

# □ A\* FLOOD ROUTING SYSTEM

*Smart Navigation with Real-Time Flood Avoidance*

## □ MALOLOS CITY, BULACAN, PHILIPPINES

Report Generated: December 01, 2025 at 04:18 AM

### ROUTE INFORMATION

#### □ **START: Malolos City Hall**

F. Llamas Street, Brgy. Sto. Niño, Malolos City

#### □ **END: Bulacan State University (Main Campus)**


MacArthur Highway, Brgy. Guinhawa, Malolos City



#### SYSTEM FEATURES:


- ✓ Real OpenStreetMap road data
- ✓ A\* optimal pathfinding
- ✓ Smart rerouting algorithm
- ✓ Respects one-way streets
- ✓ Real-time flood detection
- ✓ Turn-by-turn directions

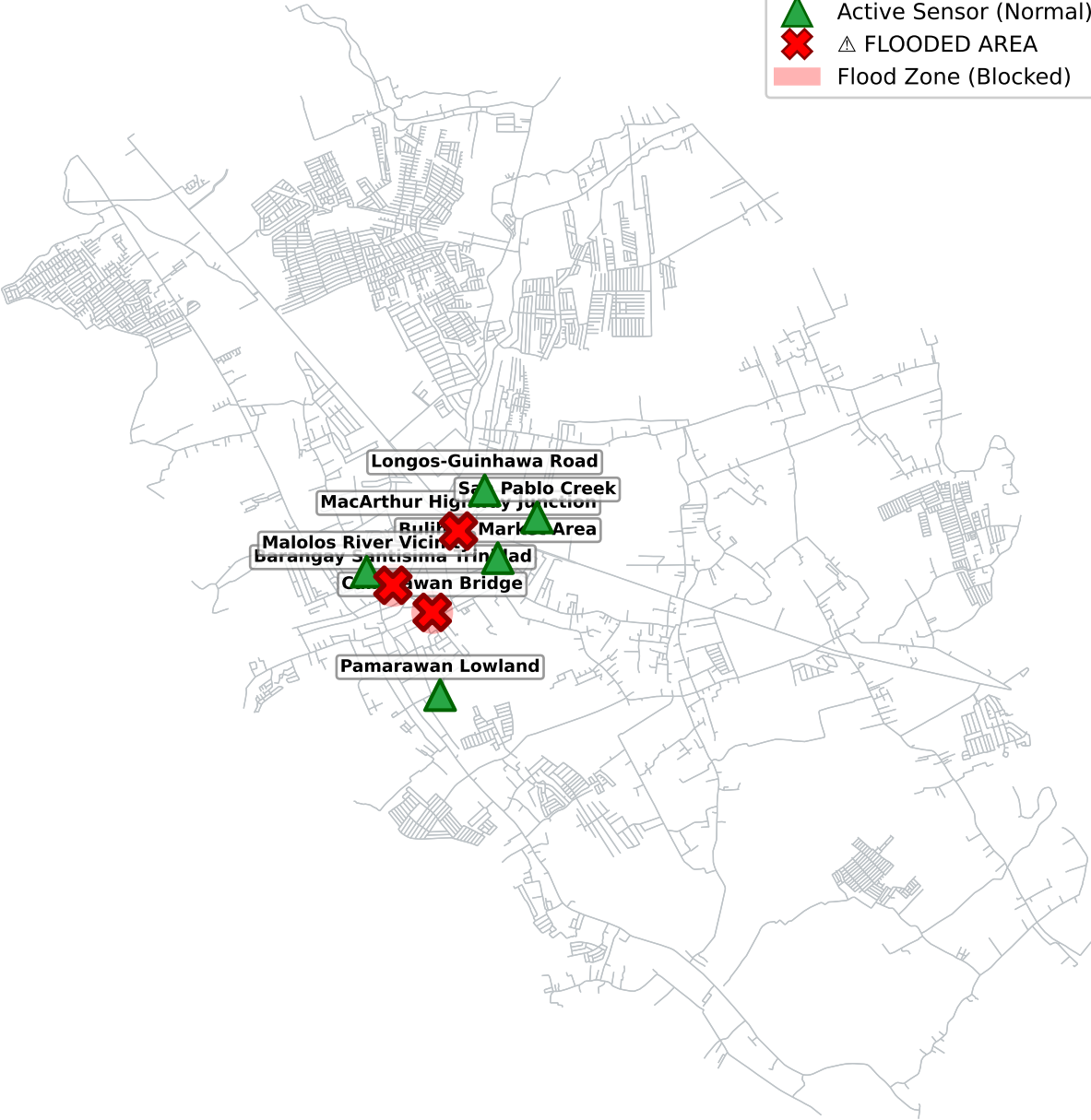
# FLOOD SENSOR NETWORK - Malolos City, Bulacan

