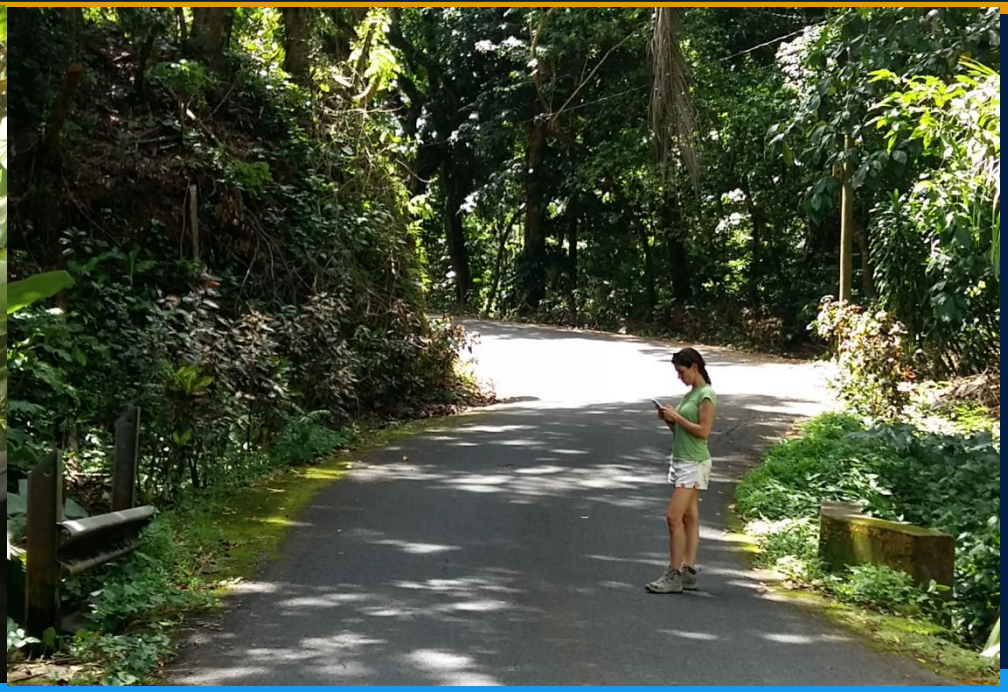
Risk - Based Infrastructure Asset Management System in Dominica



Yohannes Kesete
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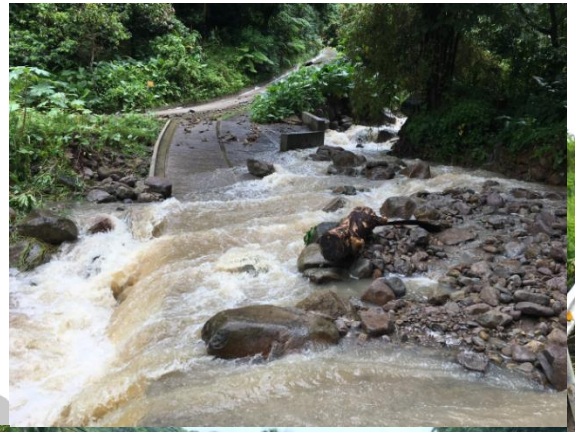
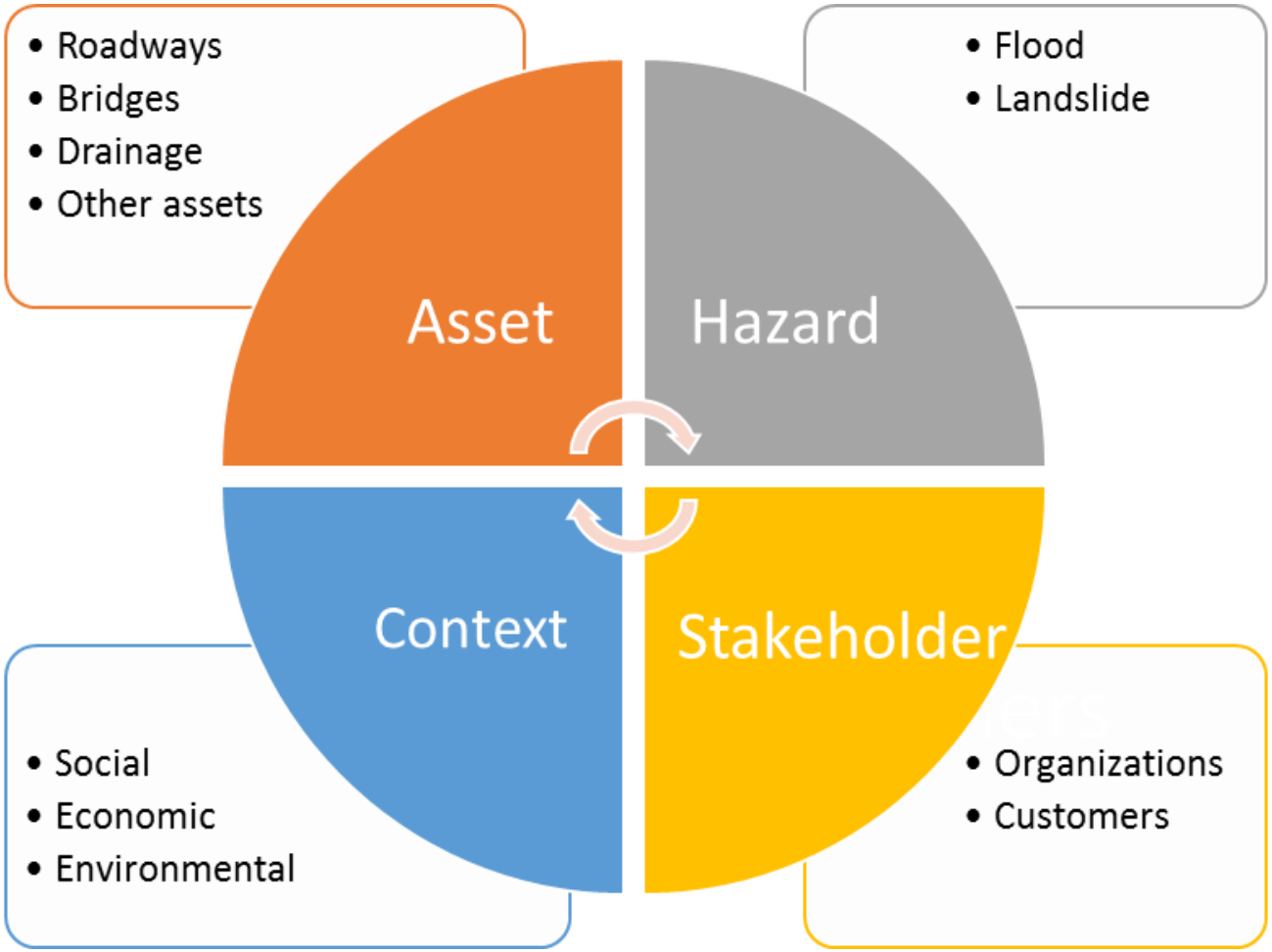
Motivation



Risk-based Asset Management Dimension and Complexity



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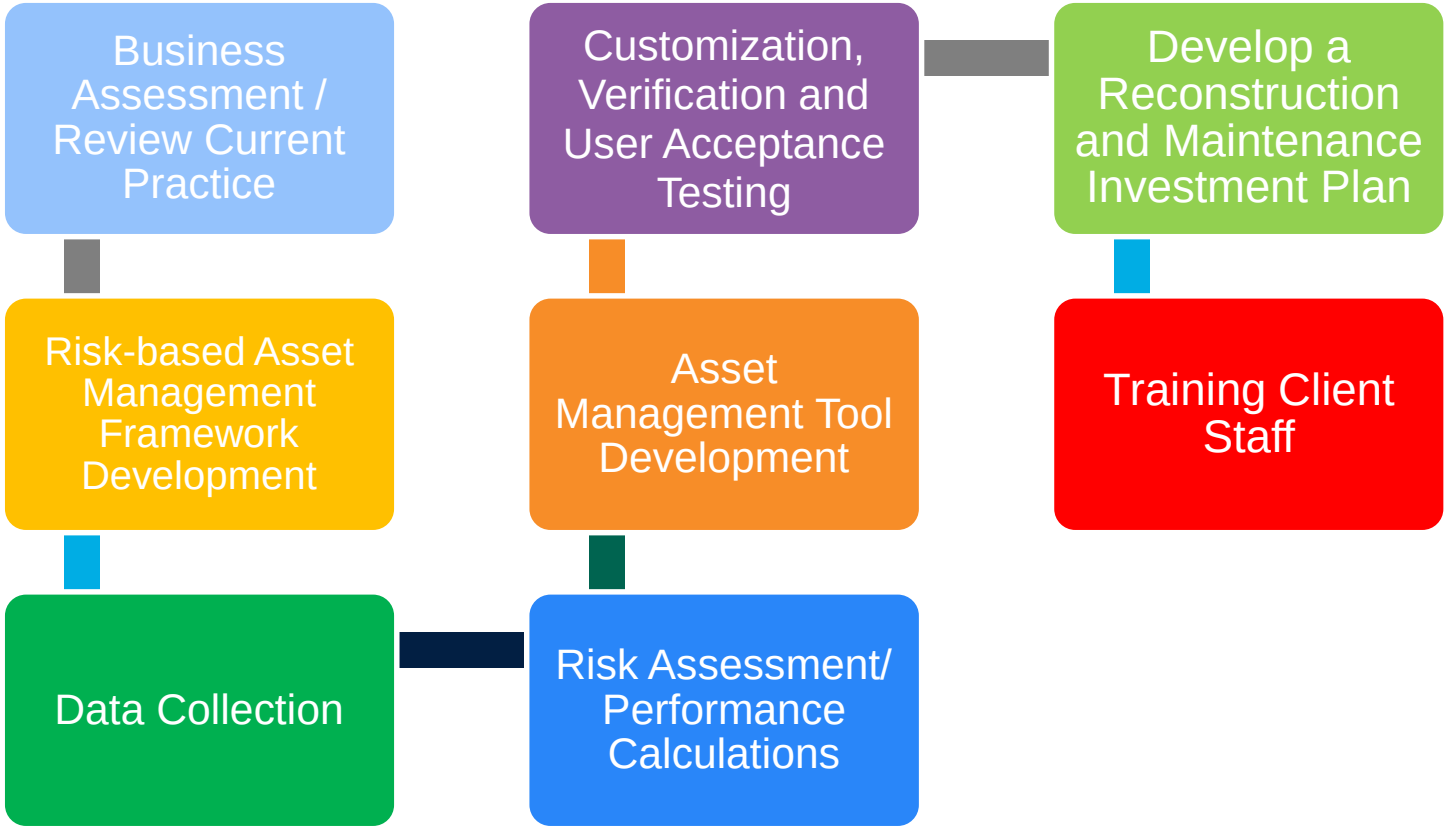
Project Steps



