Prim's Algorythm Application in Connecting Rice Fields

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Abstract*—This paper will discuss about the possible way to link the rice field in some area. Area sample is located in South Bandung, Indonesia. Prim's Algorythm is choosen to find the shortest way from all of the rice field that captured from the selected map** **based on the weight or the distance of any rice field in the area.** ***The linked rice field will connected to the shortest path with the others through the lines. This paper will give an analysis problem that occured and also will give the sollution to one of the agriculture's problem in Indonesia.

***Index Terms*— Prim Algoryhtm, Rice filed, Graph, map.**

I. Introduction

Indonesia is known as a country that rich in rice production in each province. But now, the country itself is still not able to meet the needs of rice for all populations. There are many rice fields that have been drought. This is because Indonesia is unable to anticipate the arrival of the dry season so that they will have water shortages in every six months a year. Even if they keep the amount of water in the dry season, it's still not enough. According to data in Central Bureau of Statistics in 2008, the potential of land in west Java area is 1.522.109 hectares of the overall total of 15.429.317 or about 9.86% of the total from all lands in Indonesia. So it's a big trouble if there's no sollution in a quick time.

Another problem that arises is the uneven distribution of water in each region. There are rice fields with excess water and any areas of deficiency.
With a variety of specification ground, Bandung is the altitude where the land is not uniform, causing uneven distribution of water.

If in every region in Indonesia, a similar thing happened, this will have an impact big enough on agricultural production in Indonesia.

With such problems, we can provide a solution by connecting each area of rice fields. Rice fields that are connected can be used for equitable distribution of water to a shortage of rice fields.

For its own water distribution, has developed a prototype that is GravEkoR WLCS-RI [3]. This prototype was developed with the aim to supply water to the rice field land that will be realized in the project AgroInformatic Engineering System.

Fig. 1. AgroInformatic Engineering System [3]

Therefore, there is no problem in implementing its own technology. This paper is made to help provide solutions to the government so that problems can be overcome water crisis.

II. Basic Theory

A. Graph

A graph G = (V, E) consists of V, a nonempty set of vertices (or nodes) and E, a set of edges. Each edge has either one or two vertices associated with it, called its endpoints. An edge is said to connect its endpoints.

Now suppose that a network is made up of data centers and communication links between computers. We can represent the location of each data center by a point and each communications link by a line segment, as shown in Fig. 2.

This computer network can be modeled using a graph in which the vertices of the graph represent the data centers and the edges represent communication links.1n general, we visualize graphs by using points to represent vertices and line segments, possibly curved, to represent edges, where the endpoints of a line segment representing an edge are the points representing the

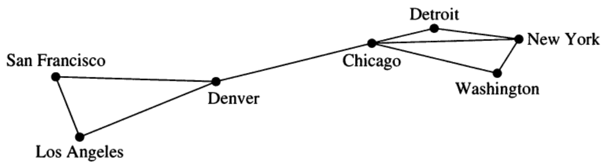


Fig. 2. A Computer Network [2]

endpoints of the edge. When we draw a graph, we generally try to draw edges so that they do not cross. However, this is not necessary because any depiction using points to represent vertices and any form of connection between vertices can be used. Indeed, there are some graphs that cannot be drawn in the plane without edges crossing. The key point is that the way we draw a graph is arbitrary, as long as the correct connections between vertices are depicted.

Note that each edge of the graph representing this computer network connects two different vertices. That is, no edge connects a vertex to itself. Furthermore, no two different edges connect the same pair of vertices. A graph in which each edge connects two different vertices and where no two edges connect the same pair of vertices is called a simple graph. Note that in a simple graph, each edge is associated to an unordered pair of vertices, and no other edge is associated to this same edge. Consequently, when there is an edge of a simple graph associated to {u, v}, we can also say, without possible confusion, that {u, v} is an edge of the graph.

