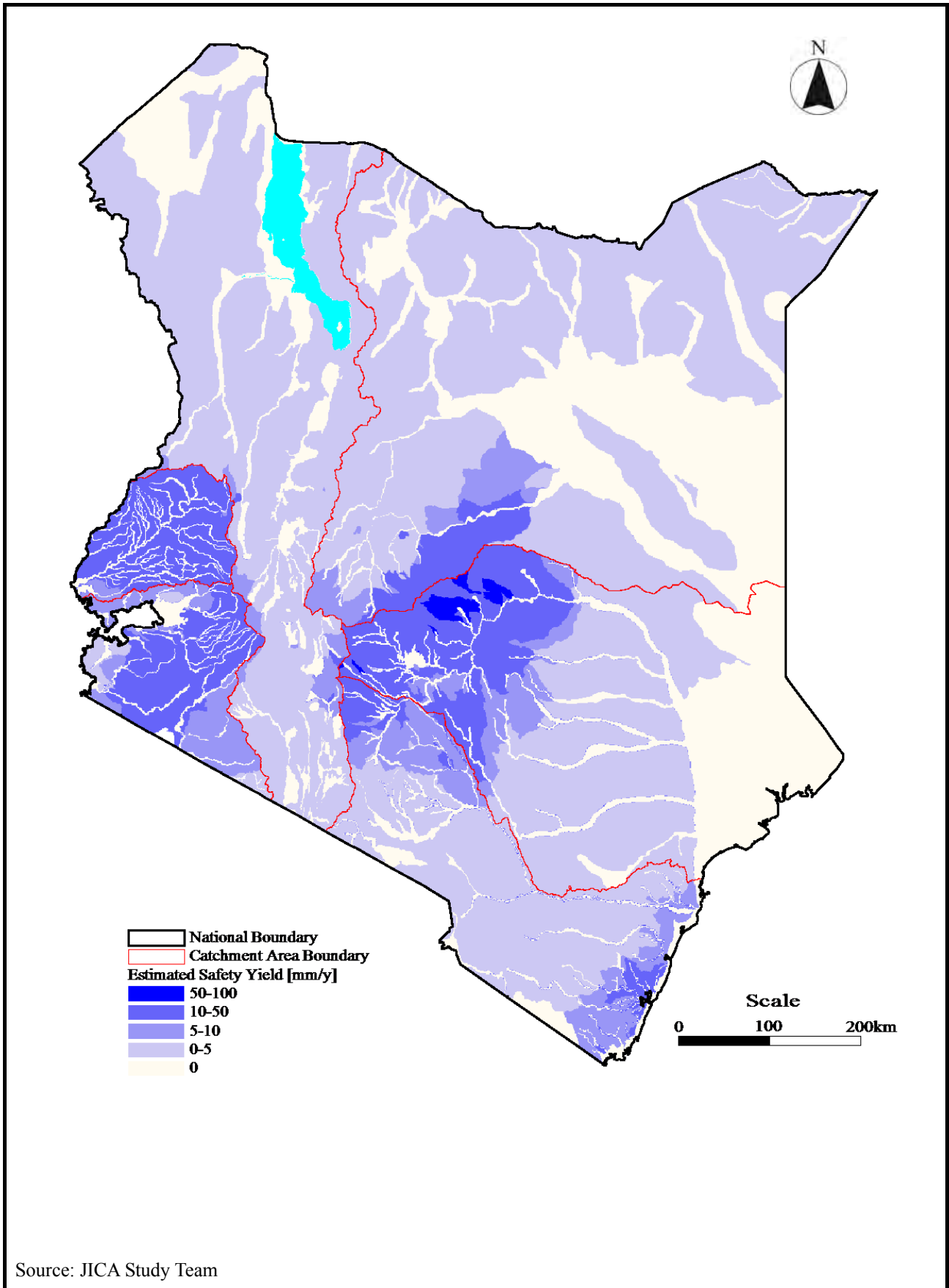
**Figure 7.6.15
Locations of Groundwater
Evapotranspiration in Bare Land (2/2)**