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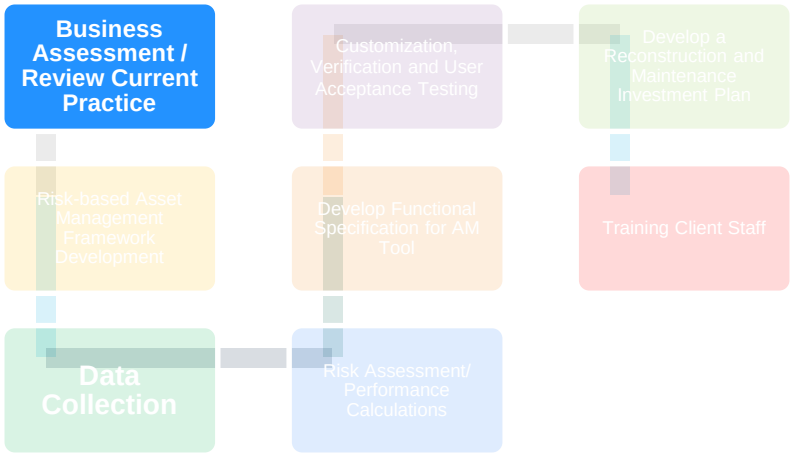
Business Assessment

CURRENT PRACTICE REVIEW AND GAP ASSESSMENT



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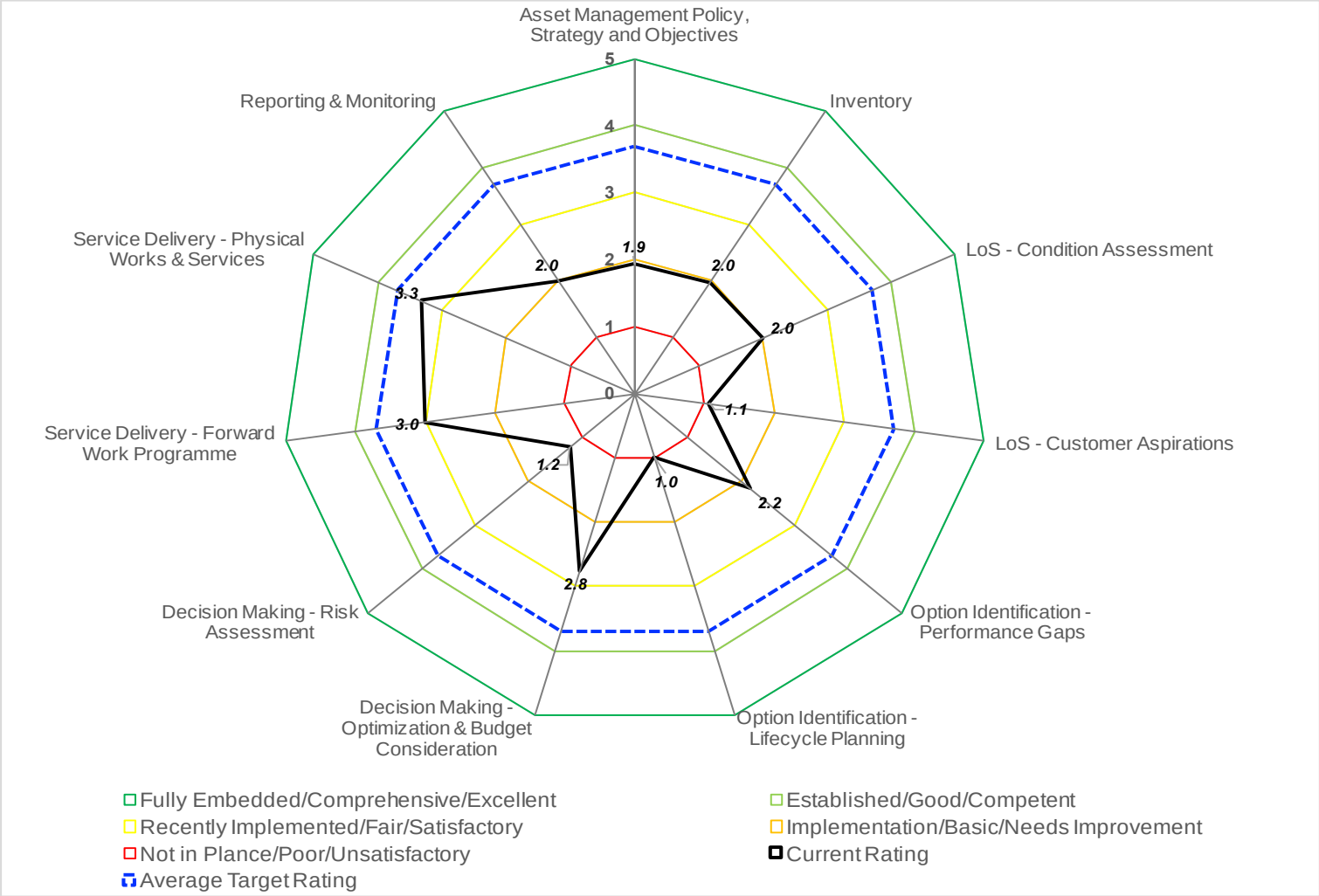
Assessment of Current Capabilities



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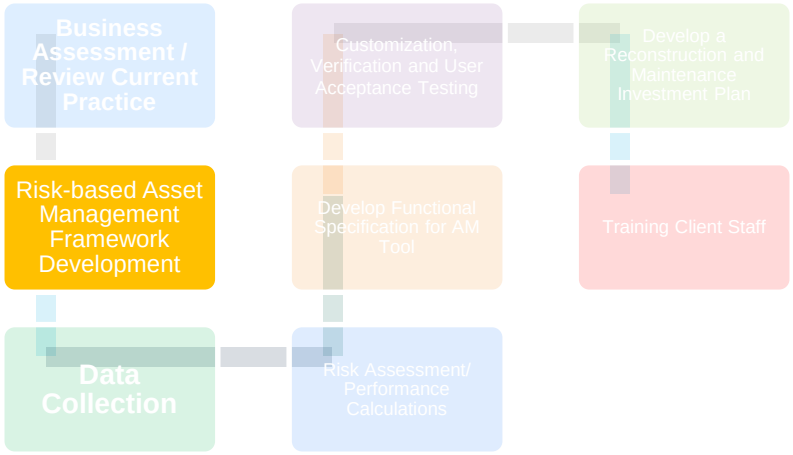
Asset Management Framework Development

