Valued Graph Analysis

So far we have been using topologic distances to determine isolation / connectivity. However both connectivity and Shimbel distance have shortcomings:

Connectivity:

- All steps are of equal topologic length (1).
- Indirect and direct linkages are treated equally.

Shimbel Distance:

- All steps are of equal topologic length (1).
- We assume that fewer steps equals lower isolation.

The Five Measurement Problems in Matrix Analysis

1. **Placement:** consideration is given to *where* linkages are located in a network.

2. **Direct/Indirect Linkages:** both should be considered.

3. **Attenuation:** differences between direct and indirect linkages should be treated.

4. **Redundancy:** corrections should be made for meaningless round trips.

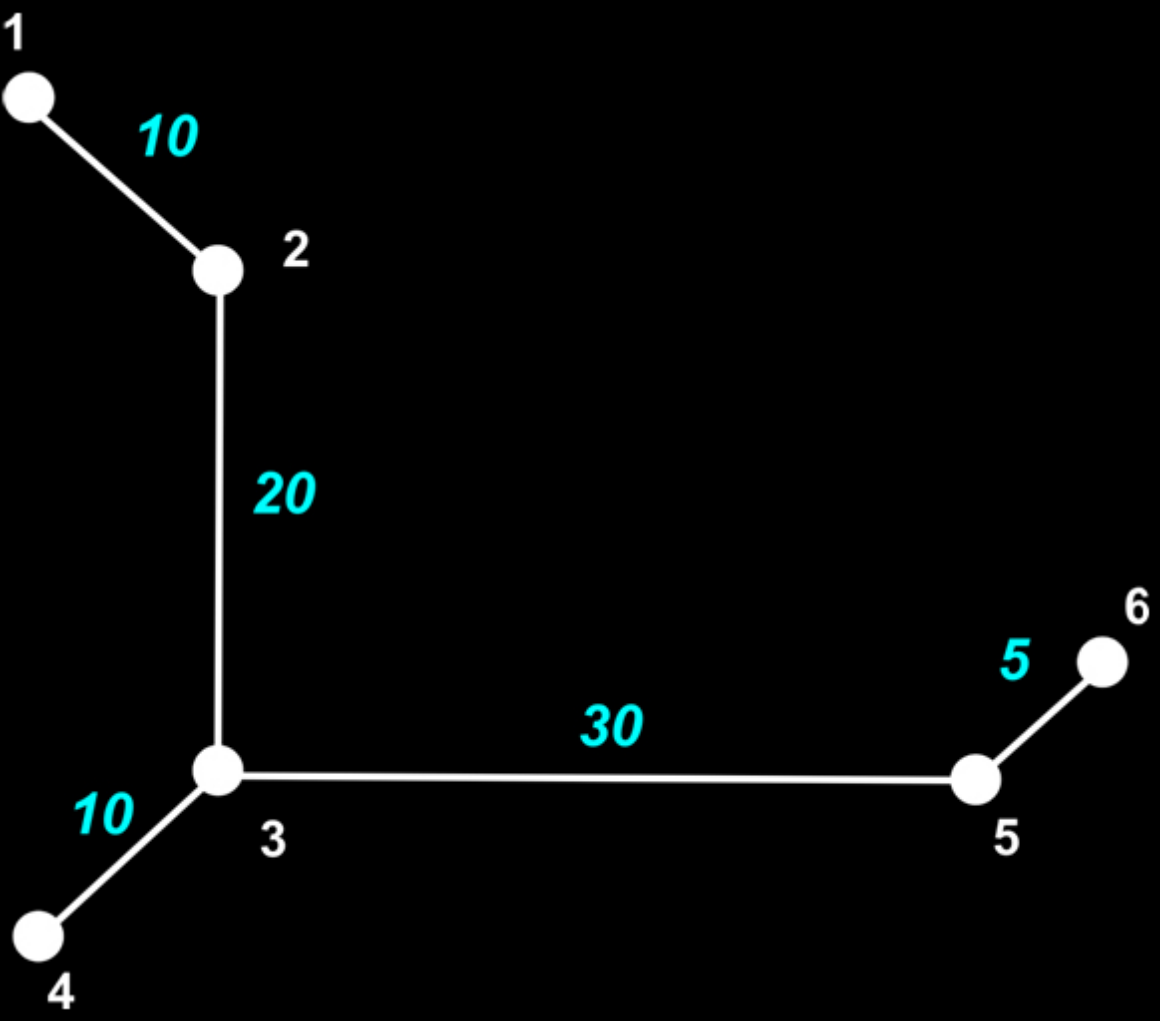
5. **Unequal Linkages:** linkages should be weighted based on some measure.