THE DEVELOPMENT OF THE NATIONAL WATER MASTER PLAN 2030 JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 7.7.1 Sustainable Yield of Groundwater Excluding Locations with Rivers
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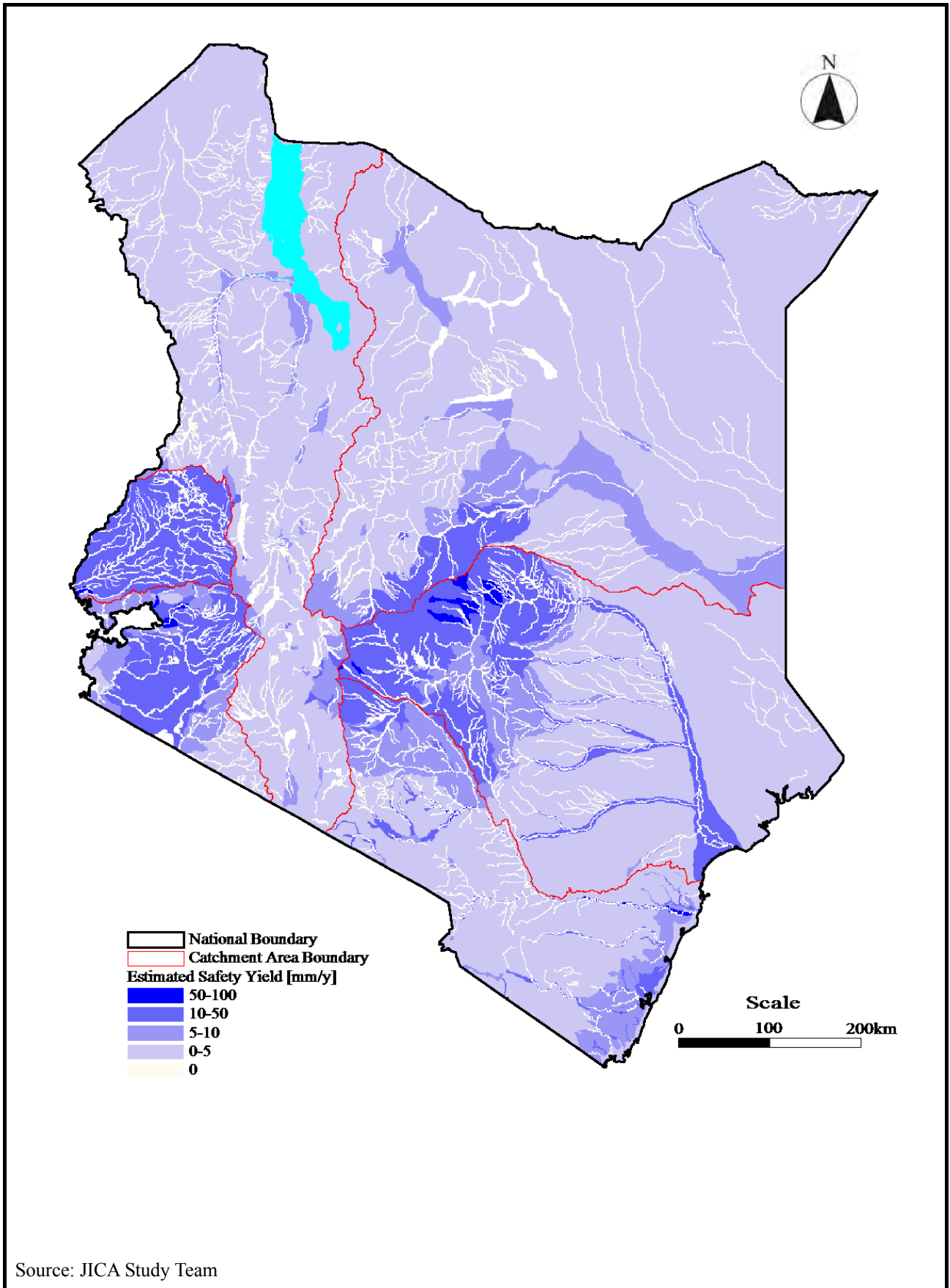


THE DEVELOPMENT OF THE NATIONAL WATER MASTER PLAN 2030	Figure 7.7.2 Sustainable Yield of Groundwater Including Locations with Rivers
JAPAN INTERNATIONAL COOPERATION AGENCY	