RISK-BASED AM METHODOLOGY



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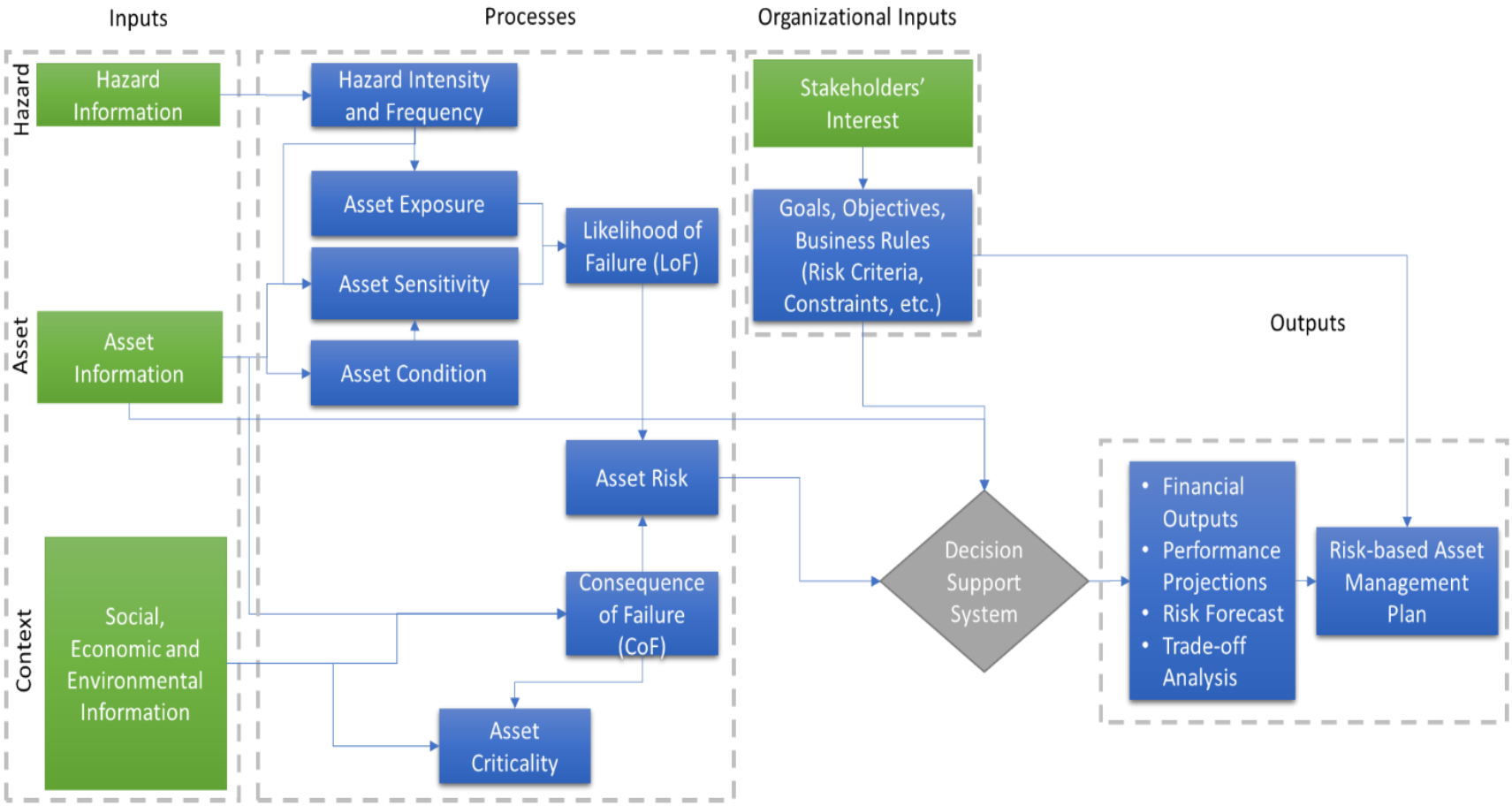
Risk-based Asset Management Methodology Overview



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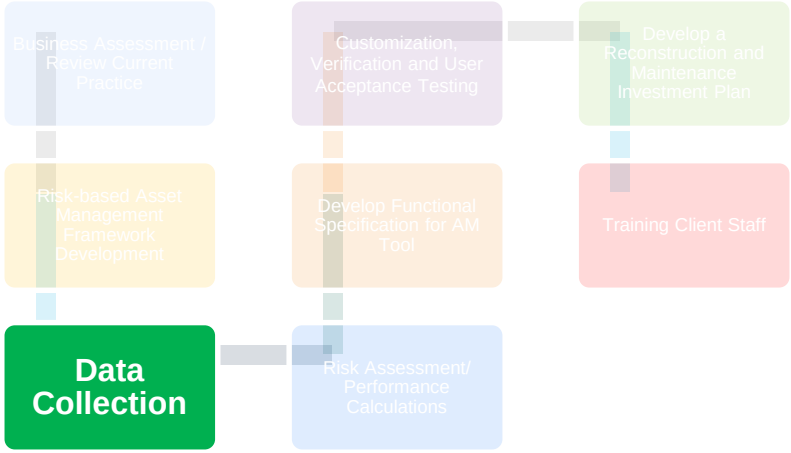
HAZARDS

DATA COLLECTION AND ANALYSIS



Flood Hazard Map

Design Rainfall Characteristics

	1:5 year	1:10 year	1:20 year	1.50 year
Depth (mm)	163.9	204.4	244.9	299.8
Max Intensity (mm/h)	237.8	232	216.6	187.4
Length Duration (min)	165	265	300	375

Dominica Flash Flood Map
(Source: CHARIM)

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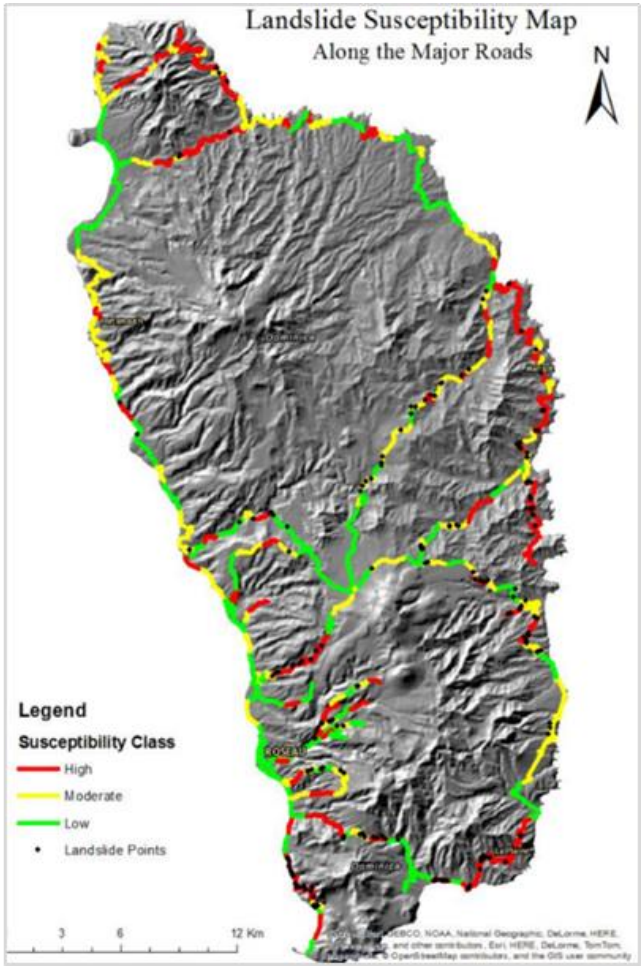
Landslide Hazards Map

Dominica Landslide Susceptibility



Dominica Landslide Susceptibility along Major Roads

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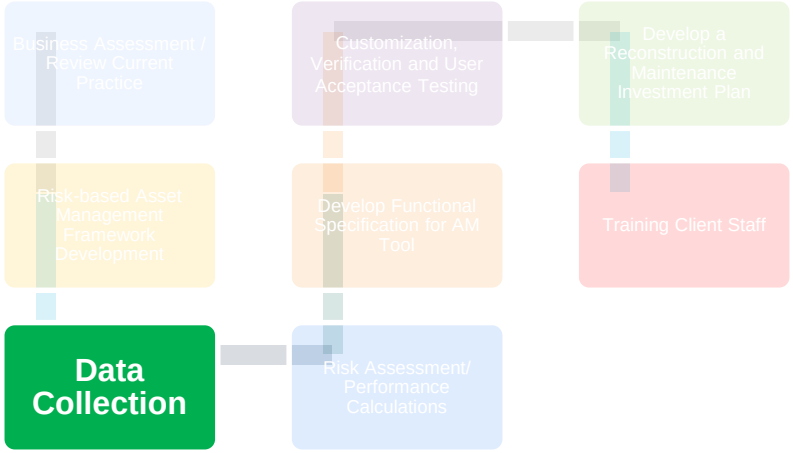
Debris Flow Risk

Evidence of:

1. Bypass flow over bridge
2. Large quantity of floating debris
3. Large volumes of sediment deposited during event modifying channel geometry

Asset

DATA COLLECTION



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General Data	Operational Data	Financial Data
Geometry Location Material Configuration	Maintenance History Traffic Physical condition Protections	Maintenance and Rehab Cost

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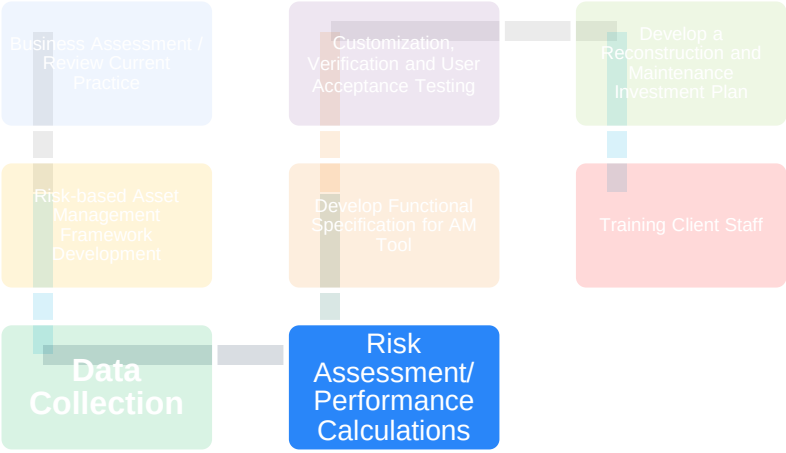
Performance Assessment

RISK AND CONDITION ASSESSMENT



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Condition

- Directly relates to the likelihood of asset failure

- Two Condition Assessment Methods:
  - Visual Condition assessment
  - Analytical Assessment (algorithms and criteria)

Rating			Drainage	Geotechnical Assets	Pavement	Structures
A	5	Excellent	Newly installed or nearly new condition, correct size, free flowing.	New or nearly new condition with no obvious visual defects.	IRI < 5. Smooth with few bumps or depressions.	Bridge in excellent condition, or presenting minor and isolated durable damages.
B	4	Good	Structurally sound, correct size, free flowing.	No visual defects and with few visible signs of surface deterioration. No evidence of previous failures.		Bridge presenting extended minor durable damages.
C	3	Fair	Structurally sound, slight siltation and likely to cause drainage problems during times of heavy rains.	Evidence of initial deterioration and minor previous failures. Minor tension cracks, minor ravines, or evidence of minor slippages/falls are visible.	IRI = 5 - 8. Comfortable with intermittent bumps or depressions.	Bridge presenting medium extended durable damages. Functional damages affecting non-structural elements of the bridge.
D	2	Poor	Signs of deterioration of structure, evidence of silting and likely to cause drainage problems with medium to heavy rains.	Evidence of slippages of embankment or cutting slopes and previous slides that do not interfere with carriageway; tension cracks or ravines in a soil slope. Similar areas of material around current location have already failed.	IRI = 8 - 11. Uncomfortable with frequent bumps or depressions.	Bridge presenting severe durable or functional damages, affecting structural elements. Medium bearing damages.
E	1	Very poor	Severe structural damage, blocked with silt, vegetation or other material, inadequate in size and likely to cause flooding even in light rainfall.	Deep seated soil slippage, normally indicated by slip circle. Rock slides resulting in danger to road users or damage to highway condition. Settlement causing damage to the carriageway or safety fence. Foundation failures of retaining structures. Visual evidence that possible slides may occur.	IRI > 11. Uncomfortable with constant bumps or depressions.	Collapsed bridge or presenting severe bearing damages.