Graphs that have a number assigned to each edge are called weighted graphs. Weighted graphs are used to model computer networks. Communications costs (such as the monthly cost

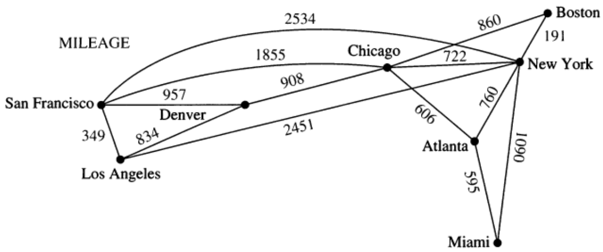


Fig. 3. Weighted Graph [2]

of leasing a telephone line), the response times of the computers over these lines, or the distance between computers, can all be studied using weighted graphs. Fig. 3. displays weighted graphs that represent three ways to assign weights to the edges of a graph of a computer network, corresponding to distance, response time, and cost. [2]

B. Tree

A tree is a connected undirected graph with no simple circuits. Because a tree cannot have a simple circuit, a tree cannot contain multiple edges or loops. Therefore any tree must be a simple graph.

Gland G 2 are trees, because both are connected graphs with no simple circuits. G 3 is not a tree because e, b, a, d, e is a simple circuit in this graph. Finally, G 4 is not a tree because it is not connected.

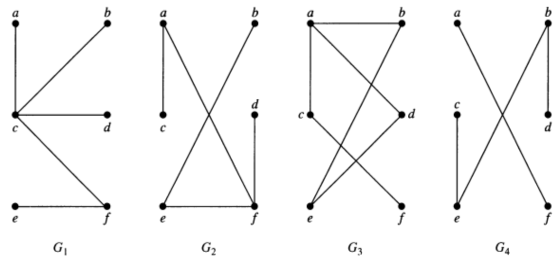


Fig. 4. Example of Trees and Graphs That Are Not Trees [2]

Any connected graph that contains no simple circuits is a tree. Graphs containing no simple circuits that are not necessarily connected called forests and have the property that each of their connected components is a tree. Fig. 4. displays a forest.

Trees are often defined as undirected graphs with the property that there is a unique simple path between every pair of vertices. Theorem 1 shows that this alternative definition is equivalent to our definition.

C. Spanning Tree

Let G be a simple graph. A spanning tree of G is a subgraph of G that is a tree containing every vertex of G.

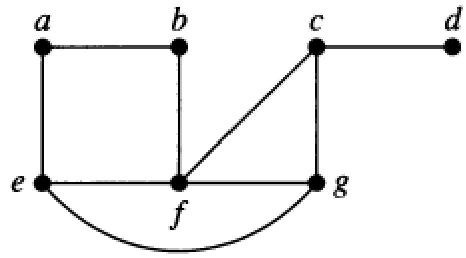


Fig. 5.The Simple Graph G [2]

A simple graph with a spanning tree must be connected, because there is a path in the spanning tree between any two vertices. The converse is also true; that is, every connected simple graph has a spanning tree. We will give an example before proving this result. [2]

D. Prim's Algorythm

Prim's algorithm is the algorithm used to find the minimum spanning tree. Minimum spanning tree is a graph which contains no circuit and contain the most minimum weight.

Suppose that T is a spanning tree of the edges taken from the graph G. Prim's algorithm to form the minimum spanning tree step by step. At each step we take the side e of graph G which has the minimum weight and side by side with nodes in T but e does not form a circuit in the T.

Here are the steps Prim's algorithm:

1. Take the side of a weighted graph G is the minimum, enter into the T
2. Select the sides that have a minimum weight e and side by side with the node in T, but e do not form circuits in the Q. Enter the e to T
3. Repeat steps 2 n-2 times (n is the number of vertices).