Source: JICA Study Team

THE DEVELOPMENT OF THE NATIONAL WATER MASTER PLAN 2030	Figure 7.7.3 Sustainable Yield of Groundwater excluding Locations in Discharge Area
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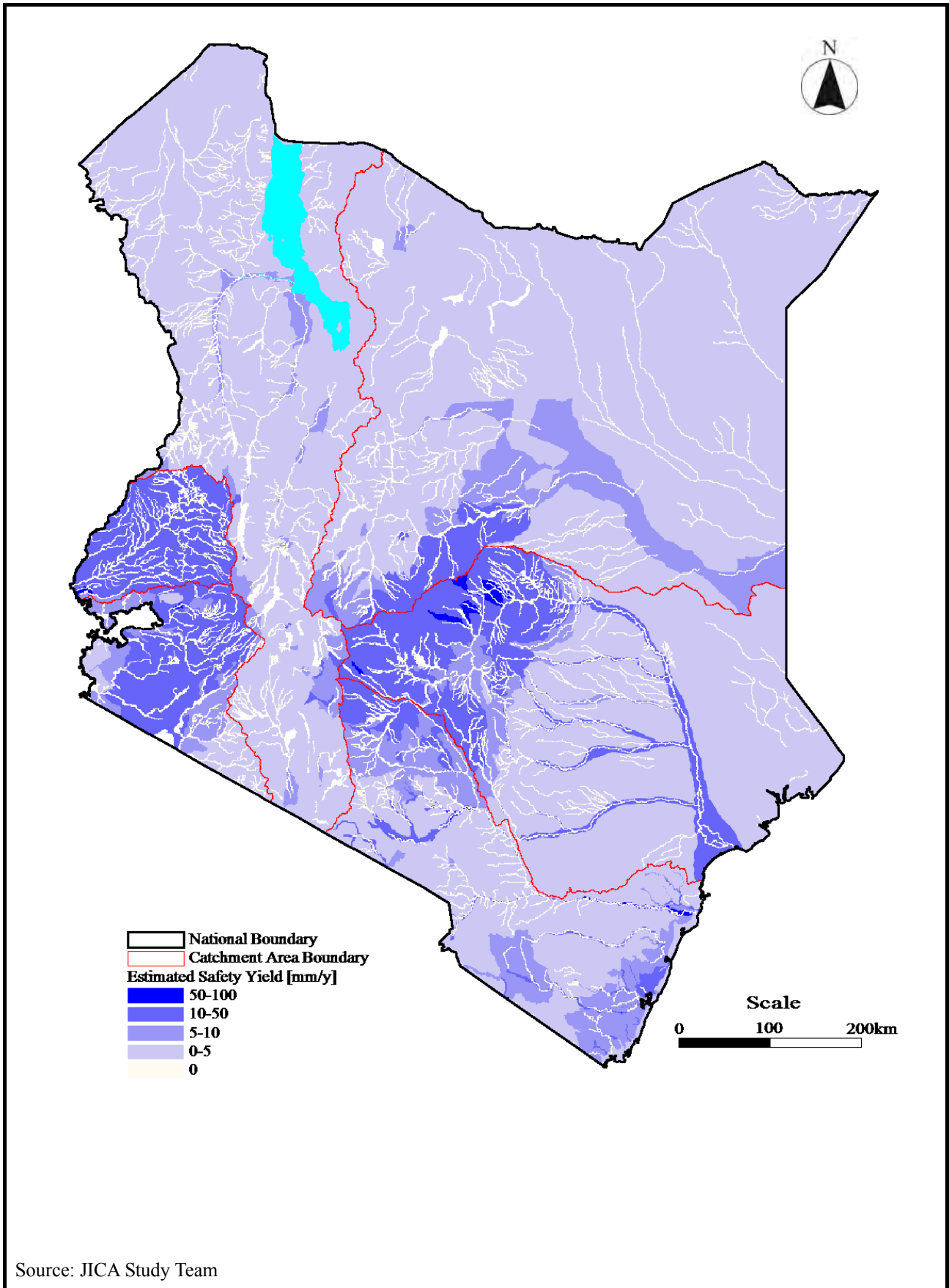


Source: JICA Study Team

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Figure 7.7.4
Sustainable Yield of Groundwater (2030)