Risk

$$Risk = f(Likelihood\ of\ Failure, Consequence\ of\ Failure)$$

$$LoF = f(Exposure, Sensitivity)$$

$$CoF = f(scoring\ tables)$$

$$Exposure = f(Hazard\ Information, Road\ map)$$

$$Sensitivity = f(Condition, Response\ Against\ Hazard)$$

$$Asset\ Condition = f(Scoring\ tables)$$

$$Asset\ Response\ Against\ Hazard = f(Scoring\ tables)$$

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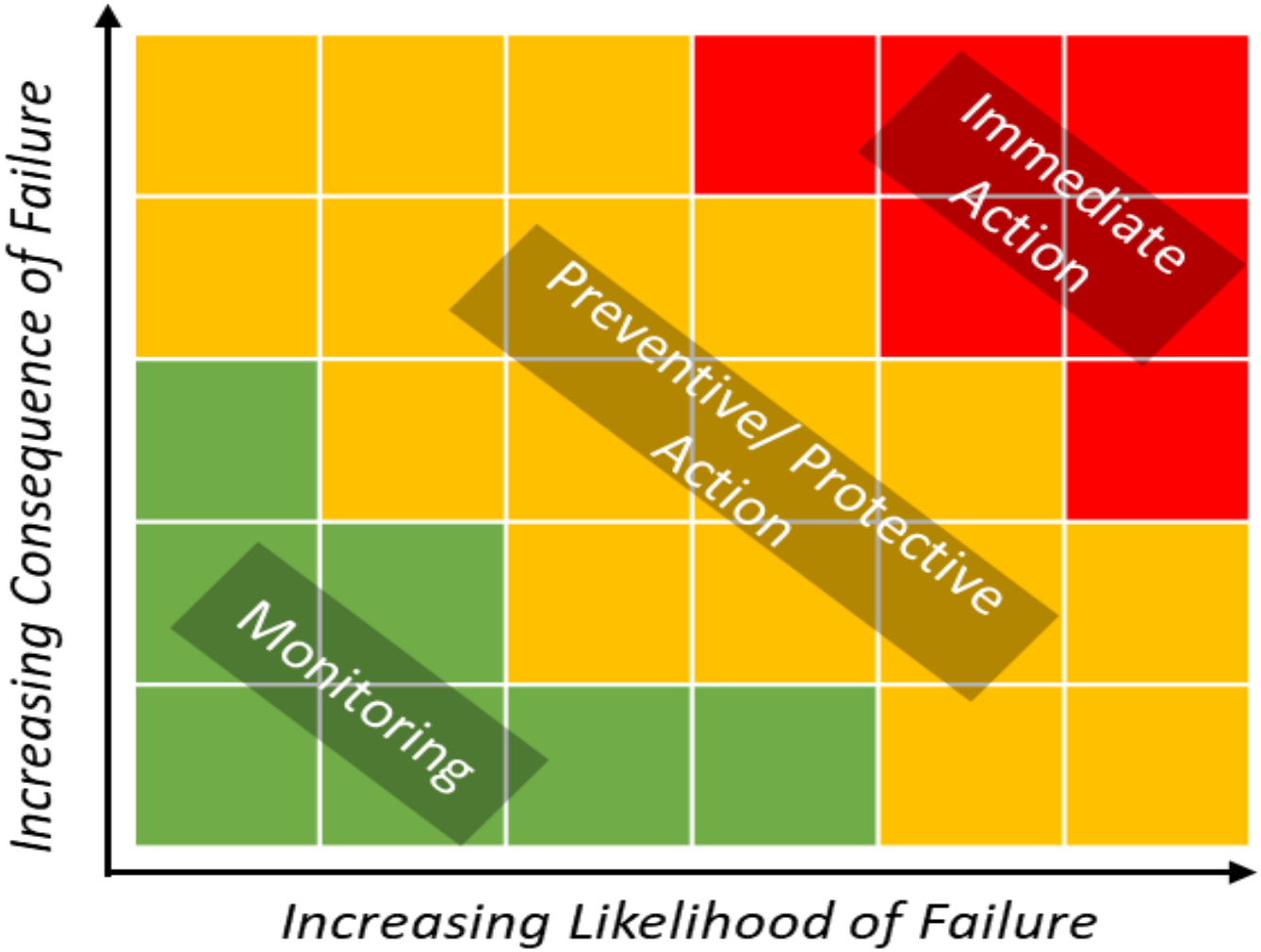
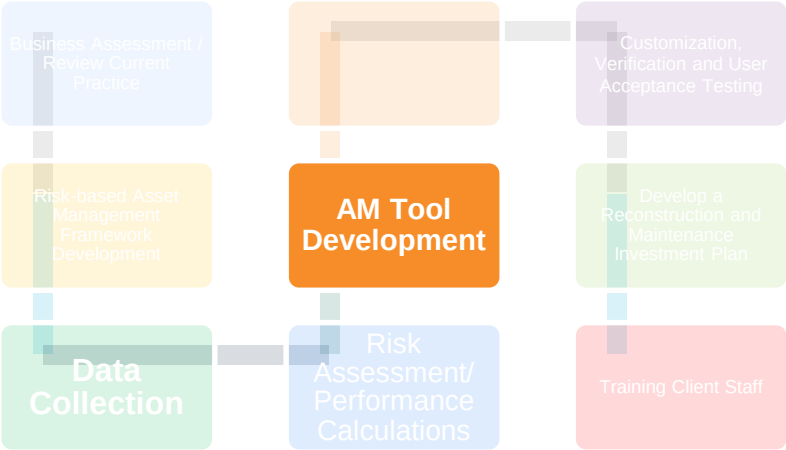
Risk Management



Asset Management Tool Development



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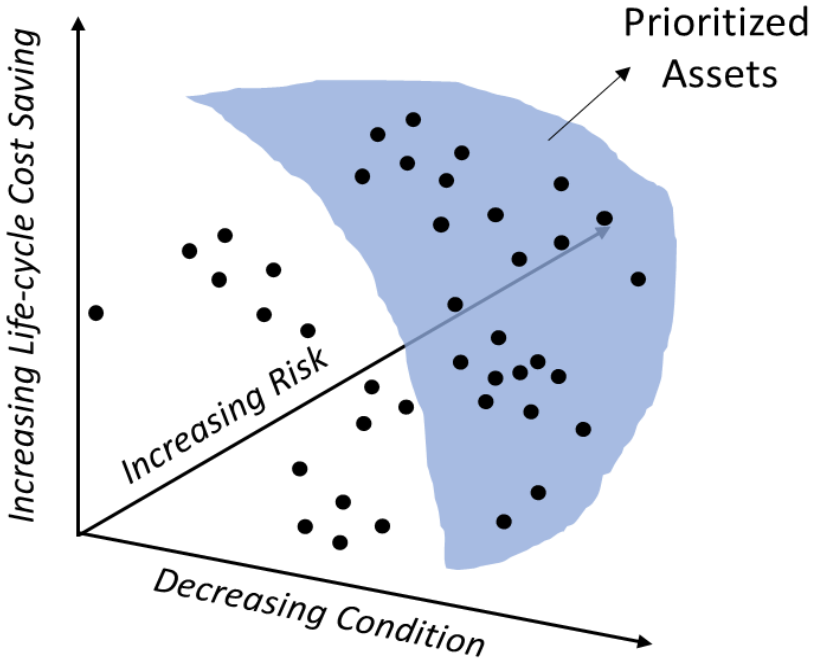
Integration of risk and condition into decision making

- **Unconstrained** needs assessment: Determines the financial needs to maintain assets in an acceptable performance level (assuming there is no budgetary constraints).

- **Constrained** needs assessment: determines the optimal financial strategies to maintain assets at an acceptable performance level considering annual budget limitations.