***Valued graphs*: the shortest actual (rather than topological) distance needed to connect one node to all other nodes.**

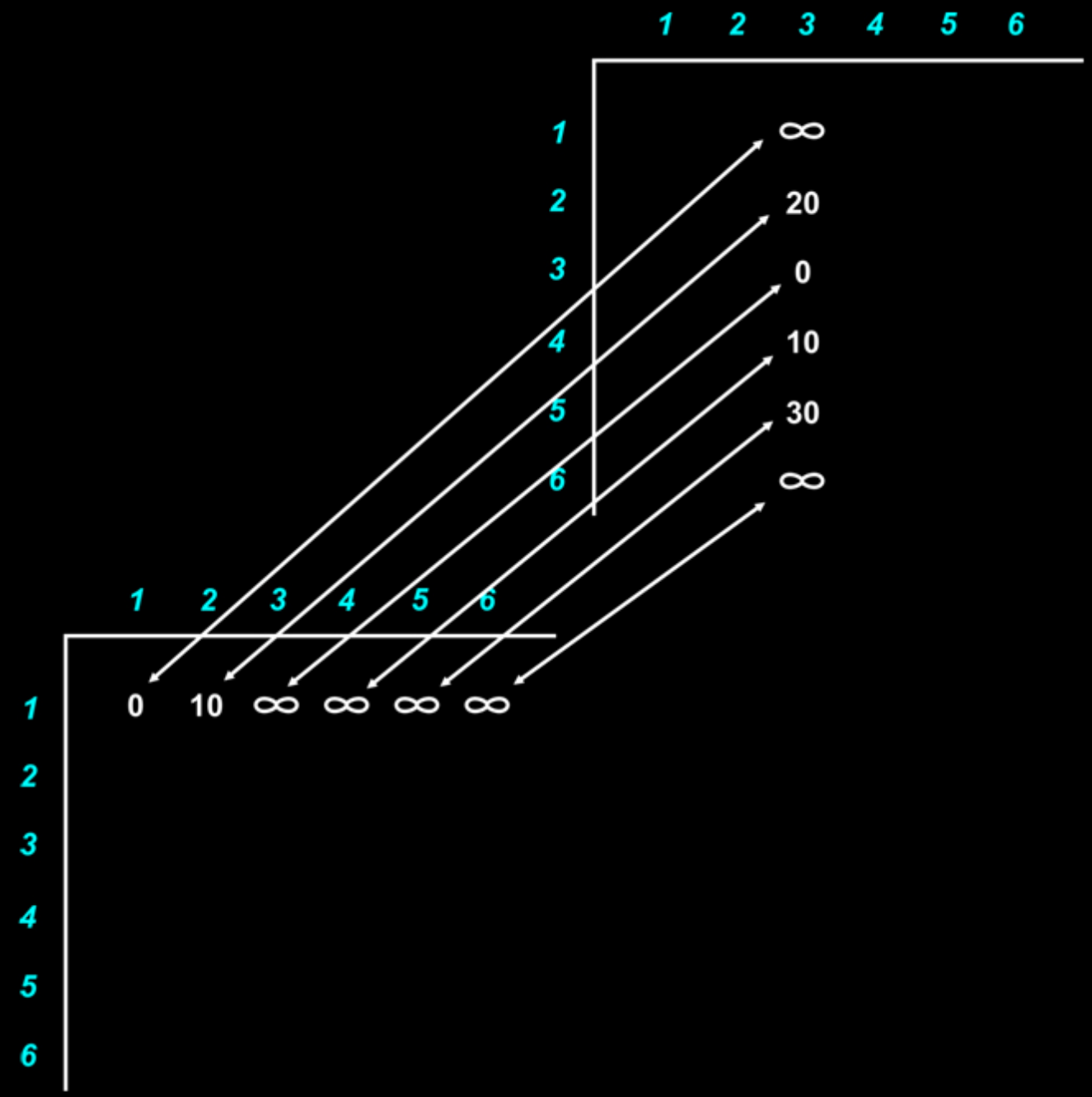
- **Also referred to as *L-matrix*.**

- **Addresses all five of the network measurement problems, including unequal linkages.**

- **This is done by using real-world distances and shortest routes.**


1
10
2
20
6
5
30
10
3
5
4

	1	2	3	4	5	6
1	0	10	∞	∞	∞	∞
2	10	0	20	∞	∞	∞
3	∞	20	0	10	30	∞
4	∞	∞	10	0	∞	∞
5	∞	∞	30	∞	0	5
6	∞	∞	∞	∞	5	0


1 2 3 4 5 6
1
2
3
4
5
6
∞
20
0
10
30
∞
1 2 3 4 5 6
1
2
3
4
5
6
0
10
∞
∞
∞
∞

With a few simple modifications we can use the same procedure as in the connectivity matrix to give us valued results.

- Code direct connections with the actual route distance.

- Code cells with no direct connections as ∞

  … leave them blank.

- Use matrix addition rather than multiplication.

$(n_1 \rightarrow n_1) + (n_1 \rightarrow n_3) = 0 + \infty = \infty$

$(n_1 \rightarrow n_2) + (n_2 \rightarrow n_3) = 10 + 20 = 30$

$(n_1 \rightarrow n_3) + (n_3 \rightarrow n_3) = \infty + 0 = \infty$

$(n_1 \rightarrow n_4) + (n_4 \rightarrow n_3) = \infty + 10 = \infty$

$(n_1 \rightarrow n_5) + (n_5 \rightarrow n_3) = \infty + 30 = \infty$

$(n_1 \rightarrow n_6) + (n_6 \rightarrow n_3) = \infty + \infty = \infty$

The ∞ results above mean that there is no connection, or that it would take an infinite amount of time.

L1

	1	2	3	4	5	6
1	0	10	∞	∞	∞	∞
2	10	0	20	∞	∞	∞
3	∞	20	0	10	30	∞
4	∞	∞	10	0	∞	∞
5	∞	∞	30	∞	0	5
6	∞	∞	∞	∞	5	0