## (Strategic Monitoring Points)

 Active Sensor (Normal)









  FLOODED AREA

 Flood Zone (Blocked)



# FLOOD SENSOR STATUS REPORT

Real-time monitoring of strategic flood-prone locations

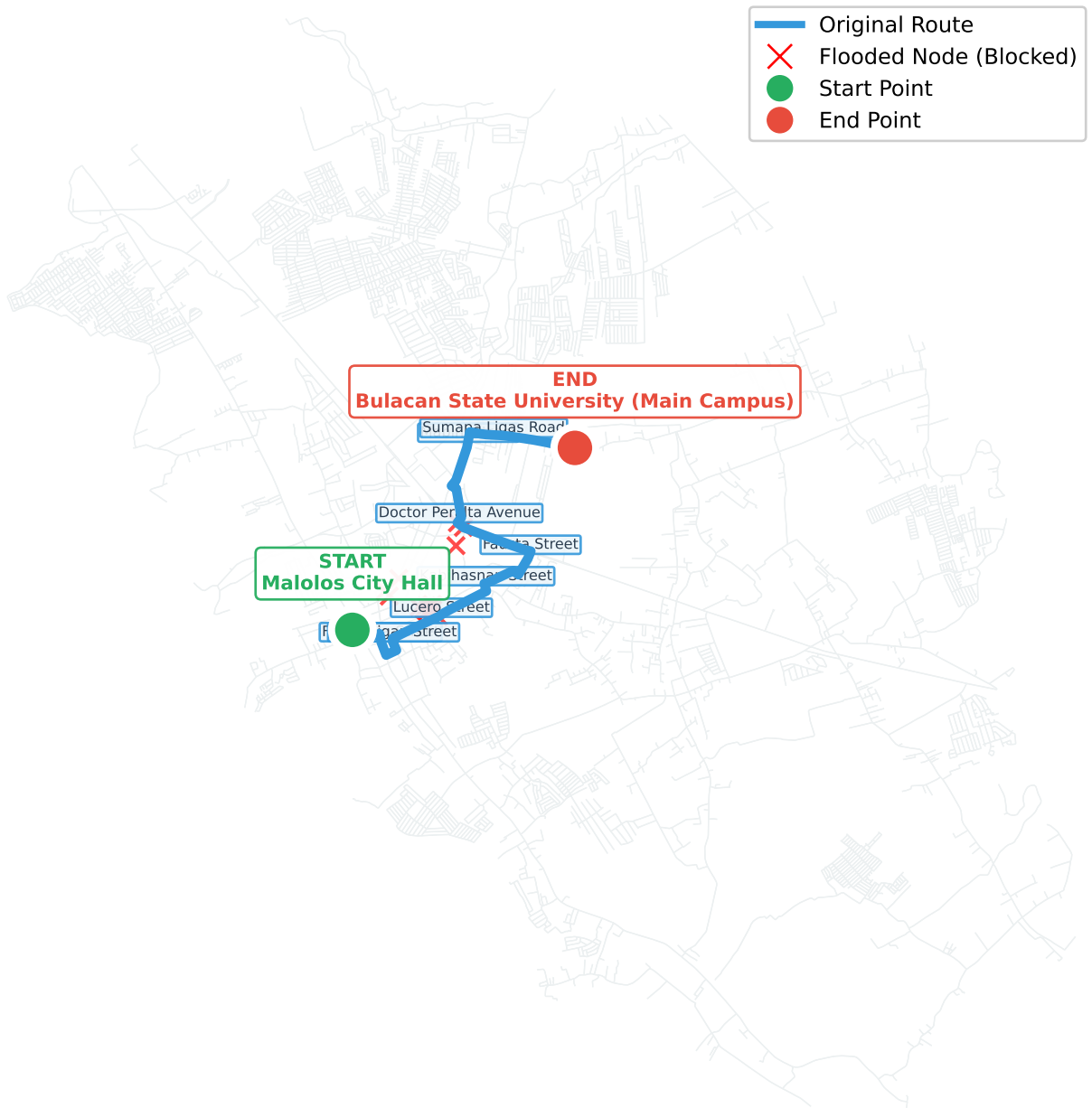
ID	SENSOR LOCATION	COORDINATES	STATUS
00	Barangay Santisima Trinidad	(14.8470°N, 120.8120°E)	 FLOODED
01	MacArthur Highway Junction	(14.8510°N, 120.8170°E)	 FLOODED
02	Bulihan Market Area	(14.8490°N, 120.8200°E)	 Normal
03	Pamarawan Lowland	(14.8389°N, 120.8156°E)	 Normal
04	San Pablo Creek	(14.8520°N, 120.8230°E)	 Normal
05	Caliligawan Bridge	(14.8450°N, 120.8150°E)	 FLOODED
06	Longos-Guinhawa Road	(14.8540°N, 120.8190°E)	 Normal
07	Malolos River Vicinity	(14.8480°N, 120.8100°E)	 Normal