Example use Prim's algorithm:

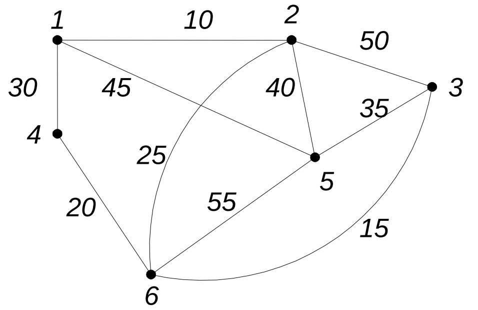


Fig. 6. Graph G [1]

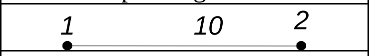
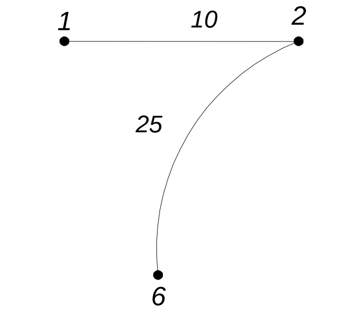
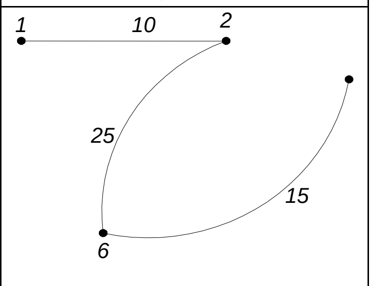
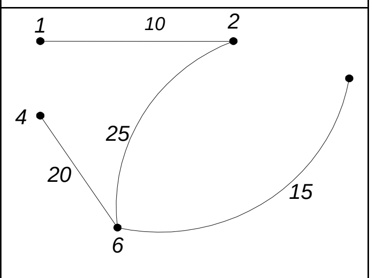
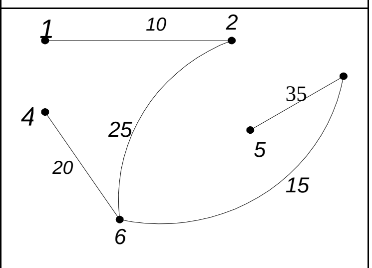
Step	Side	Weight	Spanning Tree
1	(1,2)	10	
2	(2,6)	25	
3	(3,6)	15	
4	(4,6)	20	
5	(3,5)	35	

Table 1. Prim Algorythm [1]

Weight = 10 + 25 + 15 + 20 + 35 = 105

III. APPLICATION

To use the shortest way with Prim's algorythm in our project, the steps are:

1. Take the map that we need. Look at Fig. 7, we'll se the map that was captured with scale 1:226.090 cm. The blue colour is South Bandung City with it's potential land of rice field. Every name that puts is the name of every rice field in that area.
2. Transform the map into the weighted graph, the rice field as a knot and the path as a side. Lok at Fig. 8, every land is connected by a line and it's weight.
3. Do the Prim's algorythm step until it showed all of the link. Look at Fig. 9, the lines are deleted and leaves the shortest line. Sign (x) with x is number of step from Prim's Algorythm beginning from 1. Then the complete result can be seen in Fig. 10.
4.

tep	Distance (cm)	Step	Distance (cm)
1	13045	31	203481
2	406962	32	226090
3	203481	33	226090
4	180872	34	113045
5	226090	35	361744
6	226090	36	135654
7	226090	37	226090
8	339135	38	113045
9	135654	39	135654
10	203481	40	113045
11	271308	41	158263
12	135654	42	180872
13	180872	43	158263
14	361744	44	135654
15	113045	45	248669
16	293917	46	135654
17	113045	47	226090
18	271308	48	226090
19	339135	49	135654
20	135654	50	339135
21	429571	51	339135
22	678270	52	180872
23	226090	53	226090
24	226090	54	339135
25	158263	55	384353
26	226090	56	113045
27	248699	57	113045
28	90436	58	429571
29	226090	59	452180
30	226090		

Table 2. Distance of every step

In South of Bandung, there are many rice field spread in this area. some places have access to other areas while others do not. places that do not have access to such areas may only have a river so it does not have a problem with drought. However, for those who do not have the water source, may be over in a way that has been mentioned in the beginning so that it takes a fairly efficient water lines at least to connect the whole place.

With this method, all of the rice field will be connected by efficient way. According to the table 2, the total length of graph is 26.551.718 cm almost 27 km. The total length after we use Prim's algorythm is 13.587.997 cm almost 14 km. The percentage of the efficiency is 51,17%. Prim's algorythm will give benefit of efficiency almost it's half. This advantage can be more benefit if we talk about cost. The cost to build a street will decrease until it's half with this algorythm.