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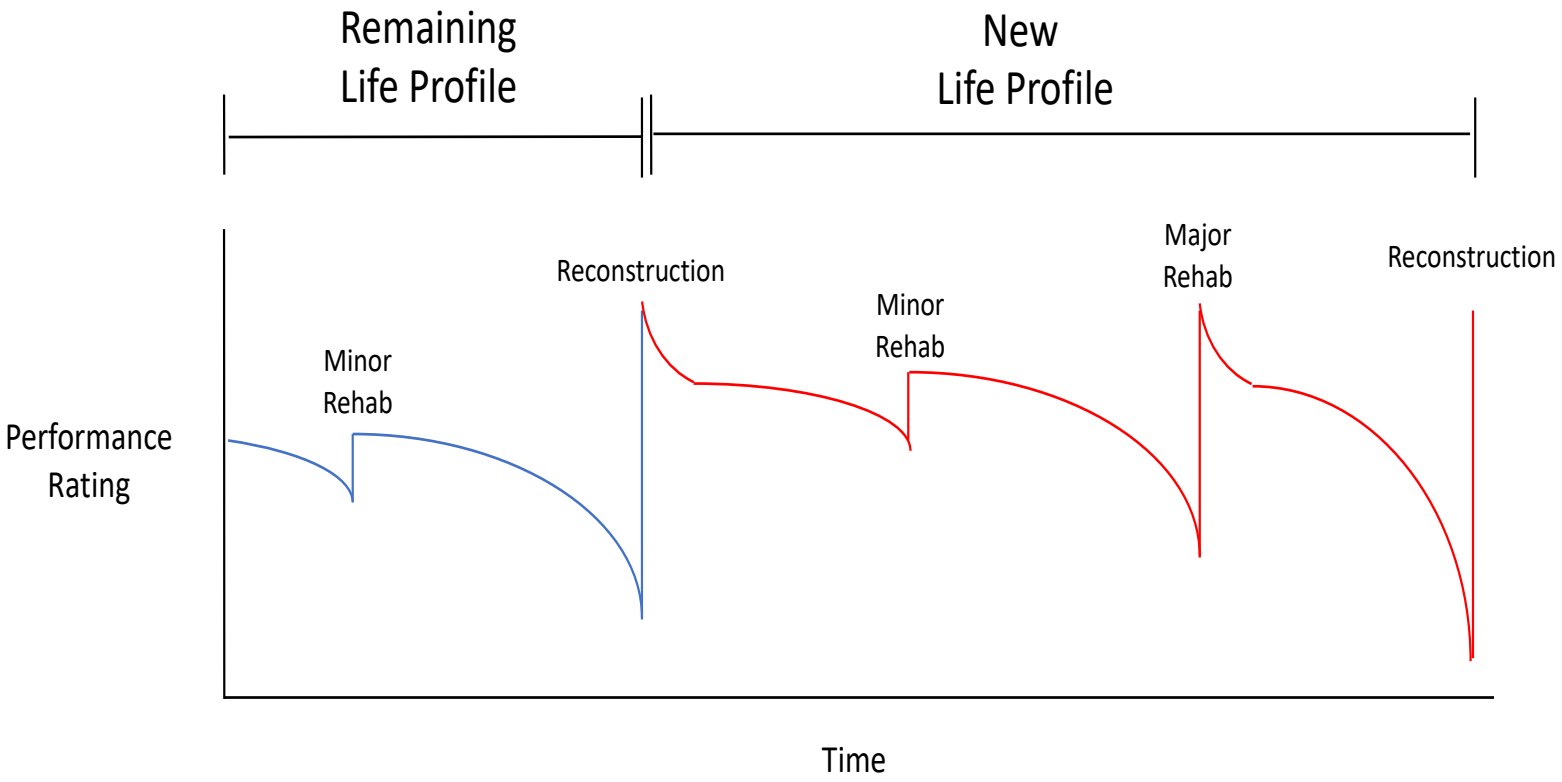
Optimal life-cycle activity profile



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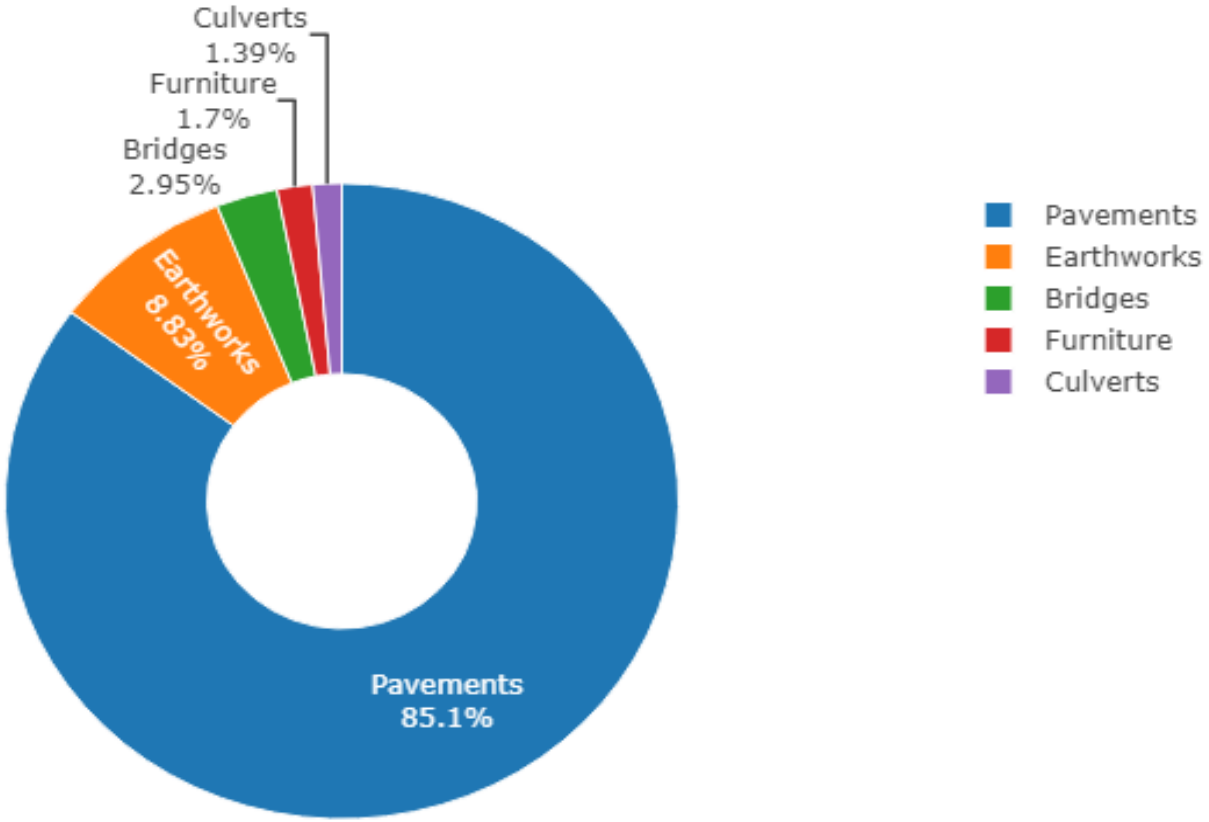
Resource allocation across various asset classes



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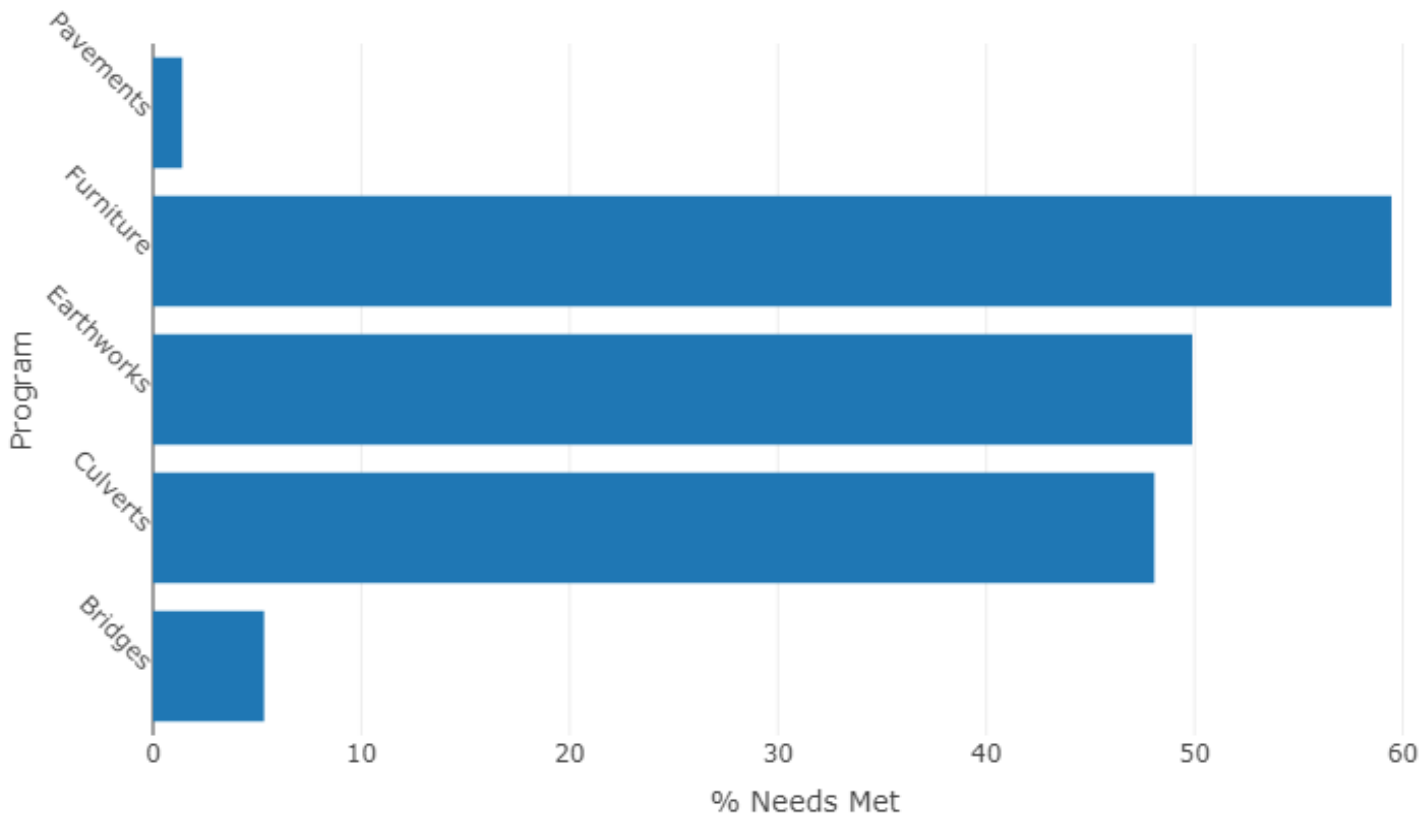
Percent needs met over a planning period of 10 years