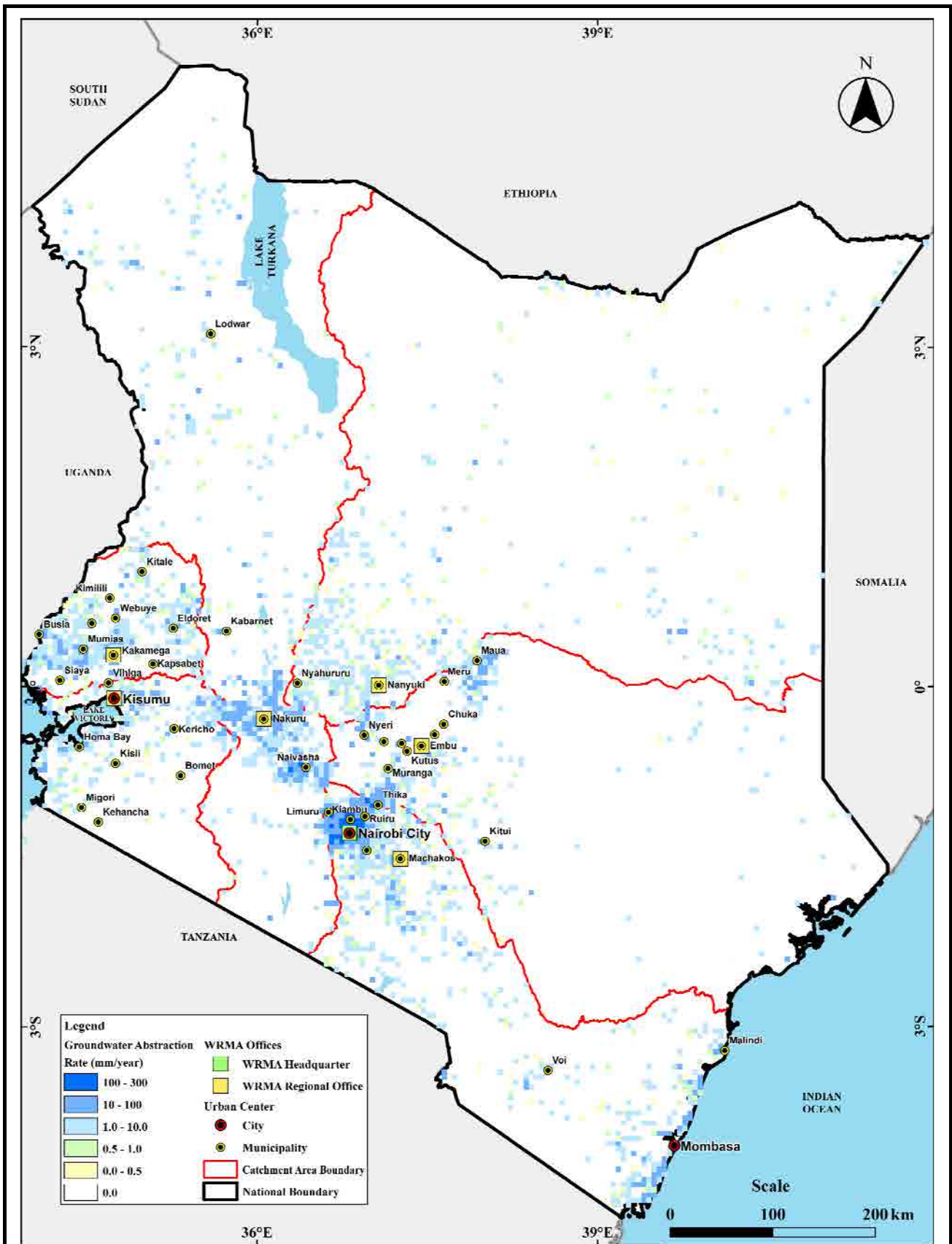


Source: JICA Study Team

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Figure 7.7.5
Sustainable Yield of Groundwater (2050)