From that sample we can see that the area are connected to the shortest way. It is possible to build a water connection between the rice field with an efficient cost. Pathway that connects is an efficient way according to Prim's algorithm. The algorithm provides a solution for each node connected through the shortest side. The finishing step is using the technology of AgroInformatic System Engineering.

The problem of this solution is, if there is no path between regions or in other words, these areas have no access to other areas so as not to form a graph because it was prevented by a mountain or cliff. However, this graph theorem can still be done because at least there is a path through each area, although having to go through a long route.

That sample just showed in South of Bandung. There are still many rice field land in every city or province around of Indonesia that hadn't touched already for the water shortage sollution even in foreign countries as in other developing countries.

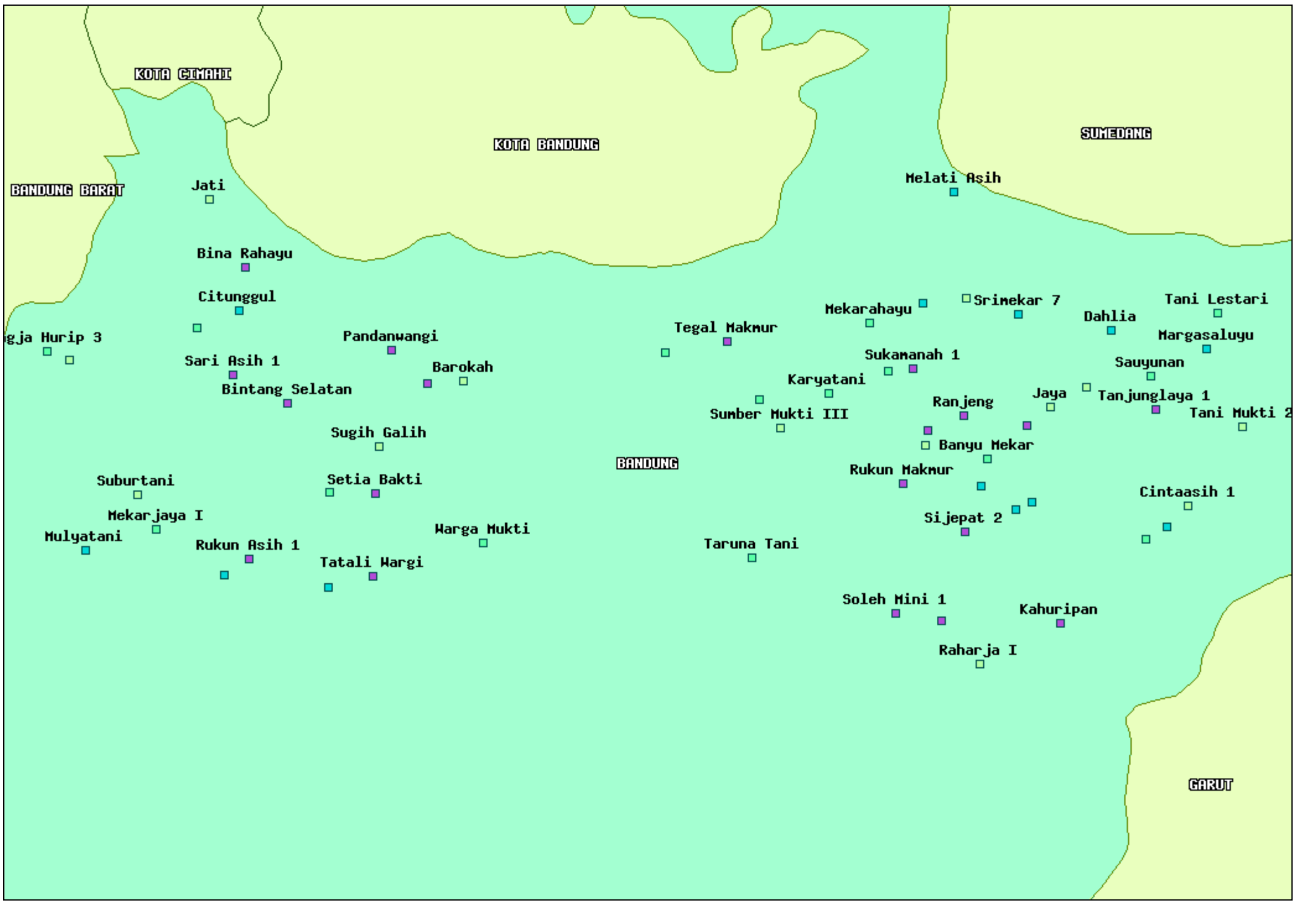


Fig. 6. Map of rice field in South Bandung (blue colour) [6]