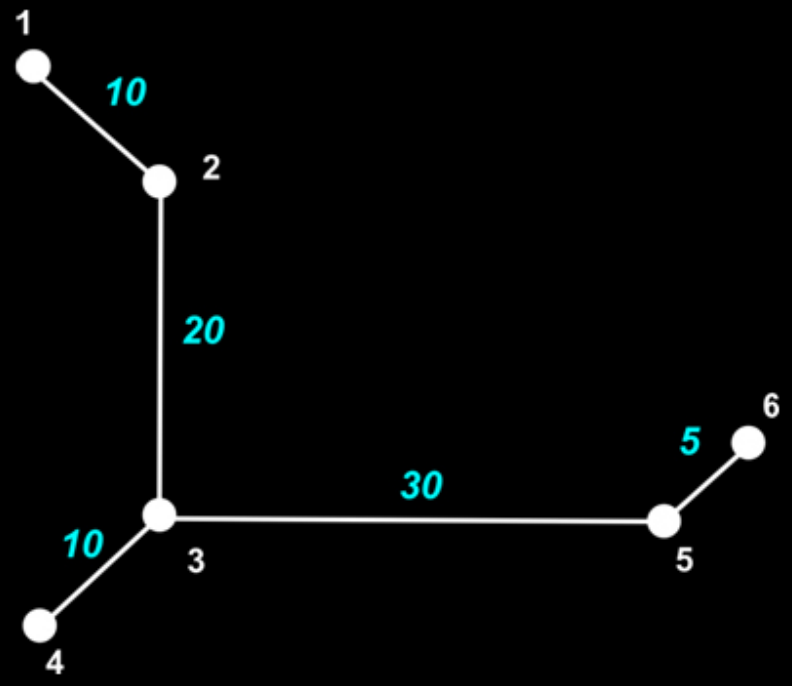
L2

	1	2	3	4	5	6
1	0	10	30	40	60	∞
2	10	0	20	30	50	55
3	30	20	0	10	30	35
4	40	30	10	0	40	45
5	60	50	30	40	0	5
6	∞	55	35	45	5	0

L-Total

	1	2	3	4	5	6	
1	0	10	30	40	60	65	= 205
2	10	0	20	30	50	55	= 165
3	30	20	0	10	30	35	= 125
4	40	30	10	0	40	45	= 165
5	60	50	30	40	0	5	= 185
6	65	55	35	45	5	0	= 205

Power the matrix to its diameter and sum the rows.



L-Total

	1	2	3	4	5	6	
1	0	10	30	40	60	65	= 205
2	10	0	20	30	50	55	= 165
3	30	20	0	10	30	35	= 125
4	40	30	10	0	40	45	= 165
5	60	50	30	40	0	5	= 185
6	65	55	35	45	5	0	= 205

Route Impact Analysis Using Valued Graphs

- Determine the valued results for each node before adding a new road.
- Add a new road to a network.
- Determine the valued results for each node after adding a new road.
- Compare the results.
- Make modifications.