## FLOOD ALERT SUMMARY

Active Sensors: 5

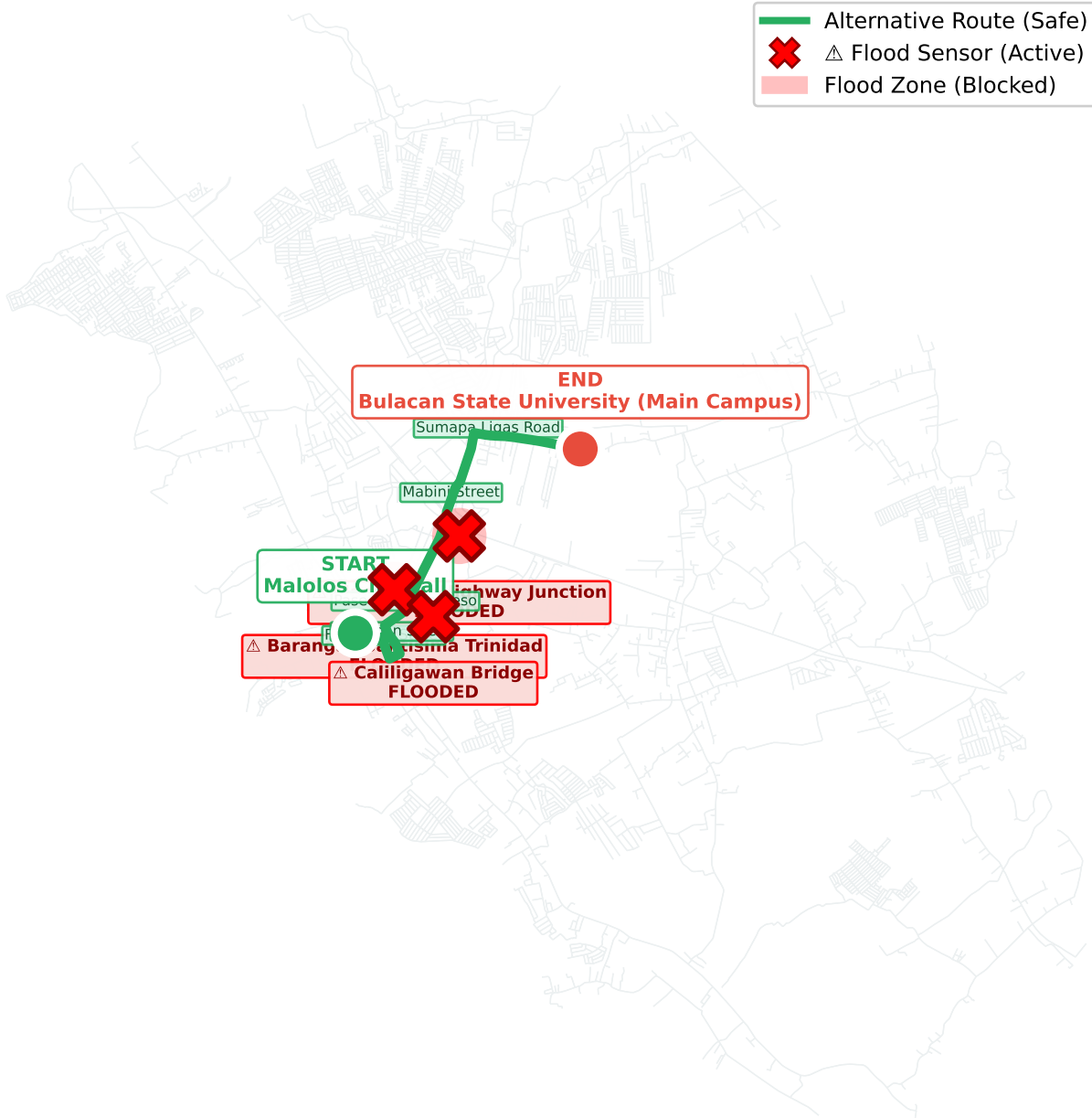
Flooded Areas: 3

# ORIGINAL ROUTE (Without Flood Consideration) Malolos City Hall → Bulacan State University (Main Campus)



□ Distance: 4.64 km | □ Travel Time: 8.0 minutes

# ALTERNATIVE ROUTE (Avoiding Flood Zones) Malolos City Hall → Bulacan State University (Main Campus)



Distance: 3.56 km | Travel Time: 4.7 minutes

# ROUTE COMPARISON: Original vs Alternative (Side-by-Side Analysis)



# TURN-BY-TURN DIRECTIONS

## RECOMMENDED ROUTE (Flood-Free):

- |    |   |          |
|----|---|----------|
| 1. | Start on Unnamed Road                       | 98 m ↔   |
| 2. | Turn right Pariancillo Street               | 218 m →  |
| 3. | Turn left F. Estrella Street                | 189 m →  |
| 4. | Turn left T. Alonzo Street                  | 95 m →   |
| 5. | Continue straight Canlapan Street           | 181 m →  |
| 6. | Continue straight Paseo del Congreso        | 1.2 km ↔ |
| 7. | Turn right Mabini Street                    | 724 m ↔  |
| 8. | Arrive at destination via Sumapa Ligas Road | 890 m ↔  |

## ROADS ON ALTERNATIVE ROUTE:

Pariancillo Street, F. Estrella Street, T. Alonzo Street, Canlapan Street, Paseo del Congreso, Mabini Street, Sumapa Ligas Road

## ORIGINAL ROUTE (May Pass Through Flood):

- |    |  |       |
|----|--|-------|
| 1. | Start on Unnamed Road                  | 98 m  |
| 2. | Turn right Pariancillo Street          | 218 m |
| 3. | Turn left F. Estrella Street           | 189 m |
| 4. | Turn left T. Alonzo Street             | 95 m  |
| 5. | Turn right Canlapan Street             | 81 m  |
| 6. | Turn left Unnamed Road                 | 19 m  |
| 7. | Turn right Pagsibigan Street           | 22 m  |
| 8. | Continue straight M. Crisostomo Street | 381 m |