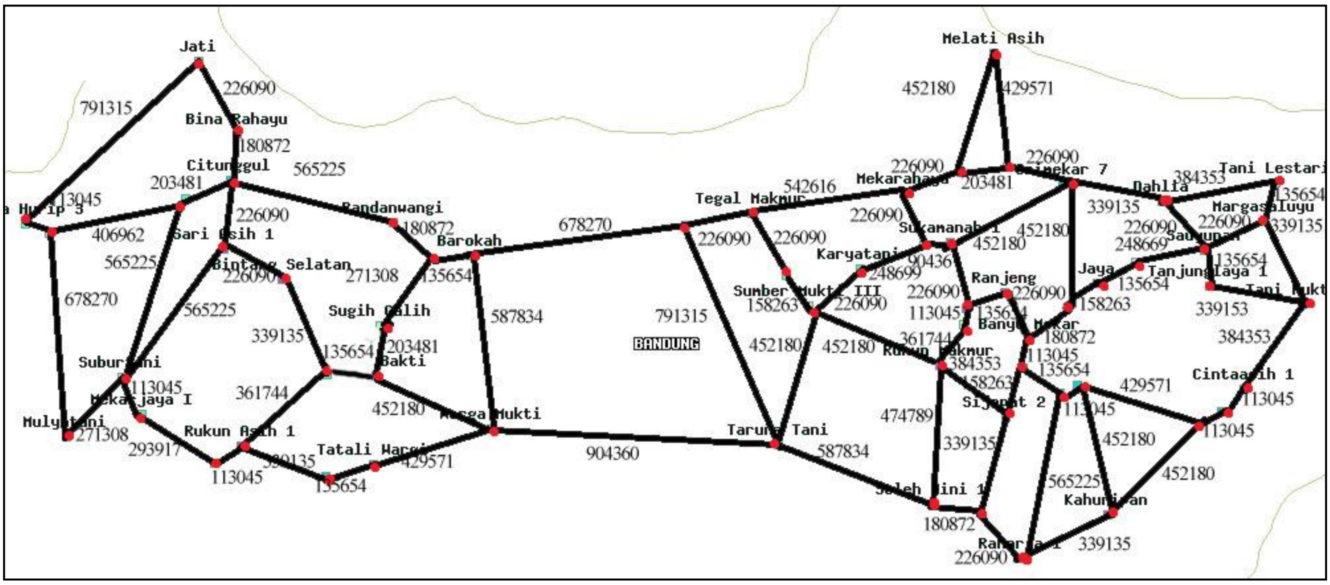


Fig. 8. Graph of map with it's possible way and it's distance with others

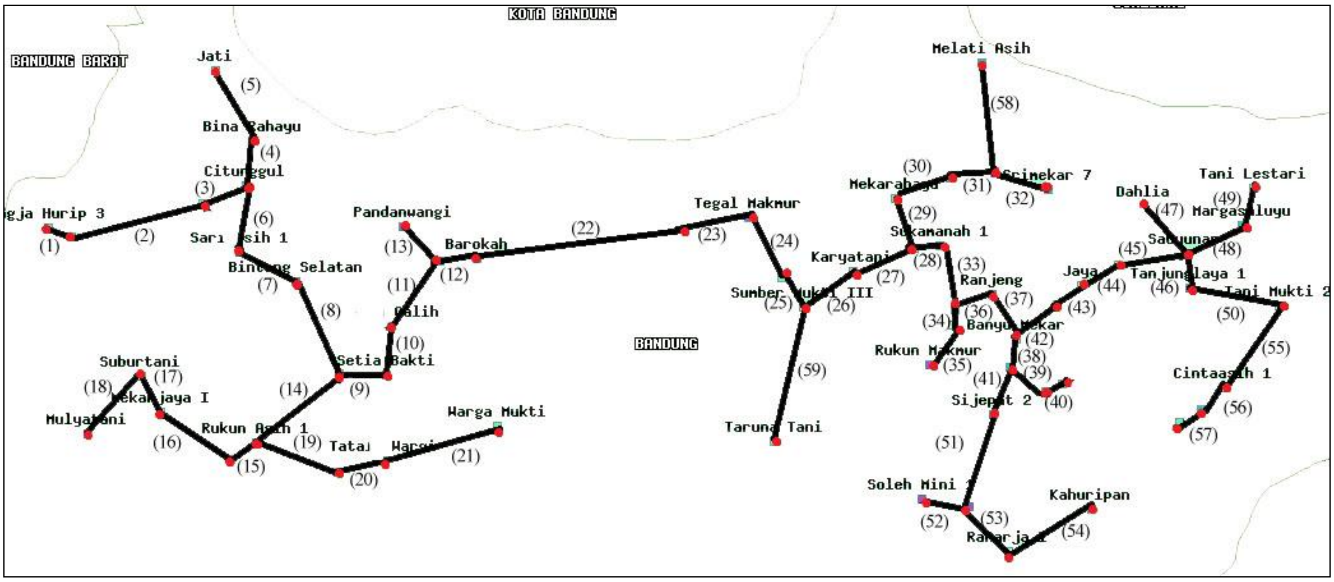


Fig. 9. Prim's Algorythm steps, (x) with x is the number of step

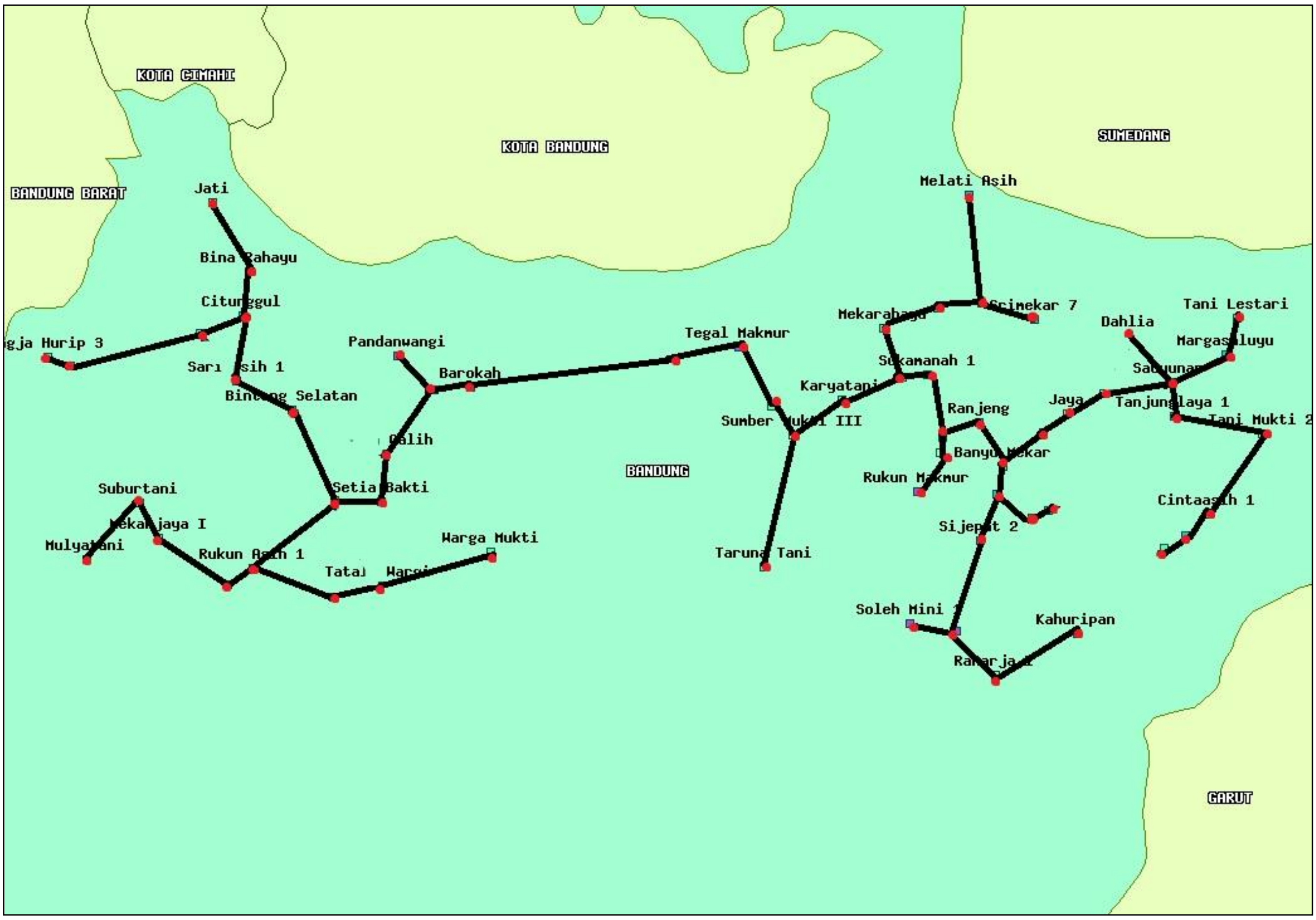


Fig. 10. Result of Prim's Algorythm

IV. Conclusion

So with the Prim's Algorythm, we can link the rice field area from the map that captured from internet efficiently. With this step, the next is manage the water spread in the area to overcome the catastrophic water shotage.

Discrete Mathematics enormous contribution in world of science and technology. For example in agriculture. Many major problem in Indonesia, which started from agriculture and can be handled this subject such as graph theory, algorithm, Prim, and others. This could be the beginning for the development of Indonesia into a better direction, especially in agriculture.