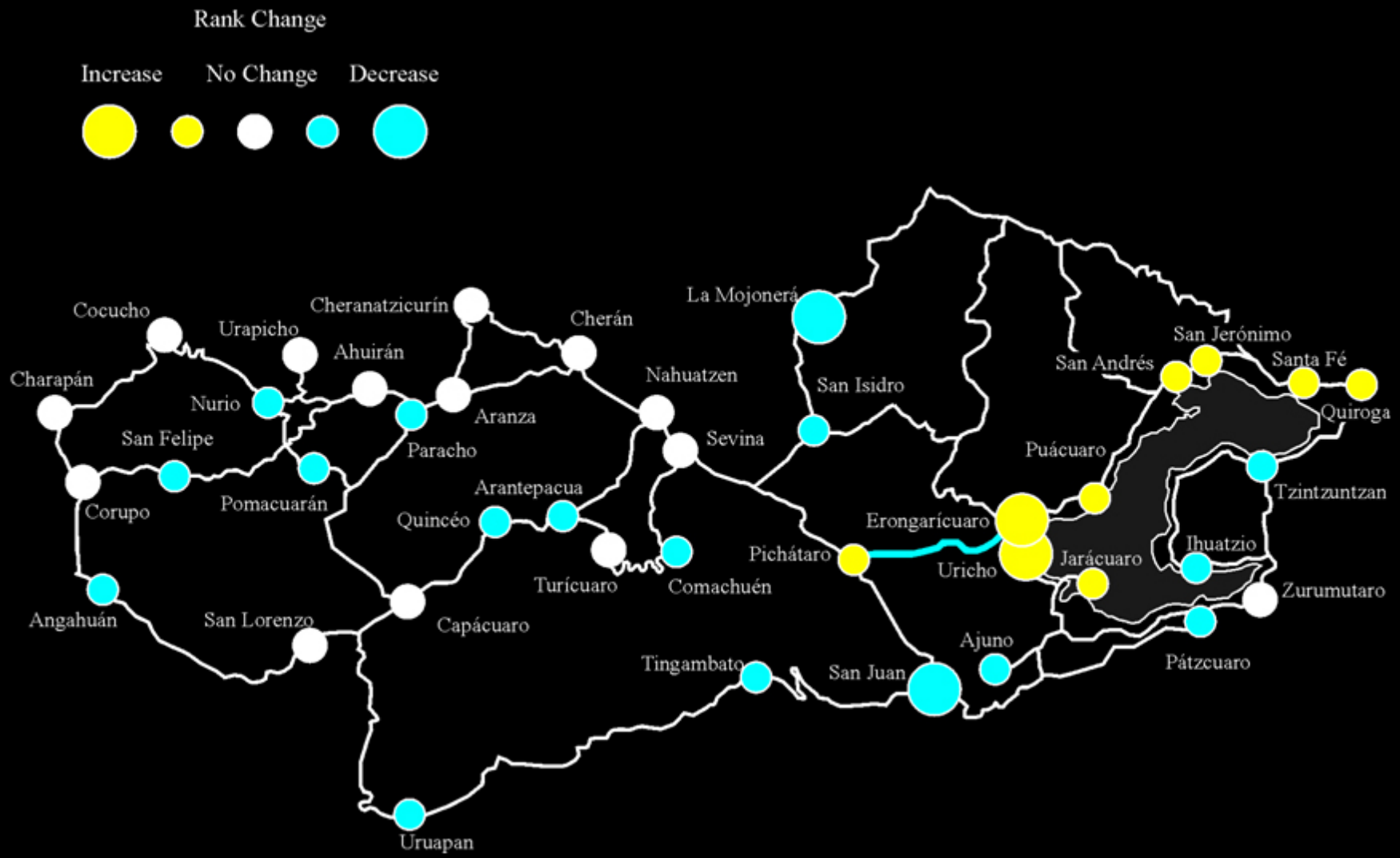
Meseta Road System: 2004

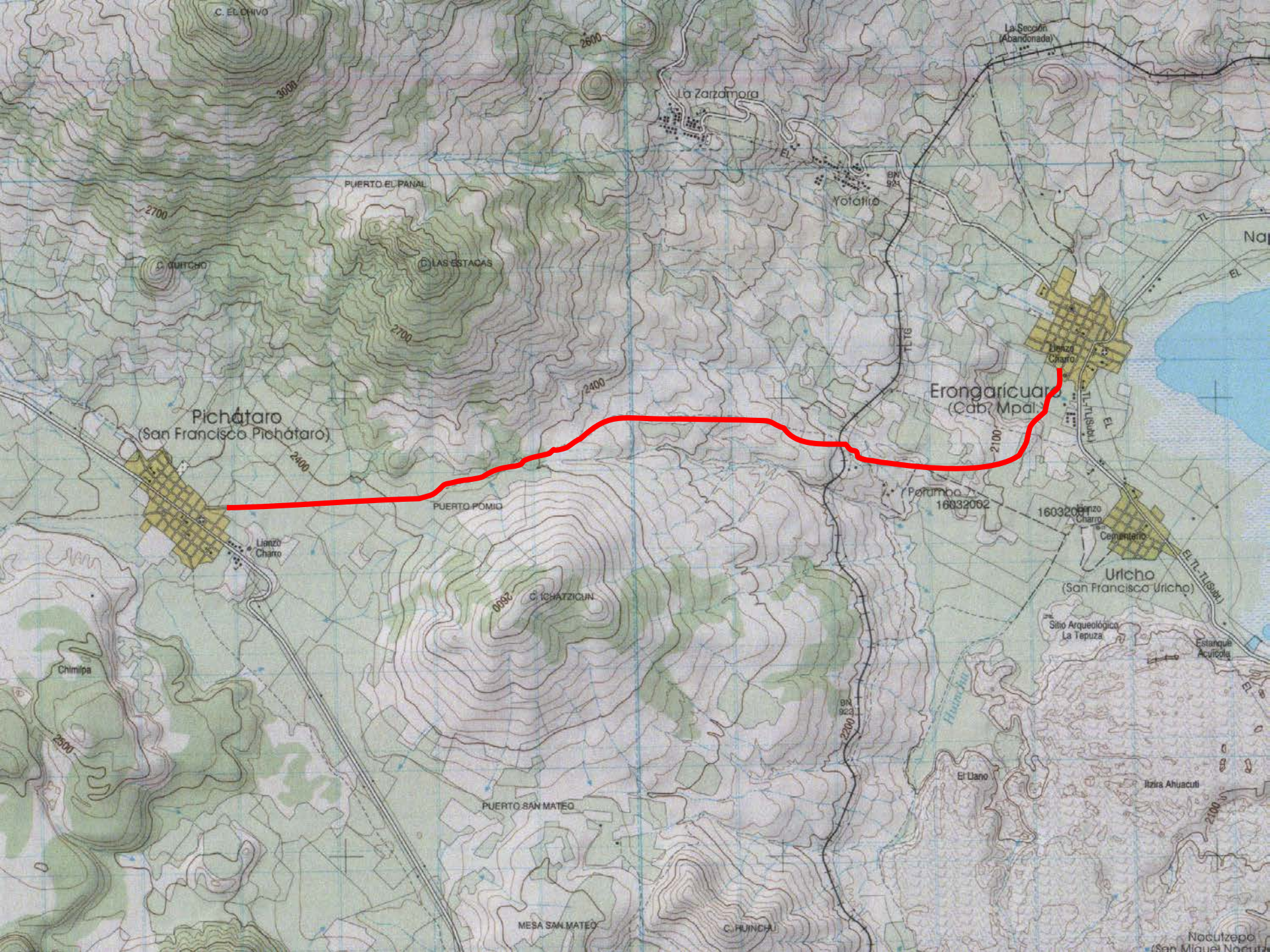
Proposed New Road

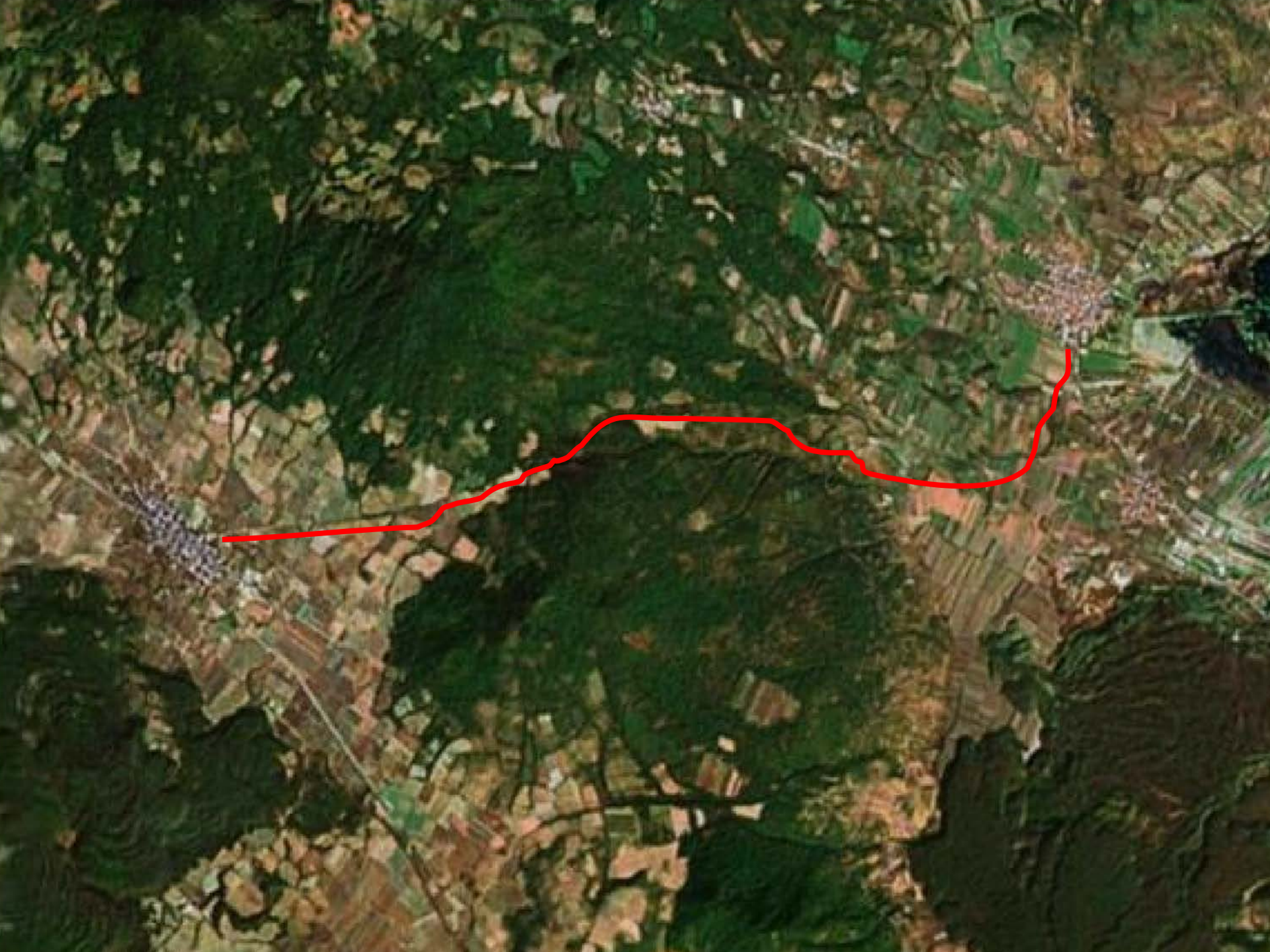