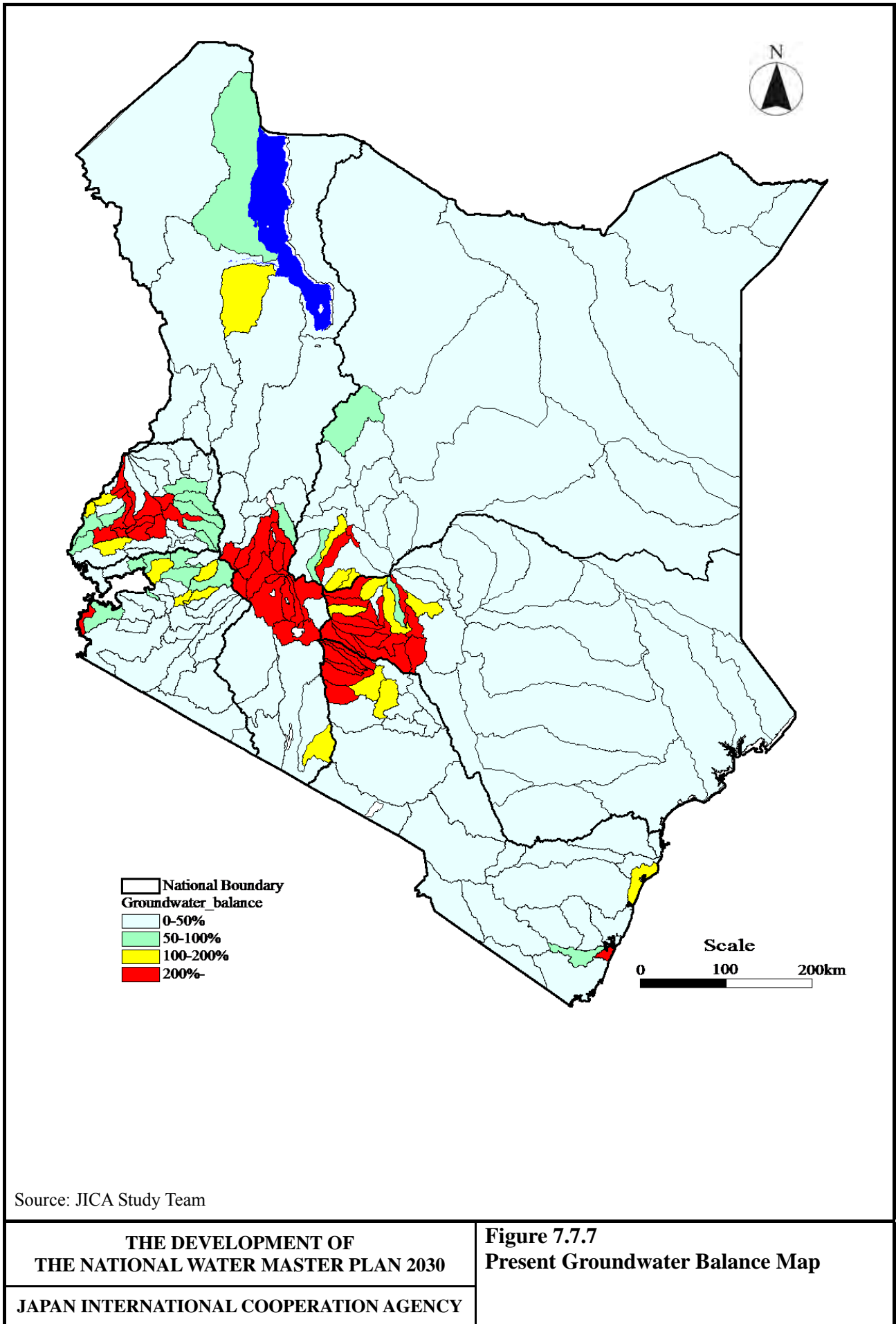


Source: JICA Study Team

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**Figure 7.7.6
Estimated Present Groundwater
Abstraction Rate Map**