V. Acknowledgment

First of all, thanks to ALLAH SWT for his mercy and guidance in giving me full confidence to finish this "Struktur Diskrit" task. Then, I would like thanks to my parents, for supporting me in my whole studies. In addition, grateful acknowledgement to all of my friends who always helped me when I met the difficult.

References

[1] Munir, Rinaldi, "Matematika Diskrit", Bandung: Informatika, 2005. pp. 450-453

[2] Rosen, Kenneth H., "Discrete Mathematics and Its Applications", 6th Ed. New York: The McGraw-Hill Companies, 2007.

[3] "*GravEkoR WLCS-RI*", URL : http://gravekorwlcs.wordpress.com/data-riset/, access date: 13th December 2010, 23:00.

[4] "Keperluan Air Bagi Tanaman Varietas Unggul", URL : http://iqra5.blogspot.com/2010/07/keperluan-air-bagi-tanaman-padi.html, access date: 13th December 2010, 23:10

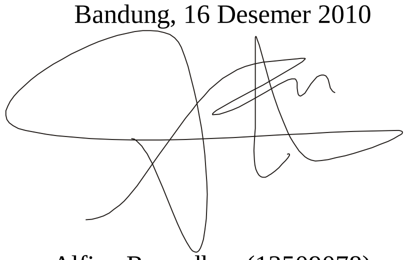
[5] "Krisis Air Bandung Dan Penanganannya", URL: http://wargahijau.org/index.php?option=com_content&view=article&id=324:krisis-air-bandung-dan-penanganannya&catid=27:green-reporter&Itemid=31, access date; 13th December 2010,23:15

[6] Map of South Bandung, URL: http://www.diperta.jabarprov.go.id/index.php/sideMenu/peta, access date: 13th December 2010, 23:10

PERNYATAAN

Dengan ini saya menyatakan bahwa makalah yang saya tulis ini adalah tulisan saya sendiri, bukan saduran, atau terjemahan dari makalah orang lain, dan bukan plagiasi.

Bandung, 16 Desemer 2010



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