## ROADS ON ORIGINAL ROUTE:

Pariancillo Street, F. Estrella Street, T. Alonzo Street, Canlapan Street, Pagsibigan Street, M. Crisostomo Street, Lucero Street, Kabihasnan Street, Paraluman Street, Fausta Street

# ROUTE ANALYSIS SUMMARY

## ORIGINAL ROUTE

Distance: 4.64 km

Travel Time: 8.0 min

Nodes: 57

⚠️ **BLOCKED BY FLOOD**

## ALTERNATIVE ROUTE

Distance: 3.56 km

Travel Time: 4.7 min

Nodes: 50

✅ **SAFE & RECOMMENDED**

## ROUTE DIFFERENCE

Distance: -1.08 km (-23.2%)

Time: -3.3 minutes

## RECOMMENDATION

Take the ALTERNATIVE ROUTE to safely avoid all flood-affected areas.



# □ A\* ALGORITHM TECHNICAL DETAILS

## THE A\* PATHFINDING ALGORITHM

A\* finds the shortest path using the formula:  $f(n) = g(n) + h(n)$

Where:

- $f(n)$  = Total estimated cost of path through node  $n$
- $g(n)$  = Actual cost from start to node  $n$
- $h(n)$  = Heuristic estimate from  $n$  to goal

## IMPLEMENTATION FEATURES:

1. REAL ROAD NETWORK DATA
  - Source: OpenStreetMap (© OpenStreetMap contributors)
  - Respects one-way streets and turn restrictions
  - Includes all road types: highways, primary, secondary, residential
2. HEURISTIC FUNCTION
  - Uses Haversine formula for great-circle distance
  - Admissible heuristic (never overestimates)
  - Guarantees optimal path finding
3. FLOOD AVOIDANCE MECHANISM
  - Sensors detect flooding at strategic locations
  - Nodes within flood radius are marked as impassable
  - A\* excludes flooded nodes from pathfinding
  - Real-time rerouting when floods detected
4. TRAVEL TIME ESTIMATION
  - Based on road type and speed limits
  - Considers road length and conditions
  - Factors in traffic characteristics

## DATA SOURCES & REFERENCES:

- Road Network: OpenStreetMap via OSMnx library
- Coordinate System: WGS84 (EPSG:4326)
- Flood Sensors: Simulated at known flood-prone areas