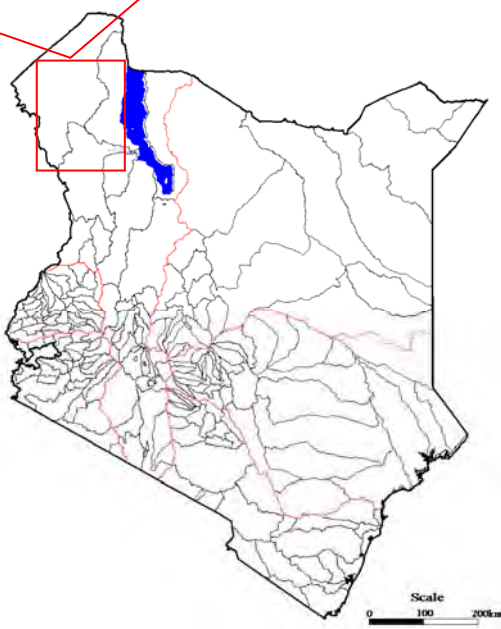
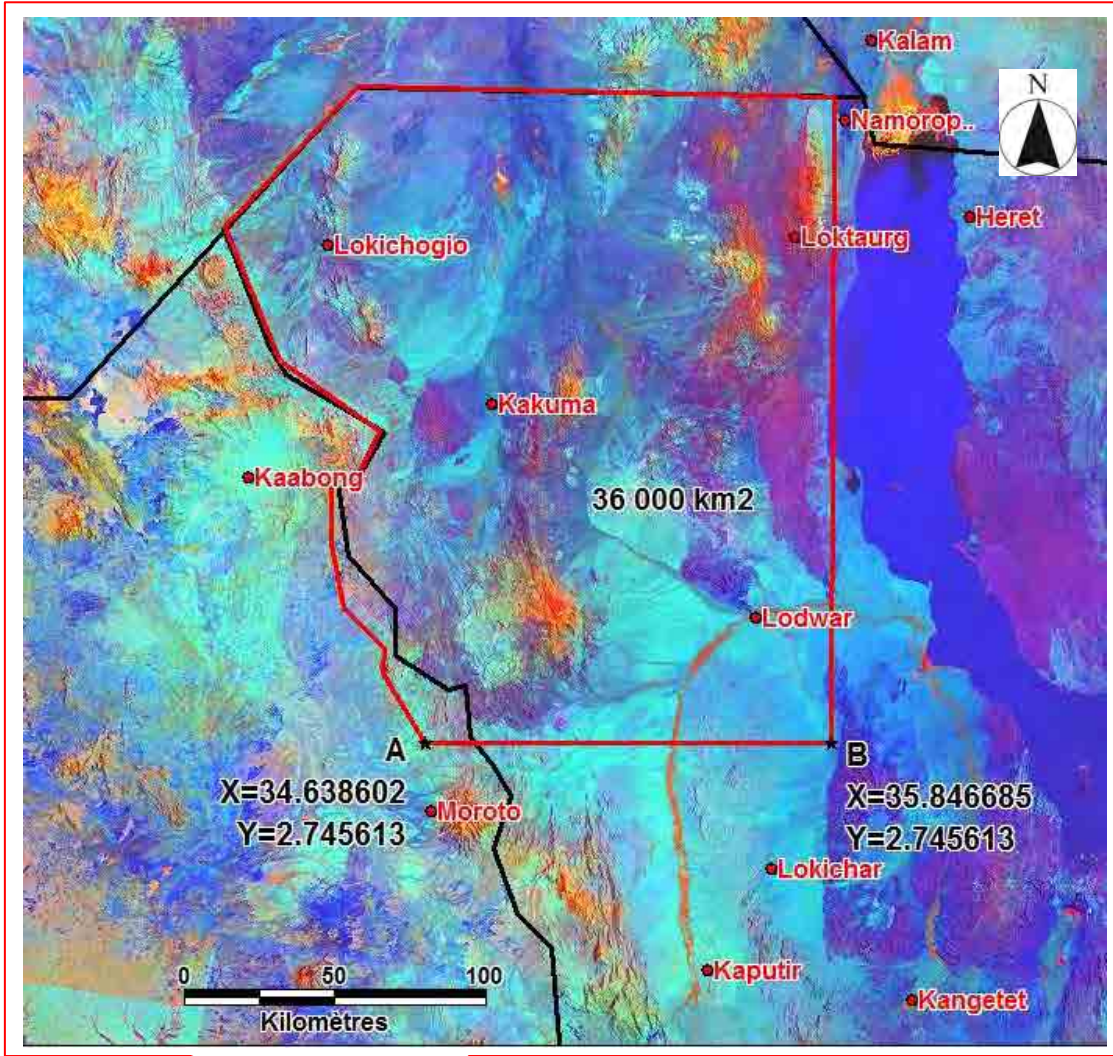