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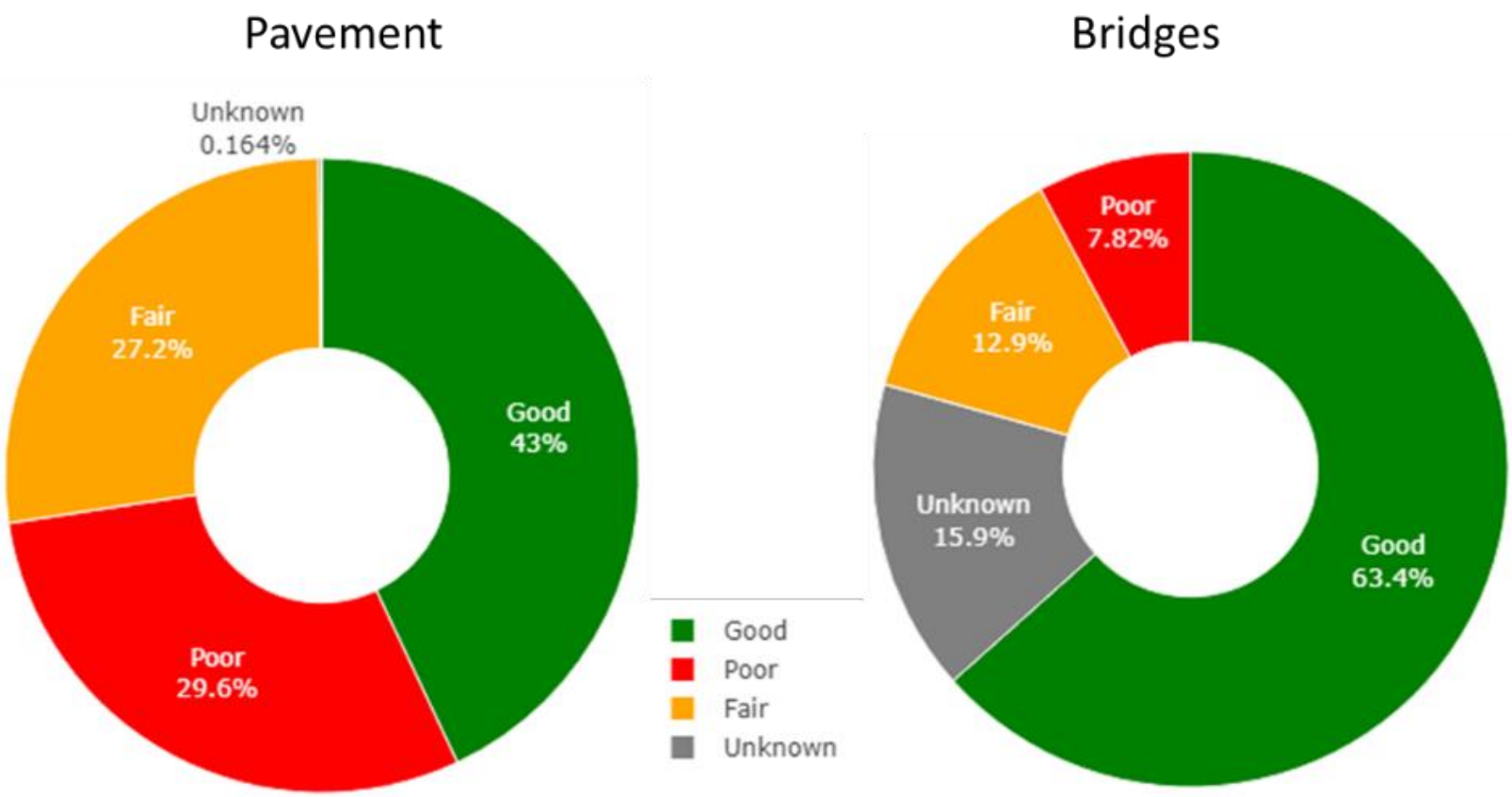
Forecasted pavement and bridge State of repair at the end of program



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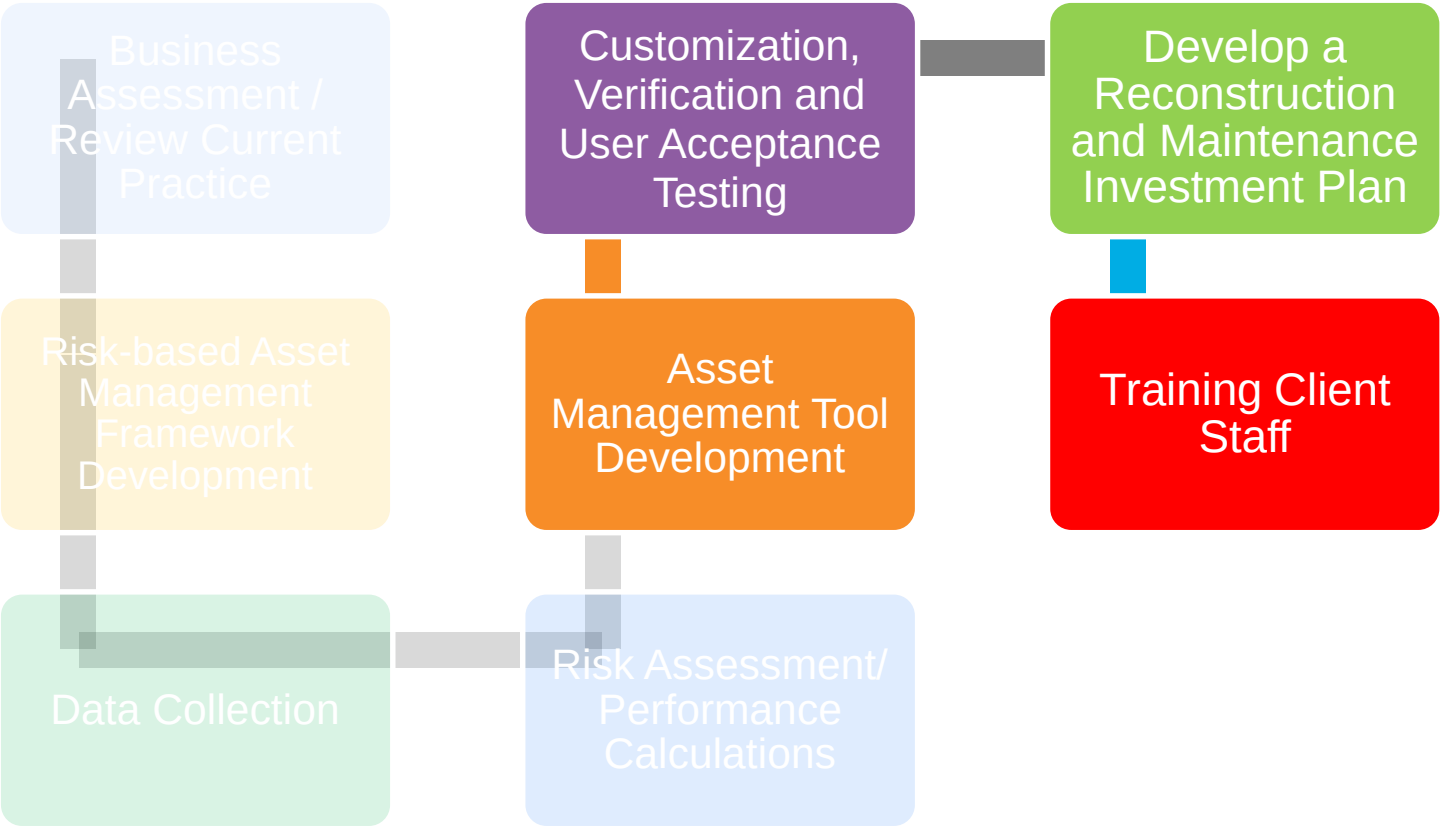
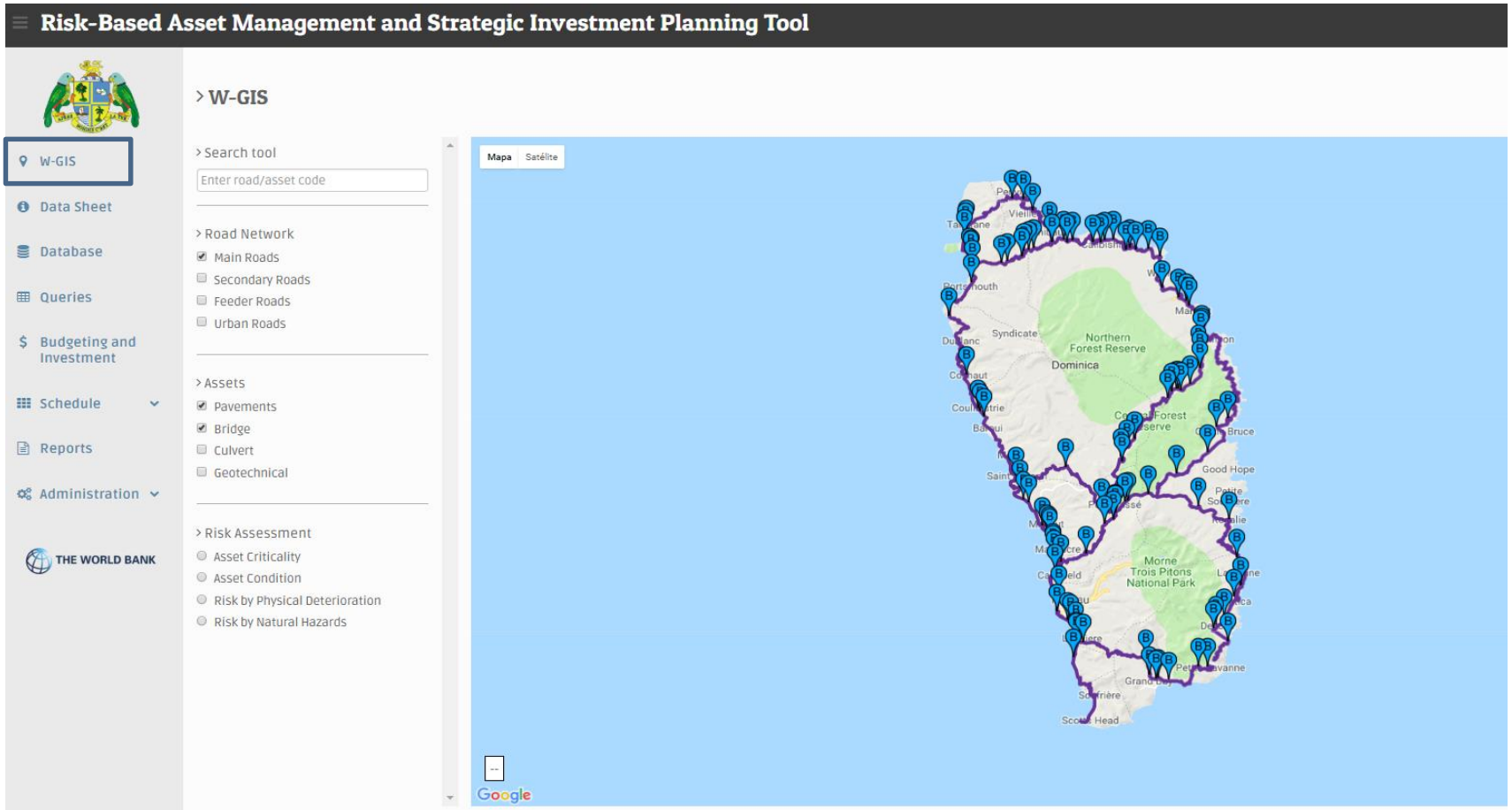
Tool and training