Rank Change After Adding New Road

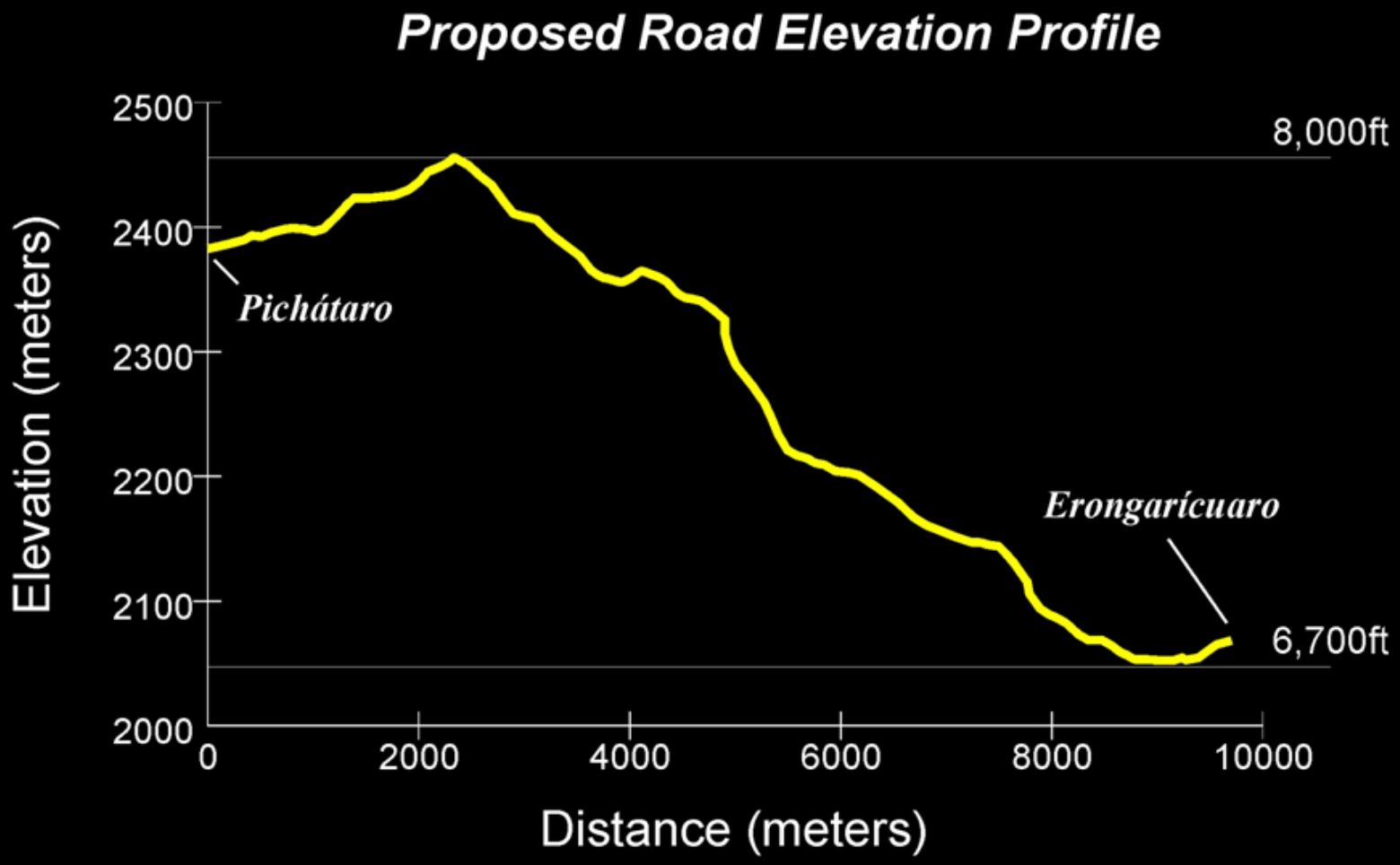
Town	Before	Rank	After	Rank	Change
Sevina	1883.4	1	1802.1	1	0
Nahuatzen	1898.2	2	1816.9	2	0
Pichataro	2103.4	5	1917.7	3	2
Cheran	2017.8	4	1936.4	4	0
San Isidro	1986.1	3	1986.1	5	-2
Aranza	2158.4	6	2077.0	6	0
Erongaricuaro	2326.4	15	2101.4	7	8
Arantepacua	2203.9	7	2122.5	8	-1
Paracho	2208.2	8	2126.8	9	-1
Comachuen	2209.0	9	2127.6	10	-1
Uricho	2388.0	18	2167.9	11	7