Source: JICA Study Team

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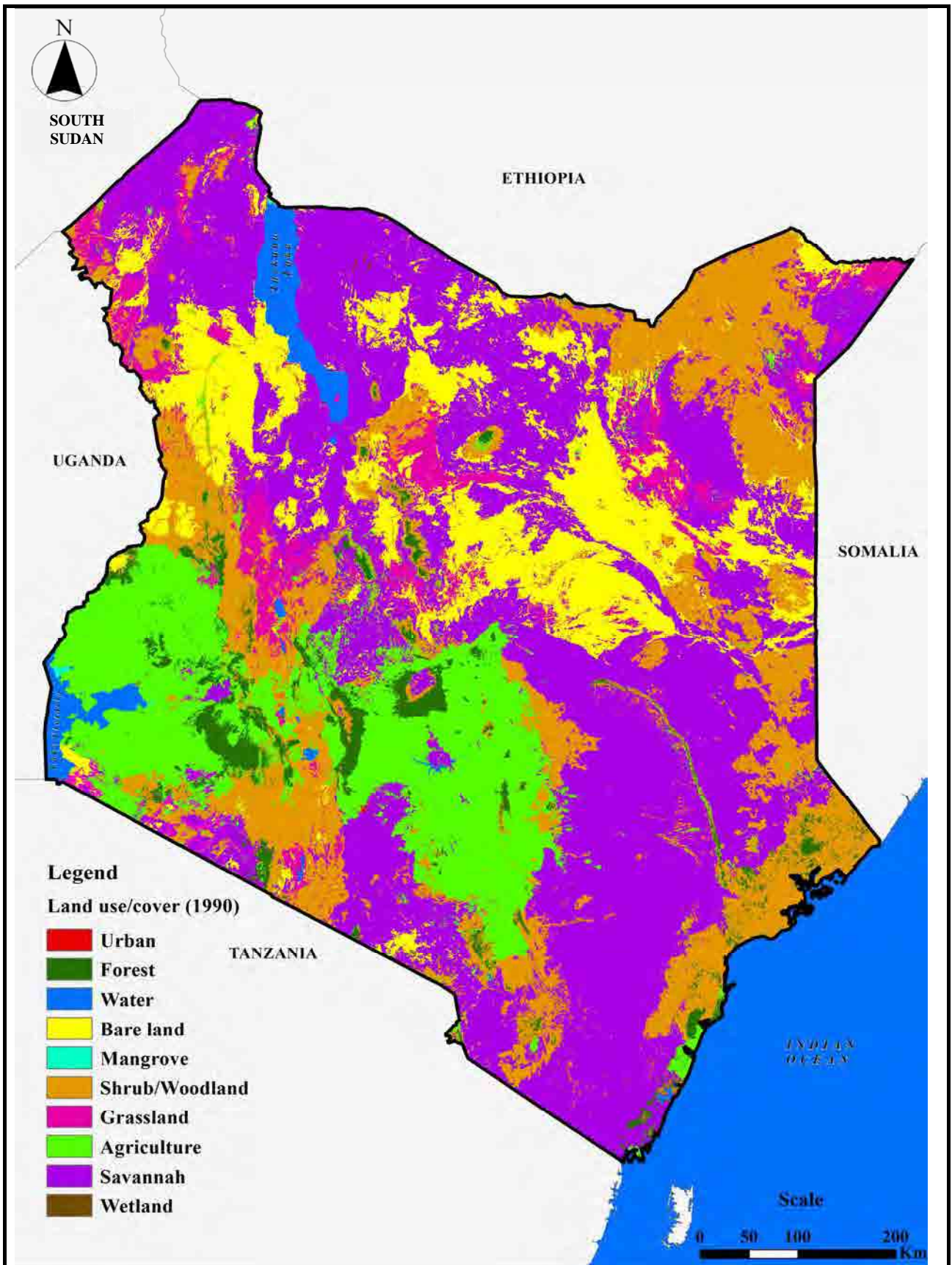
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**Figure 7.7.7
Present Groundwater Balance Map**