GIS based Inventory database



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Data base

Risk-Based Asset Management and Strategic Investment Planning Tool

dlo Logout

- W-GIS
- Data Sheet
- Database
- Queries
- Budgeting and Investment
- Schedule
- Reports
- Administration

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Data Sheet

Asset code

M1-SPR-B-2811

Asset Type: BRIDGE

Data information

- General Data
- Inventory Data
- Operation and Maintenance Data
- Indexes and risk analysis

File upload

File Upload

General Data

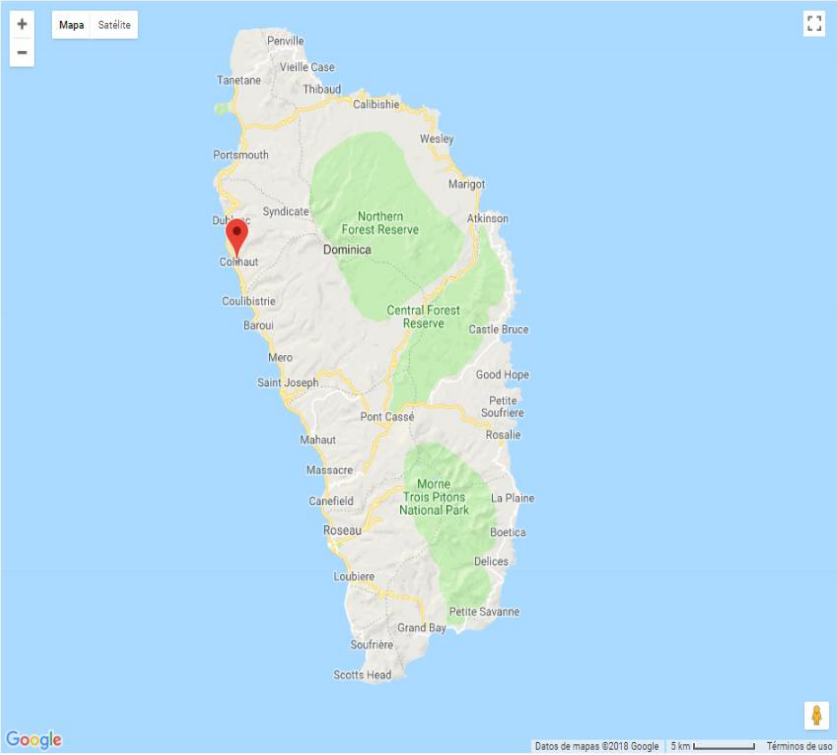
Asset Code	M1-SPR-B-2811
Structural Typology	Girder
Environment	Urban
Obstacle overpassed	River/Water stream

Inventory Data

Material - Deck	Concrete
Material - Girders	Steel
Material - Abutments	Concrete
Bridge alignment	Straight
Single or multiple span?	single
Total length (m)	15
Maximum span (m)	12.0
Total width (m)	10
Free height (m)	3.3
Foundations typology	Shallow foundations
Protection of abutments /nearby areas	Abutments protected

Operation Data

Existence of alternative itinerary	NO
Current visual condition	D
Consequences of failure on LOS	High
Damages on foundations	Damages on foundations



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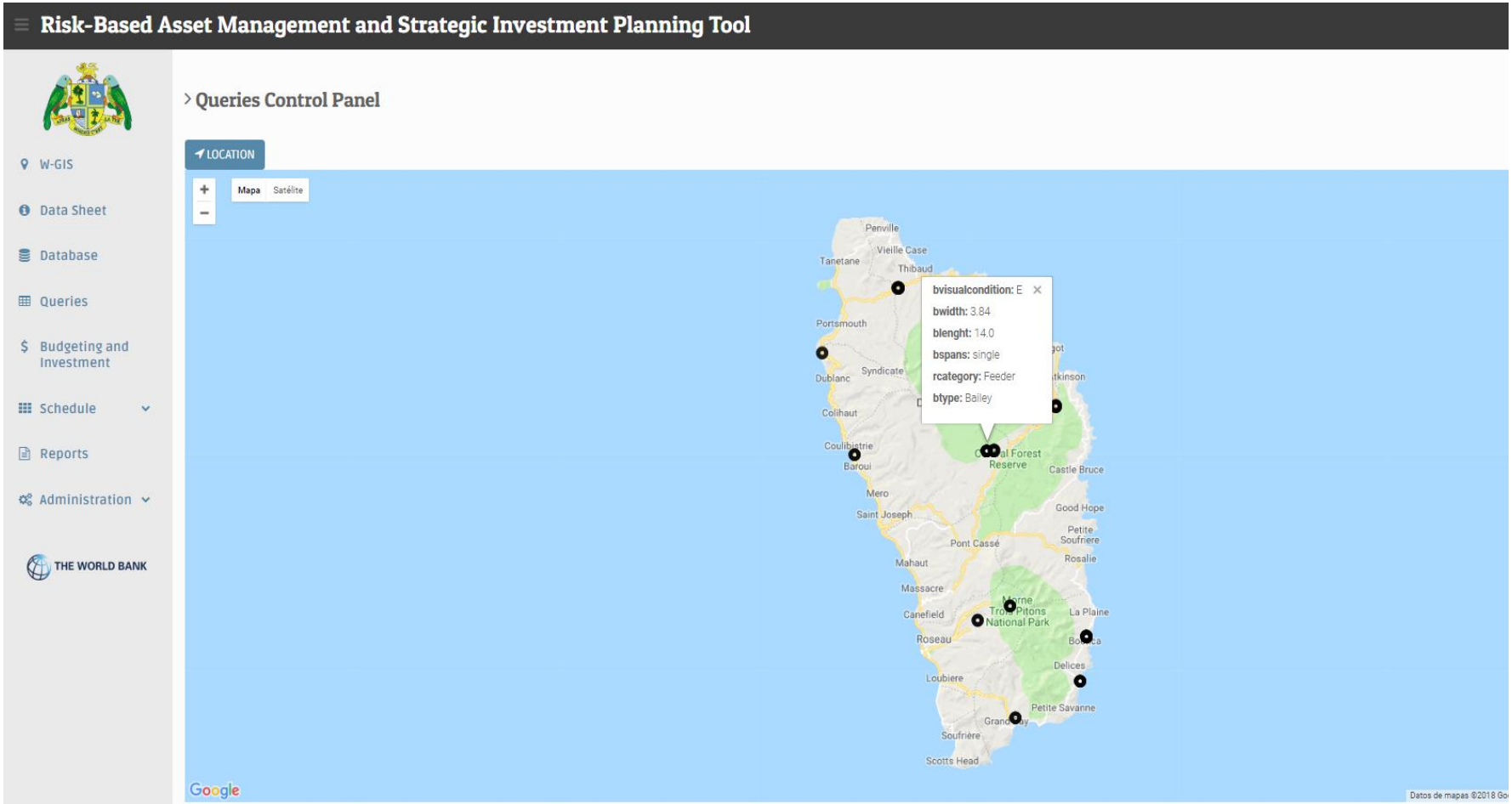
Queries



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Reports

Risk-Based Asset Management and Strategic Investment Planning Tool

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W-GIS

Data Sheet

Database

Queries

Budgeting and Investment

Schedule

Reports

Administration

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Reports Creation

Search tool

S8-SG-01-B-15

Generating...