Note: not all nodes shown.


Rank Change
Increase
No Change
Decrease
Cocucho
Urapicho
Cheranatzicurín
Cherán
La Mojonera
San Jerónimo
Santa Fé
Ahuirán
San Andrés
Charapán
Nahuatzen
San Isidro
Quiroga
Nurio
Aranza
San Felipe
Paracho
Sevina
Puácuaro
Tzintzuntzan
Arantepacua
Pomacuarán
Corupo
Quincéo
Erongarícuaro
Ihuatzio
Pichátaro
Jarácuaro
Uricho
Turícuaro
Comachuén
Zurumutaro
Angahuán
San Lorenzo
Capácuaro
Ajuno
Tingambato
San Juan
Pátzcuaro
Uruapan


C. EL CHIVO
3000
2600
La Zarzamora
La Sección
(Abandonada)
PUERTO EL PANAL
2700
Yotatiro
C. QUITCHO
C. LAS ESTACAS
2700
2400
Pichátaro
(San Francisco Pichátaro)
2400
PUERTO POMIO
Lienzo
Charro
Erongarícuaro
(Cab. Mpal.)
2100
Pórumbo
16032092
Lienzo
Charro
Cementerio
Uricho
(San Francisco Uricho)
C. ICHATZICUN
2600
Sitio Arqueológico
La Tepuza
Estanque
Acuícola
Chimilpa
2500
2200
El Llano
Ilzira Ahuacuti
2400
PUERTO SAN MATEO
MESA SAN MATEO
C. HUINCHU
Nocutzepo




Proposed Road Elevation Profile
2500
2400
2300
2200
2100
2000
Elevation (meters)
8,000ft
6,700ft
Pichátaro
Erongarícuaro
0
2000
4000
6000
8000
10000
Distance (meters)

An elevation change of 4265 feet over 6.15 miles equates to grade of 693 ft/mi.

That is a very steep grade.

One measurement that is *not* accounted for in these analyses is topography (elevation change with distance or grade).

It is unlikely that a road with this grade would be used very often.

Questions:

Are the impacts to the towns on the north shore of the lake realistic?

Will these towns really become more accessible with the addition of this road?