Source: JICA Study Team

<p>THE DEVELOPMENT OF THE NATIONAL WATER MASTER PLAN 2030</p>	<p>Figure 7.8.1 Location of Groundwater Resources Survey in Trukana County</p>
<p>JAPAN INTERNATIONAL COOPERATION AGENCY</p>	

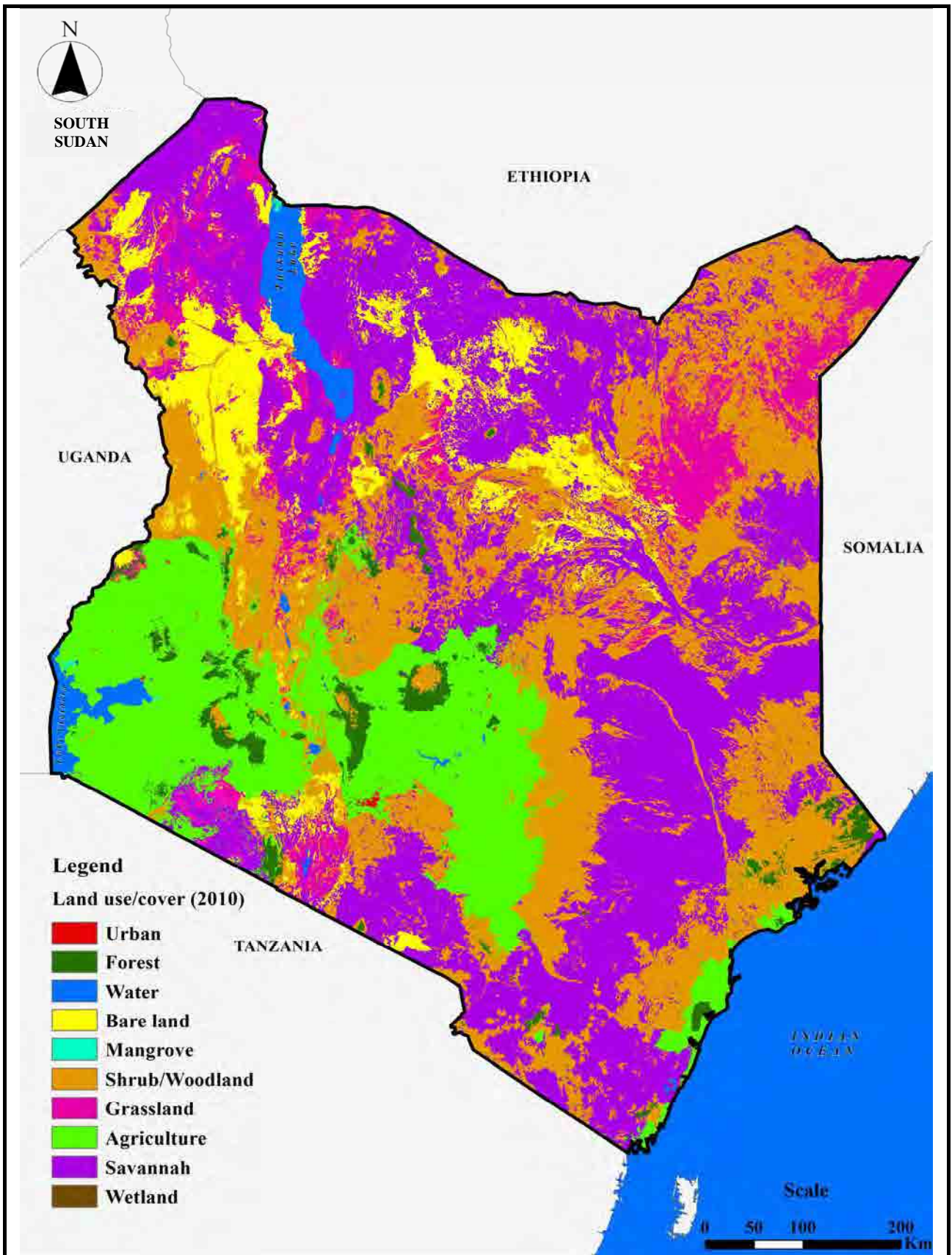


Source: JICA Study Team

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**Figure 8.3.1
Land Use Map of Kenya in 1990**



Source: JICA Study Team

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**Figure 8.3.2
Land Use Map of Kenya in 2010**