- BRIDGE INVENTORY SHEET
- EARTHWORKS INVENTORY SHEET
- RETAINING WALLS INVENTORY SHEET
- CULVERTS
- PAVEMENTS INVENTORY SHEET

Report

BRIDGE INVENTORY SHEET

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IDENTIFICATION

Asset code	S8-SG-01-B-15	Road code	S8-SG-01
Asset name		Road name	
Structural typology	Girder	KP	

GENERAL DATA

Year of construction	
Environment / surroundings	Rural
Obstacle overpassed	River/Water stream
Existence of alternative	NO

DESIGN PARAMENTERS

Design flood scenario	
Load capacity	

INVENTORY DATA

Geometry	
Alignment	Straight
N° of spans	2
Total Length (m)	30.0
Maximum Span (m)	17.5
Width (m)	5.58
Free height (m)	7.2
Materials	
Deck	Concrete
Girders	Steel
Piers	Concrete
Piers	Masonry
Foundations	
Type of foundations	Shallow foundations
Response parameters	
Existence of piers over riverbed	No piers over riverbed
Protection of abutments and nearby areas	Abutments protected

Road characteristics	
Pavement material	Asphalt
Road width	3.5
Road furniture	
Barriers	
Existence	No
Typology	
Typology of safety fences	
Signposting and road signs	
Existence	No
Typology	
Typology of vertical signaling	
Street lighting	
Existence	No
Typology	

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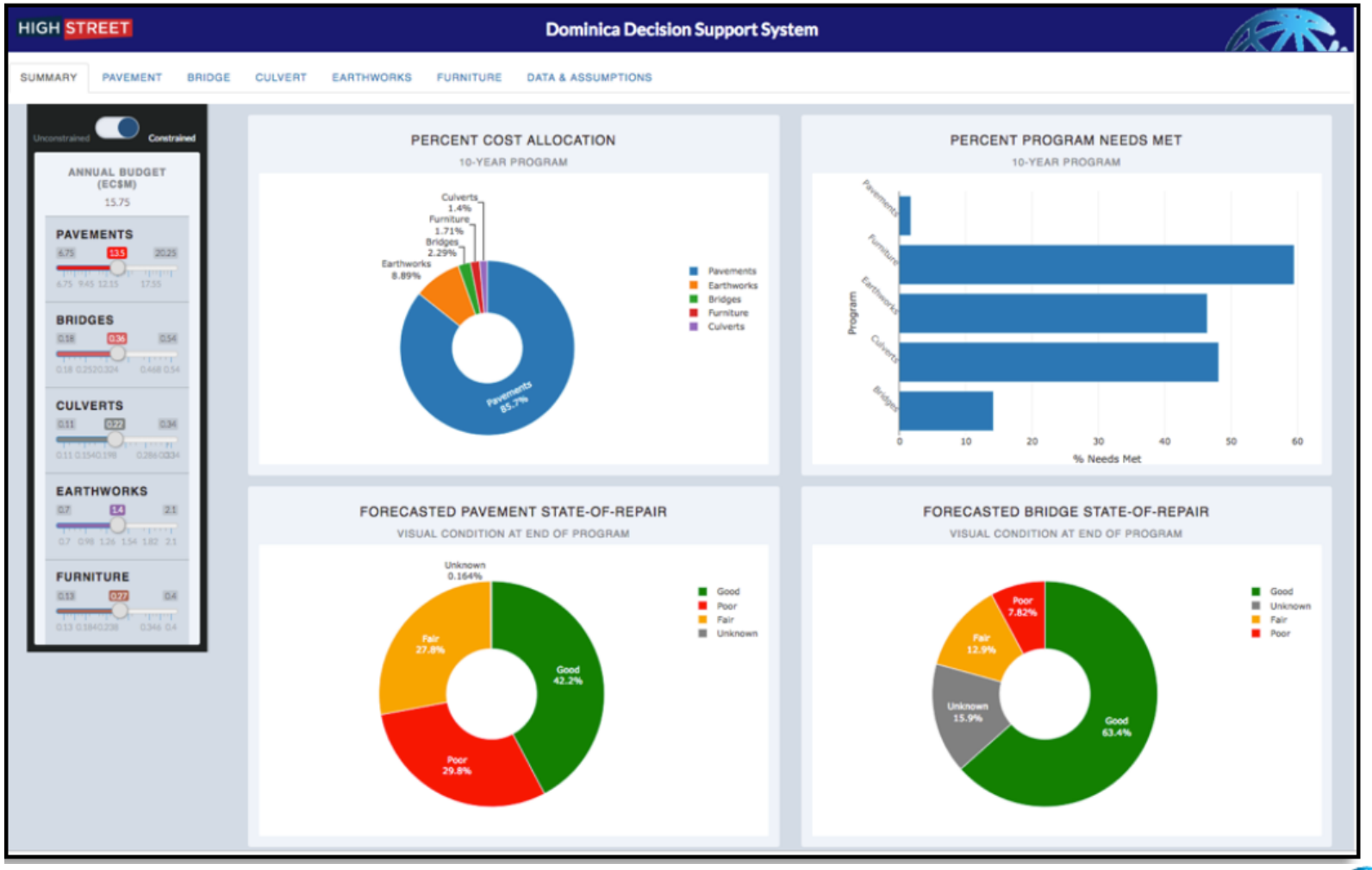
Decision support tool



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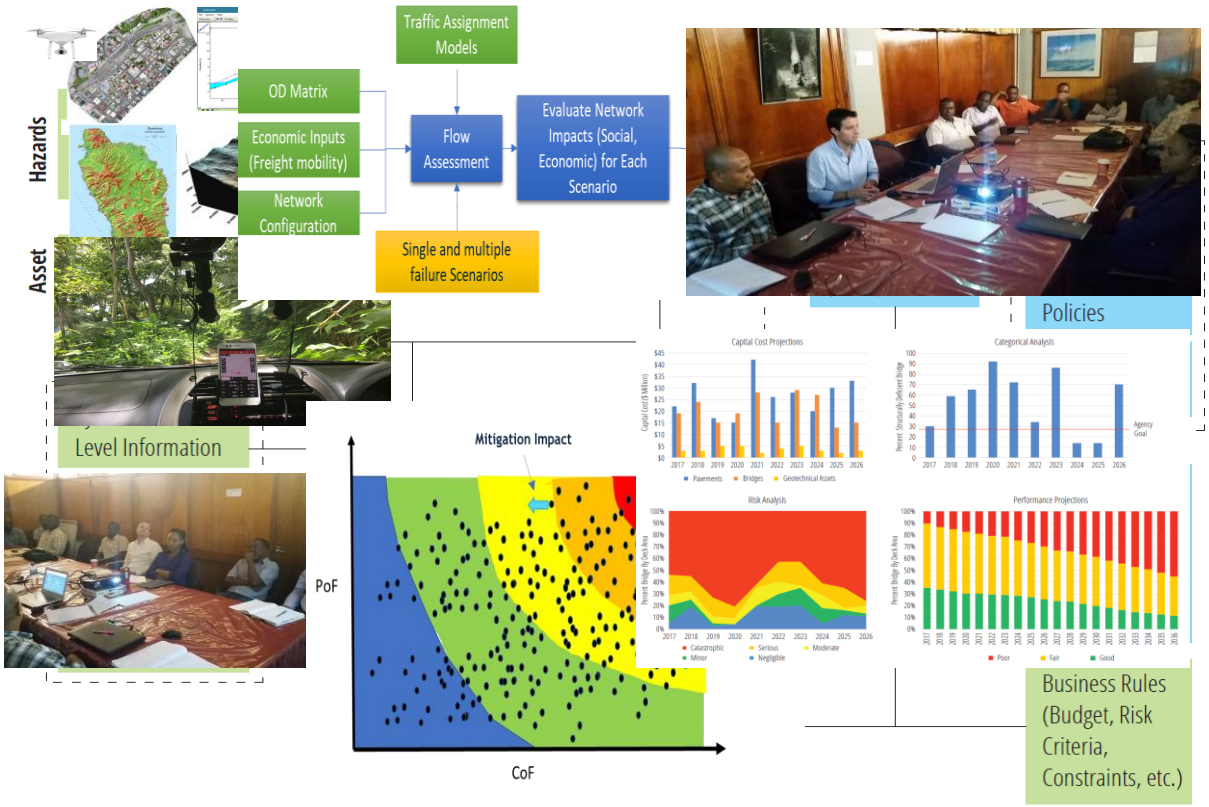
Summary

- A practical guideline on
  - what type of data can be collected
  - how data can be processed,
  - how risk is calculated and
  - how risk and other measures are used in prioritization and optimal resource allocation.

- Low-cost easy-to-use methods for data collection, performance assessment (e.g. criticality and condition) which can be used in many countries

- A multi-objective resource allocation optimization model to develop multi-year maintenance and investment plans

Thank you!



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